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NOVA SCOTIA
Transportation and Public Works

Final Draft Report

Highway 104 at Antigonish

April 2005 NSD16949

Jacques Whitford

C1442-001

PROJECT NO.NSD16949

FINAL DRAFT REPORT TO

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS

ON

ENVIRONMENTAL ASSESSMENT HIGHWAY 104 ANTIGONISH

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in association with

Atlantic Road & Traffic Management,
&
Hydro-Com Technologies Ltd.,

April 2005

EXECUTIVE SUMMARY

Nova Scotia Department of Transportation and Public Works (NSTPW) proposes to construct and operate a 15 kilometre fully controlled access, four-lane divided highway from Addington Forks Road, west of the Town of Antigonish, to Taylor Road, east of the community of South River, Nova Scotia (the Project). Highway 104 is part of the National Highway System and is therefore eligible to be cost shared by the Federal and Provincial governments. Eligibility for federal funding is dependent upon approval of the proposed Project under the *Canadian Environmental Assessment Act*. As the Project is over 10 km in length, it also requires approval as a Class II Undertaking pursuant to the *Environmental Assessment Regulations* under the Nova Scotia *Environment Act*.

NSTPW has conducted a preliminary environmental screening, public consultation and a functional analysis of the proposed alignment as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the South River crossing. These studies resulted in the selection of alignment options.

The assessment of the selected alignment considers biophysical and socioeconomic issues, focussing on issues of greatest concern known as Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) identified through a scoping process including consideration of the NSTPW Terms of Reference. Each of the following eight VECs and four VSCs selected for this assessment were evaluated for potential Project related effects:

VECs
- Atmospheric Resources
- Groundwater Resources
- Fish and Fish Habitat
- Rare Herpetiles
- Rare Mammals and Critical Habitat
- Rare and Sensitive Birds
- Rare Plants and Plant Communities
- Wetlands

VSCs
- Local Economy
- Land Use
- Archaeological and Heritage Resources
- Transportation Infrastructure

Mitigation and monitoring have been proposed to reduce or eliminate potentially adverse effects. The significance of residual environmental effects (*i.e.*, after mitigation has been applied) including cumulative effects was predicted for each VEC/VSC. In general, potential adverse effects on these VECs/VSCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods recommended in this report. Potentially adverse residual effects are therefore predicted to be not significant for all VECs and VSCs.

Operation of the Project will provide safe, convenient, economic and efficient movement of persons and goods through the area, thereby having a positive effect on transportation infrastructure. Decreased traffic along the most existing uncontrolled access Highway 104 will contribute to a quieter, safer living environment for most residents.

In summary, this Project will provide a long term public benefit by reducing current traffic volumes on the existing uncontrolled access portion of Highway 104. It will also provide infrastructure to handle future traffic volumes and patterns, thereby improving public safety, without significant adverse environmental effects.

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LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ACCDC	Atlantic Canada Conservation Data Centre
AEC	Atlantic Expressway Committee
ARDA	Antigonish Regional Development Authority
CEA Agency	Canadian Environmental Assessment Agency
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act*
CLC	Community Liaison Committee
CMA	Calcium Magnesium Acetate
CO	Carbon Monoxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Department of Fisheries and Oceans Canada
EA	Environmental Assessment
ECM	Environmental Compliance Monitoring
EEM	Environmental Effects Monitoring
EPP	Environmental Protection Plan
FCR	*Federal Coordination Regulations*
FHWA	Federal Highway Administration
FWAL	Freshwater Aquatic Life (Guidelines)
HADD	Harmful Alteration, Disruption or Destruction
HMVK	Hundred Million Vehicle Kilometres
H_2S	Hydrogen Sulphide
IT	Information Technology
JW	Jacques Whitford
JWEL	Jacques Whitford Environment Limited (pre 2004)
NEB	National Energy Board
NO_x	Nitrous Oxides
NO_2	Nitrogen Dioxide
NSDAF	Nova Scotia Department of Agriculture and Fisheries
NSDEL	Nova Scotia Department of Environment and Labour
NSDNR	Nova Scotia Department of Natural Resources
NSDOE	Nova Scotia Department of Environment
NSDOTC	Nova Scotia Department of Transportation and Communications
NSPI	Nova Scotia Power Inc.
NSTPW	Nova Scotia Department of Transportation and Public Works
O_3	Ozone
PDO	Property Damage Only

POLs	Petroleum, Oils, or Lubricants
RA	Responsible Authority
Rcap-MS	Rapid Chemical Analysis Package-Metals Scan
RoW	Right of Way
RWIS	Road Weather Information System
SARA	*Species at Risk Act*
SO_2	Sulphur Dioxide
SSHR	South Side Harbour Road
St. FX	Saint Francis Xavier (University)
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
VECs	Valued Environmental Components
vpd	Vehicles Per Day
VSCs	Valued Socioeconomic Components

1.0 INTRODUCTION

Nova Scotia Department of Transportation and Public Works (NSTPW) proposes to construct and operate a 15 kilometre (km) fully controlled access, four-lane divided highway from Antigonish to South River, Nova Scotia (the Project). This Project is subject to federal and provincial regulatory approval under the *Canadian Environmental Assessment Act* (CEAA) and Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. This document has been prepared to meet the Terms of Reference issued by the Nova Scotia Department of Environment and Labour (NSDEL) (NSDEL 2002a) for a harmonised federal/provincial environmental assessment.

1.1 Study Background and Objectives

The primary function of a 100 series highway network in Nova Scotia is the safe and efficient movement of large volumes of people and goods over long distances at high speeds while minimizing negative economic, social and environmental impacts (NSTPW 2001a). The Project is located near the Town of Antigonish and the community of Lower South River where the alignment parallels the existing Highway 104 for approximately 15 km from Addington Forks Road to Taylor Road. Traffic along this portion of Highway 104 has increased considerably since construction of the highway. The existing highway has high traffic volumes, including a high percentage of heavy truck traffic. It also has significant strip development and pedestrian activity. Traffic is a mixture of through and local traffic. Access is uncontrolled for most of this segment of the highway and the geometry is described as poor. These conditions are incompatible with a well functioning 100 series highway and have resulted in poor levels of service and safety performance.

Average daily traffic volumes on Highway 104 range from 10,000 to 15,000 vehicles per day (vpd) in the study area. The average number of accidents on this section of highway is 84.1 per hundred million vehicle km (HMVK) for the five year period from 1996 to 2000. This is above the Provincial average (61.0 per HMVK) for the same time period, as reported in the most recent publication of *Motor Vehicle Collision Rates for Numbered Highways and Sections 1996 to 2000,* for 100 series highways without access control (NSTPW 2002a). Completion of this portion of the National Highway System to 100 Series standards will increase safety and comfort for motorists and local residents using both the new and existing highways.

The highway design includes a fully controlled access, four lane, divided 27.6 m wide median facility with a design speed of 120 km/hr and a 35 m proposed centreline spacing. The proposed width of the right of way (RoW) is 150 m. The proposed alignment (refer to Figure 1.1) is intended to divert through traffic from the uncontrolled, heavily developed sections of the existing Highway 104 near Antigonish. The presence of ribbon development along the current highway is such that additional land was not available for highway expansion without directly impacting or significantly disrupting a large percentage of this development. Land acquisition would be costly and lost revenue compensation significant. Since upgrading of the existing alignment was not considered to be a feasible alternative, NSTPW initiated a route selection study in 1996 to identify lands suitable for preservation for a new four-lane 100 series highway.

In order to preserve a corridor and construct a four-lane highway, completion of the federal/provincial environmental assessment, detailed field survey and geometric design, and acquisition of the lands required for the RoW are first necessary. This process is estimated to take four to five years to complete. Subsequently, commencement of construction will be based upon prioritization of the project and the availability of funding.

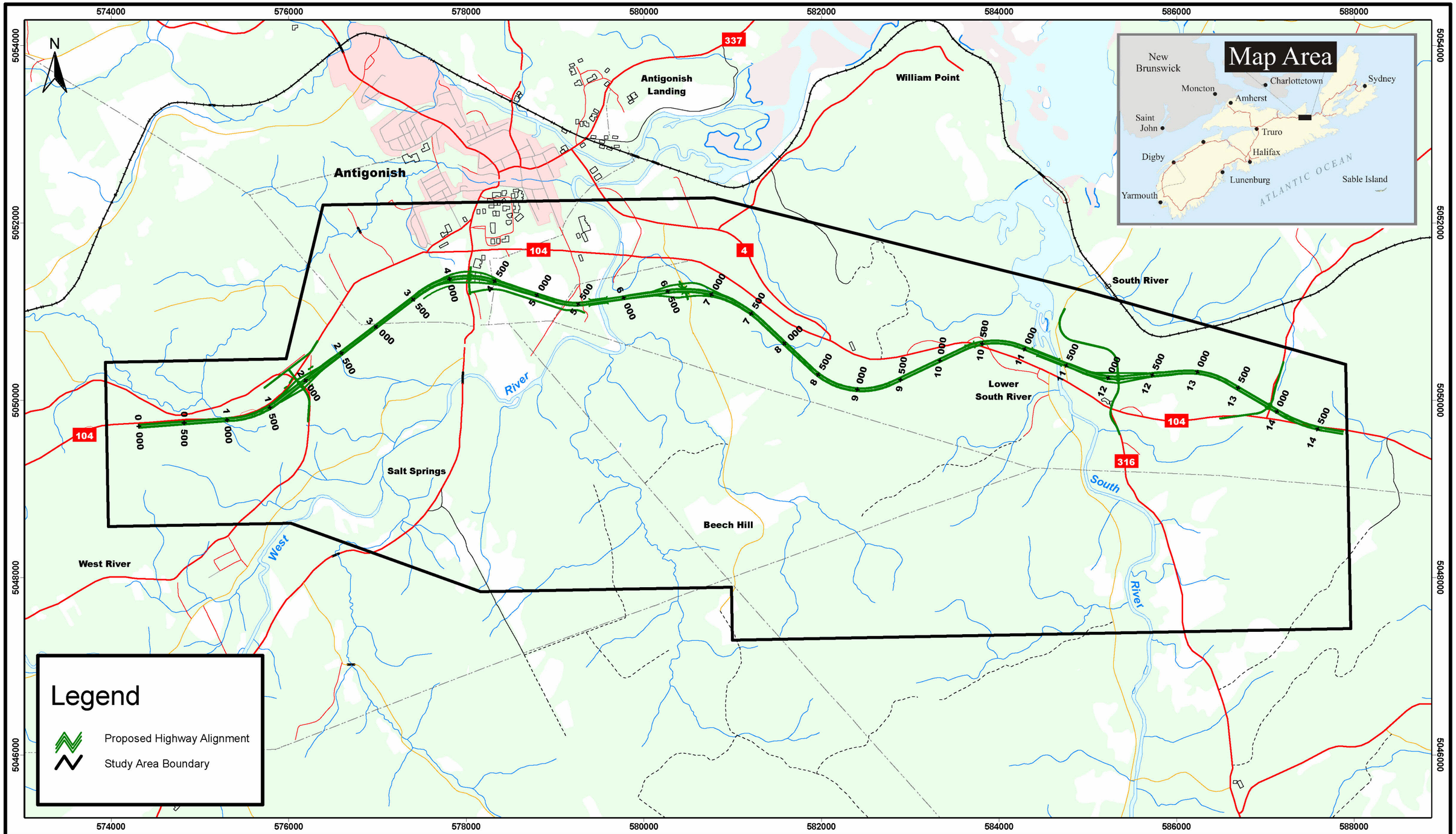
Highway 104 is part of the National Highway System and is therefore eligible to be cost shared by the Federal and Provincial governments. Eligibility for federal funding is dependent upon approval of the proposed Project under the *CEAA*. As the Project is over 10 km in length, it also requires approval as a Class II undertaking under the *Environmental Assessment Regulations* pursuant to the Nova Scotia *Environment Act*.

NSTPW has conducted a preliminary environmental screening, public consultation and a functional analysis of the proposed alignment as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the proposed South River crossing.

The purpose of this report is to create an Environmental Assessment Report which meets both the requirements for a Class II Undertaking under the Nova Scotia *Environment Act* and an Environmental Screening under *CEAA*.

1.2 Organization of the Report

The Environmental Assessment (EA) Report is organized to reflect the process by which the assessment has been conducted. Section 1.0 introduces NSTPW and the undertaking, providing background information on the Project. Section 2.0 provides a description of the proposed undertaking. Construction activities are discussed as well as the purpose, location, scope and schedule for the Project. Alternatives to the Project and potential malfunctions and accidental events that may arise during construction and operation of the Project are described.



Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 40,000
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Project Location

0 0.5 1 1.5 2 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 1.1

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Section 3.0 provides an overview of the existing biophysical and socioeconomic characteristics of the study area. A summary of the existing environment is provided with respect to constraints listed in the NSTPW Highway Screening Criteria. Relevant legislation, regulations, and guidelines are also referenced where applicable.

A description of the environmental assessment methodology employed for this environmental assessment is provided in Section 4.0. Section 5.0 and Section 6.0 provide the results of the environmental effects assessment for biophysical components and socioeconomic components, respectively.

Section 7.0 provides a discussion of the potential malfunctions and accidental events, and mitigative measures that could occur during construction and operation of the proposed alignment. Section 8.0 includes a discussion of potential cumulative effects of the Project considered in conjunction with past, present and likely future projects in the study area. Section 9.0 discusses the effects of the local environment on Project activities and operation.

Section 10.0 details NSTPW's commitment to environmental management and provides a framework for compliance and environmental effects monitoring programs to be undertaken. A description of the public information programs initiated by NSTPW as well as planned consultation activities are provided in Section 11.0. A summary of the EA Report and conclusions from the EA are presented in Section 12.0. Section 13.0 details literature and personal communications cited in the report. A series of technical reports and other supporting information is contained in the appendices to this document.

1.3 Proponent Information

Name of Undertaking:	Highway 104 Antigonish
Location:	Nova Scotia
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2.0 PROJECT DESCRIPTION

2.1 Purpose and Need for the Project

The purpose and need for the Project are related to the increasing level of through traffic and truck traffic on the Antigonish to Lower South River segment of the existing Highway 104. Upgrading the existing highway to current 100 series controlled access standards was not feasible; therefore TPW initiated a route location study to identify lands suitable for preservation for a four lane divided highway alignment. The completion of the proposed section of highway will bring this segment up to required standards consistent with the remainder of Highway 104 from Amherst to New Glasgow.

The existing Highway 104 between Antigonish and Lower South River is a two/four lane highway with numerous intersections and driveways. This section of the highway is characterized by high traffic volumes, a high percentage of heavy truck traffic, poor geometry, uncontrolled access, strip development, pedestrian activity and a mixture of through and local traffic. The existing road includes 25 road intersections and some 76 entrances to residential, commercial, agricultural and institutional locations. The two/four lane highway, which must carry a mix of local and through traffic, poses safety concerns for local residents. The existing Highway 104 between Addington Forks Road and Taylor Road supports 9 different posted speed limits varying from 100 km/hr to as low as 60 km/hr. Two lane controlled access highways generally have speed limits of 100 km/hr.

The purpose of a 100 series highway is to provide safe, convenient, economic and efficient movement of persons and goods throughout the Province. The lack of vehicle access control and numerous conflict and decision points between traffic and pedestrians along the existing road are potential safety concerns. Also, the degree of roadside development and reduced speed limits (60 km/hr sections) affect the convenience, cost and efficiency of operation for through traffic. The purpose of this undertaking is to construct 15 km of the divided portion of Highway 104 to provide safe, convenient, economic and efficient movement of persons and goods.

Problems with existing highway to be resolved by the Project include: poor cross-sections; high traffic volumes; an increase in truck traffic; uncontrolled access from numerous intersections and driveways; extensive roadside signage and relatively high collision rates for a 100 series highway (NSTPW 2001a). Upgrading the existing route (*e.g.*, widening) is not a viable option as it would be cost prohibitive and disruptive to the ribbon development located in proximity to the existing highway over much of its length.

In 1996, the Atlantic Expressway Committee (AEC), recognized the need to replace or upgrade the existing Highway 104 in the near future and commissioned an economic impact study (Louis Berger (Canada) Ltd. 1996) of such a project. The AEC comprised representatives from the Town of Antigonish, Municipality of the County of Antigonish, Chamber of Commerce, Federation of Agriculture and St. Francis Xavier

University. The investigation indicated that traffic congestion and safety concerns would become a detriment to local businesses, and that the section from Antigonish to Lower South River required upgrading in the near future. Furthermore, it indicated that the economic impacts to the community increased as the distance from the existing alignment increased. The report recommended prompt collaboration between the community and NSTPW to identify and preserve a corridor that would minimize economic impacts. Consequently the AEC contacted NSTPW in the fall of 1996 to initiate a joint planning process to identify an appropriate alignment for the approximately 15 km section from the Addington Forks Road to the Taylor Road. Identification of the proposed alignment is the result of the efforts of the AEC and NSTPW to provide a safe travelling environment while maintaining economic viability of businesses in the community.

2.2 Project Scope and Location

The scope of the Project to be assessed includes construction, and operation and maintenance of the 15 km controlled access four lane divided highway between the Addington Forks Road (west of Exit 31) and Taylor Road (west of Exit 35) along the existing Highway 104 in Antigonish County. Decommissioning and abandonment of the proposed highway is not planned. The location of the Project is shown in Figure 1.1. The alignment closely parallels, within 600 m, the existing Highway 104. The proposed RoW follows south of the existing Highway 104 until it traverses to the north of the highway just west of the South River. Full diamond interchanges are proposed to connect with the existing Highway 104 at Addington Forks Road, Trunk 7, Beech Hill Road and Route 316. Overpass structures are proposed to ensure continued access along Beech Hill Road, and the existing Highway 104 between the South River Loop and Dunn's Loop. Underpass structures are proposed to maintain access where the highway intersects with Route 4 at Addington Forks, Trunk 7, at Route 313 where it joins with the new alignment of South Side Harbour Road, and at Taylor Road. The estimated cost of constructing the 15 km highway and associated structures is $65 million (NSTPW 2001a), excluding property acquisitions.

2.3 Project Schedule

Planning for the proposed alignment began in 1996 with NSTPW staff working with the AEC to identify an alignment, including access locations. An environmental screening conducted by the NSTPW in 1996 identified environmental, social and economic constraints associated with the study area. Three open house public meetings were held by NSTPW to gather public input on routing. At the first open house, held in May 1997, potential constraints and broad study corridors were identified in which alignment alternatives could be investigated. Constraint identification assisted NSTPW in focussing on three preferred alignments which were developed by April 1998 and presented at the second open house, in May 1998, along with proposed interchange locations. One of the main concerns at the 1998 open house was safety. A detailed safety review of the alignment options was completed in February 1999. Also in 1999, the alignment selection and planning process was subjected to an independent peer review. The results of these studies, previous public consultations, input from other government agencies, and background and further investigation by

NSTPW helped define the preferred alignment for EA registration. The preferred alignment was presented at the third open house meeting in May 2001. NSTPW registered the Project with the Nova Scotia Department of Environment and Labour (NSDEL) in November 2001. A Terms of Reference for the environmental assessment was subsequently released by NSDEL in February 2002. This document has been prepared to meet the Terms of Reference issued by NSDEL for a joint federal/provincial environmental assessment. Highway construction cannot proceed until the approvals process, survey work, detailed design and property acquisition have been completed. The earliest possible construction start-up, assuming availability of funding, is Fall of 2006 (NSTPW 2001b).

In general, construction activities will be scheduled to avoid potential interactions with VECs during sensitive periods (*i.e.*, breeding periods) where: recommended as specific mitigative measures (Section 5); recommended as general protection practices (Section 2.4); or to comply with specific required permits and conditions. For example, instream work at watercourses will generally be limited to the period from June 1 through September 30, as per Nova Scotia Water Approvals, and Nova Scotia Watercourse Alteration Specifications (NSDOE 1997) to avoid fish migration and periods of higher precipitation and runoff potential.

In general construction scheduling will depend on the prioritisation of this Project with other Provincial highway construction projects, and the availability of funding.

2.4 Construction Activities

This section provides a brief description of Project construction activities. The activities described are those typically involved in highway construction in Nova Scotia. Construction activities potentially affecting the environment will be conducted according to: NSTPW Standard Specifications (1997 and revisions); Province of Nova Scotia Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al*. 1981); and the Environmental Code of Good Practice for General Construction (Environment Canada 1979). Other relevant guidelines include the Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979) and Erosion and Sediment Control Handbook for Construction Sites (NSDOE 1988). Mitigative measures for, and response to, malfunctions and accidental events are discussed in Section 7.

The design of the road and structures which make up the highway will be carried out such that contractors have clear direction for environmental controls made available to them both on the contract drawings and in the Project specifications in the form of an Environmental Protection Plan (EPP). These measures may include those described in: the EA Report; conditions of release from the assessment process; and other regulatory requirements and best management practices. NSTPW has a generic EPP which will be modified according to specific requirements of this Project.

The following description of the proposed highway construction incorporates available information specific to this Project (*i.e.*, plan and profile data and route geometry), as well as general information regarding activities that are typical of highway construction in Nova Scotia.

2.4.1 Clearing

The first phase of major construction activity will be clearing of the proposed alignment. Approximate width of clearing for the four lane highway will require clearing the right-of-way (RoW) to a width of approximately 50 m (25 m each side of the centerline), with the exception of a few areas where greater widths are required to accommodate the interchange and deep cuts and fills. Clearing width will vary depending on the toe of the slope (*i.e.*, 4 m from the toe of slope or top of cut). The primary environmental concern during clearing of the RoW is to minimize ground disturbance which may result in the erosion and sedimentation of wetlands and watercourses. The NSTPW Standard Specifications (1997 and revisions) outline procedures for clearing. Trees will be cut to within 0.3 m of the ground. Marketable timber (minimum butt diameter of 100 mm and a length of 2.5 m) will be delimbed and removed from the site, while non-salvageable material will be chipped within the RoW and left in place.

Isolated or ornamental trees will be designated by the Project Engineer and shall be removed and relocated in accordance with NSTPW's Standard Specifications (1997 and revisions). Removal will be done by excavating the tree and removing the total tree including stump and roots, limiting the damage to the surrounding property.

Where possible, clearing operations will be conducted during winter months as frozen ground provides the necessary bearing capacity for heavy machinery, protecting the underlying vegetative mat. Working on frozen ground makes the work site more accessible, reduces the cost of access road development, and increases the speed at which skid trails can be used. Hand clearing will be conducted where ground conditions are not suitable for heavy equipment access, *e.g.*, within watercourse and wetland buffer zones.

2.4.2 Grubbing

Grubbing for roadway construction involves the removal of all organic material and unsuitable soil above the underlying soil. It also consists of the removal and disposal of all stumps, roots, downed timber, embedded logs, humus, root mat and topsoil from areas of excavations and embankments or other areas as directed by the Project Engineer. All areas where fills are less than 1.5 m or where excavation is planned, must be grubbed. Grubbing is usually not required under fills greater than 1.5 m in depth, unless a structure (*e.g.*, bridge, culvert or retaining wall) is to be constructed, or where there is a significant layer of compressible soil that could cause a future settlement problem. To minimize environmental risks associated with erosion and sedimentation, grubbing is conducted only after the installation of culverts, and required erosion and sediment controls (*e.g.*, sediment fence, settlement ponds, etc.) are in place.

Bulldozers are typically used to scrape the organic material off the underlying soil and to pile the material. If the grubbed material is to be removed from the site, track-mounted excavators are sometimes used to load the material on to dump-trucks. Where grubbing involves the removal of extensive organic deposits (*i.e.*, peat), the material is usually removed by an excavator and loaded directly to dump-trucks. If the deposit of unsuitable material cannot be removed with a track mounted excavator, a drag-line excavator is often used.

The projected end use of the grubbed material and the method of disposal dictate whether incidental organic materials such as stumps, roots, etc. are removed prior to re-use or disposal. Some stumps may be removed from the grubbed material and chipped. Grubbed soil may also be used to flatten the slopes of embankments along the roadway, depending on its quality and the need for fill at the site. Topsoil will be salvaged for use in the median and on side slopes as per NSTPW's Standard Specifications (1997 and revisions). Other grubbed material is disposed of as indicated in Section 2.4.11.

2.4.3 Structures

The proposed RoW contains 16 watercourse crossings. It is anticipated that most of these crossings will be accomplished using culverts. Culvert installations at watercourse crossings are normally accomplished by constructing temporary stream diversions, allowing the culvert to be bedded 'in the dry' and backfilled prior to conveying the stream through the culvert. Applicable siltation and erosion control practices will be adhered to during this process. Culverts will be designed so as not to interfere with use of the stream by fish.
Culverts would be constructed of either cast-in-place concrete or precast concrete and can be either three-sided (open bottom) or four sided. A typical box culvert would have a maximum inside clear span of 3.6 m. Two or more lines of box culverts may be placed side-by-side to create twin or multi-barrel box culvert installations for wider watercourses. Refer to Section 5.3 for more information on watercourse crossings.

In sensitive streams that are known to be fish bearing, a short span precast bridge structure or open bottom culvert could be used. These types of structures reduce impacts on the streambed. For watercourse crossings greater than 10 m in width, a bridge structure is generally considered.

All crossings of watercourses are normally designed to accommodate the 1 in 100 year storm for the local region as defined by data from the Atmospheric Environment Service of Environment Canada. These estimates will incorporate anticipated changes in precipitation due to global warming.

Appendix B contains a hydrological study of the watercourses to be crossed by RoW. No significant hydraulic changes are expected during construction or operation of the highway. Due to the wide channel and the steep bank that exists at the West River crossing (5+700), a free-spanning structure will be considered at this location. It is noted that this type of structure is very expensive and alternative options will also be explored. The crossing at the unnamed watercourse located at 8+150 has steep banks and

contains good fish and wood turtle habitat; TPW will consider an arch at this location. The proposed South River crossing has been addressed in a previous report (Neill and Gunter Ltd. 2001) and was not therefore included in the hydrological survey. See Appendix E for this report.

The hydrologic functions at the proposed South River crossing are primarily conveyance and flood storage. Construction will not impact conveyance and will displace a negligible amount of flood storage capacity. The recommended structure for this crossing based on the impact study is a four span steel girder structural system with a concrete deck. The location of the crossing considered the environmental sensitivity at all sections across the river valley.

Estimates of run-off volumes and design of run-off control features will be made during final highway design process using standard highway design criteria once the alignment and profile have been finalized. All instream work will be conducted during low-flow periods (June 1 - September 30) to avoid interference with fish spawning, incubation and hatching activities. Further detail on watercourse construction activities is provided in Section 5.3.5.1.

Construction of structures will begin with the installation of properly designed siltation and erosion control measures followed by clearing and grubbing, excavation, embankment fills, etc. as required. The foundations for abutments and piers will be cast-in-place reinforced concrete on either spread footings or piles. The prefabricated girders, either of pre-stressed concrete or steel construction, will then be put into place using cranes. The bridge deck will be constructed of cast-in-place reinforced concrete, a waterproofing membrane will be applied and the surface will be paved to match the design grade of the road surface at that point.

Wildlife crossings/underpasses will be considered to minimize effects of habitat fragmentation and wildlife mortality (road kill) (refer to Sections 5.4, 5.5 and 5.8). The design and construction of these structures will coincide with planned culvert/bridge crossings and will draw upon experience and observation of the effectiveness of established wildlife crossings on existing highways in Nova Scotia (e.g., wildlife tunnels on the Cobequid Pass) and other areas in North America (e.g., salamander tunnels in Amherst, Massachusetts) (FHWA 2000). Refer to Sections 5.4, 5.5 and 5.8 for more information on wildlife crossings.

2.4.4 Major Cut / Fill Operations

Many cuts and fills will be required throughout the proposed Highway 104 alignment to provide an appropriate vertical alignment in the rolling terrain prevalent throughout the study area. Changes in vertical alignment involving cuts and fills are also required on the approaches to highway overpasses or underpasses of other roads, and watercourses.

The vertical alignment of a highway consists of straight grades, and crest (hill tops) and sag (valleys) vertical curves. The highway will be constructed as a four lane divided roadway with a wide median and the limiting design criteria for vertical curves is based on comfort and safety. Vertical curves must be sufficiently 'flat' so vehicle occupants do not feel uncomfortable on crests or sags. The design of vertical curves must also consider provision of adequate stopping sight distance and headlight visibility.

Cuts and fills of greater than 6 m are generally considered to be 'major' operations. Fifteen sections containing major cut and fill operations, identified from the NSTPW centerline profile, are shown in Table 2.1. The 'start' chainage for the affected section begins where the cut or fill first exceeds 3 m, and continues through the critical area to the 'end' chainage where the operation becomes less than a 3 m depth.

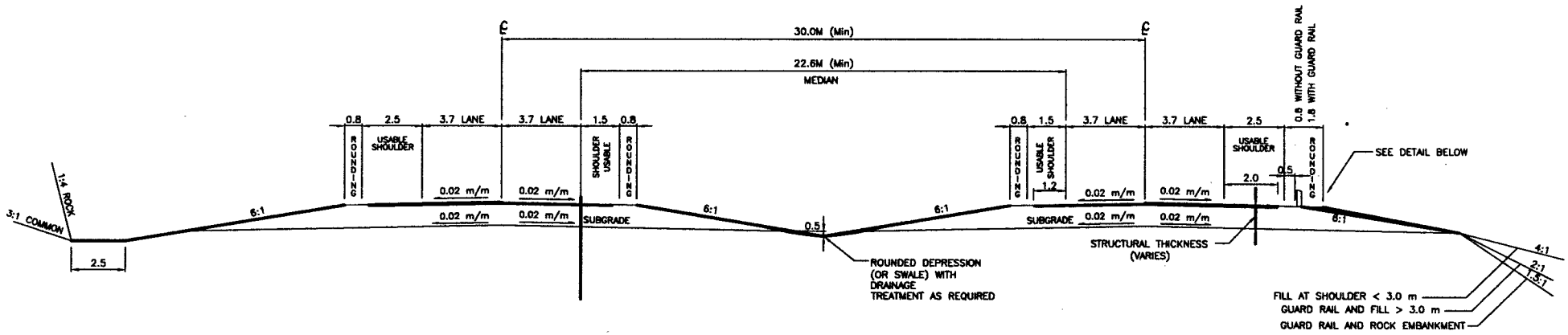
Table 2.1 Major Cut and Fill Operations

No.	Type	Start Chainage	End Chainage	Length (m)	Approximate Deepest Point (m)	Comment
1	Fill	2+350	2+450	100	8.0	Stream
2	Cut	4+240	4+450	210	7.5	-
3	Fill	5+630	5+870	240	9.5	West River
4	Cut	5+900	6+200	300	11.0	-
5	Fill	6+350	7+000	650	9.5	Beech Hill Rd. and a stream
6	Cut	7+230	7+410	180	8.5	-
7	Cut	7+770	7+890	120	8.0	-
8	Fill	8+000	8+200	200	10.0	Stream
9	Cut	8+430	8+760	230	9.0	-
10	Fill	8+820	9+550	730	23.0	Wetland
11	Cut	9+620	10+090	470	11.0	-
12	Cut	10+270	11+190	920	18.5	-
13	Fill	11+230	11+610	380	13.0	South River / South Side Harbor Rd.
14	Cut	11+670	11+860	90	10.5	-
15	Fill	12+990	13+290	300	6.1	Wetland

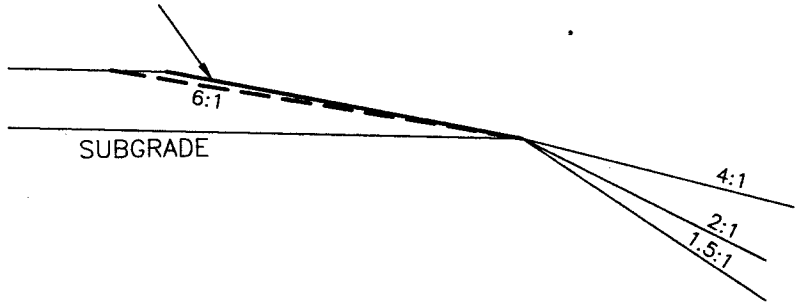
Source: NSTPW 2002 - Proposed Centerline Profile

Several factors are considered in the design of major cut and fill sections including: slope stability; erosion control; silt and runoff control; location and rehabilitation of borrow pits; impacts on groundwater; and impacts on blowing snow.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment, and connectors. As per NSTPW's Standard Cross Section (Figure 2.1), conservative slopes for cuts and embankments will not generally exceed 3 horizontal : 1 vertical; slopes may be steeper in rock, rock fill, and guardrail locations (*e.g.*, 2:1). Cut slopes in soils tend to undergo minor sloughing where high groundwater and freeze-thaw occurs. These are typically repaired using a layer of rockfill to facilitate drainage. However, such analysis is site-specific and is dependent upon the specific soil type, geological features and elevation of the water table.



NOTE: Structural Thickness sideslope to change where guardrail installed.
(Subgrade width to remain constant.)



NOTES:

- WIDTH OF SUBGRADE IS DEPENDENT UPON STRUCTURAL THICKNESS WHICH SHALL BE DETERMINED BY PAVEMENT DESIGN
- ALL DIMENSIONS ARE IN METRES

NOVA SCOTIA
Transportation and Public Works
Highway Planning & Design

Figure 2.1
Typical Cross Section
Freeway Open Median

Manager Highway Planning & Design

Director Highway Engineering Services

Executive Director Public Works

Scale : N.T.S.
Drawn by : M. LaBreche
Checked by : S. Shannon

Date of Plan : 06Mar/02
File No. : FreewayOpen.dwg
Path: G:IM\HPandD\H D D\Std\
Freeway Open Med8.5x11.0.dwg

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The overburden soils anticipated to be encountered along the proposed alignment will likely be susceptible to erosion. Several generic measures that can be taken to minimize sedimentation and erosion potential include: fitting the development to the terrain; construction sequencing to minimize soil exposure; retaining existing vegetation as long as possible; vegetation and mulching of grubbed areas; diverting runoff away from denuded (*i.e.*, bare) areas; minimizing length and steepness of slopes; keeping runoff velocities low; properly sizing and protecting drainage ways and outlets; intercepting sediments on site; and inspecting and maintaining control measures.

Erosion and consequent siltation due to direct run off is only a concern to dug wells in very close proximity to the alignment (*e.g.*, a few 10s of metres) and where direct overland flow of silt occurs. Impacts to surface watercourses by uncontrolled erosion are a more important concern (Section 5.3).

2.4.5 Excavation

The removal of material for the construction of sub-grade (bottom layer of material) may involve one or more methods of excavation including common excavation, rock excavation, and swamp excavation. Common excavation is the removal of overburden, including till, smaller boulders, and topsoil. Rock excavation is the excavation of rock which is considered to be bedrock or single pieces greater than one cubic metre in size. Cuts in 'soft' rock can be accomplished using ripper blades attached to the back of larger bulldozers, breaking up the rock so that it can be loaded on to trucks with an excavator or loader. This procedure tends to be successful in softer rock such as shales and sandstones, and in areas where the bedrock surface is highly weathered and/or fractured.

Swamp excavation occurs where soil is unsuitable for use as a sub-grade. The soil is either excavated and replaced with a competent fill, or 'floated over' using geogrids or berm construction. This may occur when peat is encountered or when exposed soil has been saturated with water. Excavated soils unsuitable for use as fill or dressing slopes are disposed of at a site approved by the Project Engineer.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment, and connectors. Conservative slopes for cuts and embankments will not exceed 3 horizontal :1 vertical in sands and gravel as well as in cohesive soils (silts and clays). Less steep slopes will be used if necessary.

2.4.6 Blasting

The use of blasting for rock excavation is dependent upon the competency of the rock. The contractor will determine whether or not blasting will be required for the construction of the proposed alignment. Wherever possible, rock excavation will be performed by ripping rather than blasting, due to the lower costs involved.

Based on overburden thickness and lithology (physical character of the rock), blasting is expected to be minor along the alignment (refer to Section 5.2). The bedrock is composed of relatively 'soft' sandstone, mudstone and limestone which should require much less blasting energy to excavate than other areas of Nova Scotia.

If blasting is deemed to be necessary, blasting operations will be conducted in accordance with the applicable regulations and guidelines. Blasting operations are governed by provincial regulations throughout Nova Scotia. Blasting in or near watercourses will require approval from the Department of Fisheries and Oceans (DFO), and will be conducted in accordance with the "Guidelines for Use of Explosives in or Near Canadian Fisheries Waters" (Wright and Hopky 1998). Blasting will also be conducted in accordance with the *General Blasting Regulations* made pursuant to the Nova Scotia *Occupational Health and Safety Act*. The contractor performing the blasting will have a valid 'Blaster's Licence' and will ensure that a pre-blast survey has been conducted, prior to blasting (see Section 10.3).

2.4.7 Highway Construction

Highways in Nova Scotia are generally constructed in three distinct layers:

- **Sub-grade** is the bottom layer in which the original ground level is adjusted to form the roadbed. The sub-grade is constructed by using materials from cut operations or borrow pits to construct fill embankments.
- **Sub-base and Base** include granular materials, crushed stone or gravels, of various sizes and appropriate depth placed on top of the sub-grade to provide drainage and strength.
- **Pavement** is placed on top of the granular material to reduce moisture penetration of the under layers, add strength, and finally to provide a smooth riding surface.

2.4.7.1 Sub-grade

Sub-grade is the bottom layer of material on a road, providing strength and stability. Sub-grade is constructed by dumping acceptable fill, either from cuts or borrow sources, spreading it in a layer of specified thickness (depending on the engineering properties of the material but not usually exceeding 300 mm), and, using moisture control procedures, compacting it to a specified density. Subsequent layers are added until the desired elevation is reached.

Where feasible, as determined by suitability of the material and hauling costs, material excavated from the RoW is used for fill. If the excavated material is determined to be unacceptable for use as road building material along the alignment, or if there is a shortage of usable materials, materials will be obtained from nearby borrow sources (see Section 2.4.8).

2.4.7.2 Sub-base and Base

Once the sub-grade has been developed, a granular graded structural base known as sub-base and base is prepared. The sub-base course (gravel) is placed immediately above the sub-grade and consists of material superior in quality to that used for sub-grade. The base course is placed immediately above the sub-base and consists of a series of layers graded to provide structural integrity and good drainage beneath the asphalt concrete surface.

2.4.7.3 Pavement

The majority of pavement used in Nova Scotia is the familiar black asphalt. An asphalt pavement surface is planned for the study area of Highway 104. Although evaluation studies of the costs and performance of concrete pavement are ongoing, asphalt pavement is typically used in Nova Scotia. This material is made by mixing petroleum based liquid asphalt with sand and crushed stone in an asphalt plant. The hot mix is easily transported, spread and rolled to provide a smooth surface that can be used almost immediately. Special care must be taken in the design and placement of granular and asphalt pavement layers to minimize wheel track rutting and frost action that may break the pavement and cause surface failures (*i.e.*, pot holes).

Portland cement concrete is an alternative type of pavement. However, the high initial capital cost relative to conventional asphalt concrete makes it a generally less attractive paving option. The material is made by mixing Portland cement, sand, gravel, and water at a concrete batch plant. The concrete mix material is transported by trucks and placed by a slip forming machine that automatically creates joints complete with steel joint dowels to ensure that adjacent slabs retain their alignment. Concrete must set or cure for several days before it can be opened to traffic. Although it has a higher initial cost than asphalt pavement, concrete pavement is rigid and provides a smooth riding surface which is not subject to rutting and generally resists frost action and pot holes. In recent years, NSTPW has been evaluating concrete pavement on an approximately 4 km long section on the Highway 104 westbound lanes east of Oxford. This section, constructed in 1995, has provided excellent performance. NSTPW plans to further evaluate concrete pavement by placing a 10 km section on Highway 101 between Mount Uniacke and Ellershouse.

Both pavement types require durable crushed stone that will meet TPW specifications. Provision of crushed stone will be the responsibility of road construction contractors, who will abide by appropriate pit and quarry regulations. It is expected that stone for pavement mixes will be obtained from existing quarries near the study area.

2.4.8 Borrow Materials

Construction of the highway will consist of cuts and fills to bring the area to sub-grade level using materials along the alignment. Based on the surficial and bedrock geology most of the materials used in the sub-grade

construction will consist of glacial tills and bedrock of the Mabou and Windsor Groups. Some alluvial type sand and gravel deposits exist in the western end of the Project and in the area of Lower South River. Borrow material required for sub-grade construction will probably be derived from glacial till and glacial fluvial materials found near the alignment. As noted in Section 5.2.2, Overburden Geology, the glacial tills are relatively fine grained. They tend to be suitable as a sub-grade fill material but are sensitive to moisture and are difficult to work with during wet periods of the year. Both tills and glacial fluvial materials are also erodible and erosion/sediment control measures will be necessary at borrow pits and along the alignment where these materials are used.

Rock fill may be used as borrow material, but tends to be more expensive to obtain than the glacial till. Aggregates for the Project will be required for such items as sub-base and base gravels, shoulder gravel, asphaltic concrete, backfill for structures and culverts, erosion protection, stream bank stabilization, etc. Pomquet Formation (mudrock and minor limestone) and Hastings Formation (sandstone and mudrock) bedrock underlies the eastern and western ends of the alignment and Hood Island Formation (siltstone, limestone, dolostone, gypsum and anhydrate) bedrock underlies the central two thirds of the alignment. It may be possible to excavate quarries near the Project within these formations to produce these aggregates. Aggregates for Portland Cement Concrete and the concrete will be provided by prequalified Ready-Mix Concrete producers in accordance with the NSTPW Specification Division 5, Section 7. All aggregates are prequalified and will meet the requirements of the Department.

2.4.9 Hydroseeding

Hydroseeding will be conducted as soon as possible after completion of the surface preparation. Table 2.2 shows the composition of seed mix currently used by NSTPW.

Table 2.2 Composition of Seed Mix for Hydroseeding

Common Name	Botanical Name	Percentage of mix (%)
Creeping red fescue	*Festuca ruba*	40
Timothy	*Phleum pratense*	15
Tall fescue	*Festuca arundinacea*	15
Kentucky Blue Grass	*Poa pratensis*	10
Alsike clover	*Trifolium hubridum*	10
Red top	*Agrostis alba*	5
Perennial rye	*Lolium perenne*	5

Source: NSTPW (1997 and revisions)

Areas to be hydroseeded will be dressed or otherwise left in a loosened condition conducive to seeding. Hydroseeding will not be performed under windy conditions or during periods of rainfall, on areas covered by standing water, or frozen surface or under other adverse conditions, as determined by the Project Engineer. Hydroseeding will be carried out as soon as possible after surface preparation is completed.

Application rates and procedures as detailed by NSTPW's Standard Specifications (1997 and revisions) for hydroseeding will be implemented.

2.4.10 Construction Vehicle Operation

Vehicles used in sub-grade construction typically include excavators, bulldozers, rollers, trucks, and graders. Most of these vehicles operate on diesel fuel and require some form of daily maintenance. The vehicles typically operate continuously for 12-hour shifts. Truck traffic during sub-grade construction will primarily be confined to on-site operations, and transportation of material for cut and fill operations. Some truck traffic will occur off-site to travel to adequate borrow and/or disposal sites. Specific information on vehicle operation is unknown at this time since specific borrow and disposal volumes and locations have not yet been identified.

Vehicles typically used in base and pavement construction include pneumatic tire and steel drum rollers, graders, trucks, and asphalt concrete pavers. If the asphalt concrete plant is located on-site and a suitable source of aggregate used for the asphalt concrete and road base construction can be found on-site, truck traffic during this phase of construction would be limited to the delivery of prime, tack coat, asphalt cement and diesel fuel. If the asphalt concrete plant is not located on-site and/or aggregate must be obtained from another source, the amount of truck traffic on the access roads would increase accordingly.

2.4.11 Construction Waste Disposal

The most desirable use of material excavated from the RoW during construction is use within the RoW (*e.g.*, buried in the toe of the slope), assuming it conforms with NSTPW standards. Disposal of waste materials from the construction of the proposed undertaking will be in accordance with NSTPW's Standard Specifications (1997 and revisions) for highway construction and any provisions included in site-specific contracts. The current specifications for clearing and grubbing do not include any specific criteria for the selection of waste disposal sites. Disposal sites are to be located by the contractor and must be approved by NSTPW.

Non-salvageable material from the clearing operations, such as limbs and non merchantable timber, are typically chipped within the RoW and left in place except within buffer zones for watercourses and wetlands. Occasionally, large items which cannot be easily chipped (*i.e.*, stumps) are buried on adjacent land. Excavated organics, overburden and rock must be disposed of where their use as fill material is impractical. According to the Nova Scotia Watercourse Alteration Specifications (NSDOE 1997), waste disposal areas must be located such that they do not interfere with any stream or drainage facility (*i.e.*, >100 m away), do not contribute to erosion and/or siltation, and are left in a neat appearance. Disposal of potential acid generating bedrock, if encountered, will be conducted in compliance with the *Sulphide Bearing Material Disposal Regulations*.

2.4.12 Acid Producing Bedrock

Acid drainage problems have long been associated with mining related activities in Nova Scotia and in the past 20 years such problems have also been identified with corridor-type developments such as highways. In Nova Scotia, excluding mining projects, acid drainage problems have been almost exclusively associated with developments in the Halifax Formation Slates. Presence of the Halifax Formation bedrock is not anticipated along the proposed Highway 104 alignment.

Where acid producing bedrock is identified as a potential constraint during the planning design process, NSTPW implements various avoidance measures including raising the road profile, shifting the alignment and minimizing width of RoW. Acid producing bedrock is not expected to be encountered on this Project, therefore these measures were not necessary.

As outlined in Section 5.2.2, Bedrock Geology, the RoW is underlain by five geological formations: the Mabou Group Pomquet and Hastings Formations and the Windsor Group Hood Island, Bridgeville and Gays River Formations.

A site reconnaissance was carried out on October 10 and 11, 2002 to observe bedrock exposures. All roads along the proposed RoW were traversed to determine the accuracy of the geological mapping. No bedrock outcrops were observed within the areas investigated at the time of the field reconnaissance, due to the presence of thick glacial overburden. Bedrock exposures could occur along streams and rivers where the overburden has been eroded. However, based on the current highway alignment, acid producing bedrock is not expected to be encountered during construction.

2.4.13 Karst Topography

Karst is a distinctive landscape topography typically formed by dissolving carbonate rocks such as limestone, dolomite and marble, or other highly soluble rocks such as halite, gypsum and anhydrite. The geological process involved can result in unusual surface and subsurface features ranging from sinkholes, irregular surface topography, vertical shafts, disappearing and reappearing springs as well as complex underground drainage systems and caves.

Throughout Nova Scotia the formation of Karst Topography is typically associated with areas underlain by Carboniferous rocks of the Windsor Group which contain the rock types noted above. Karst is known to occur in several areas around Antigonish County, including the Lower South River area near the RoW. A borehole investigation conducted at the proposed South River crossing (Neill and Gunter Ltd. 2001) revealed that the contact between the Mabou Group (formerly the Canso Group) and Windsor Group underlies the South River. The Hood Island Formation of the Windsor Group was confirmed approximately 20 m north of the existing Highway 104, west of the backwater channel of the South River. Limestone

bedrock was encountered at approximately 14 m from the surface, however Karst topography was not encountered during the borehole investigation.

Windsor Group rocks occurring along the alignment consist of the Hood Island Formation, which underlies approximately 7 km of the route. The rocks in this formation consist of red siltstone and sandstone with intercalated marine limestone and dolostone and minor gypsum.

Geological mapping by R. C. Boehner and P. S. Giles (1993) indicates minimal occurrence of soluble rock and limited outcropping of other sedimentary rock types along the proposed highway alignment. The overburden throughout the area generally comprises relatively thick deposits of fine grained glacial till which forms gently rolling terrain masking the underlying bedrock features.

A walkover survey of the alignment (October 10 and 11, 2002) was carried out and observations were made for evidence of Karst Topography. There were no areas noted where evidence of Karst occurred along the alignment. The proposed alignment crosses the same geology as the existing Highway 104 where there have been no issues identified associated with Karst development. Problems associated with Karst along the parallel section of highway are not anticipated.

The review carried out indicates there is risk of subsidence features developing along the alignment due to the underlying bedrock. However, observations of the current surface conditions suggest that active Karst development has not occurred within this area.

2.4.14 Contaminated Sites

There are several gas stations and autobody shops along the RoW. While these properties have not been specifically investigated for this assessment, it should be noted that these types of land uses are more susceptible to potential contamination. If contaminated soils are encountered, the sites will be managed in accordance with the Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996). If a potentially contaminated site is encountered, the owner of the site will be notified. The site will be evaluated in a timely manner to determine whether there are off-site impacts or unacceptable on-site impacts. If impacts or risks are identified, the owner is required to: advise affected third parties, if appropriate; determine whether active remediation or ongoing site management is to be implemented; and submit a contaminated site Notification Report to NSDEL.

2.4.15 Erosion and Sediment Control

Erosion is defined as the gradual wearing away of the land surface by the action of water, wind, ice and gravity. Sedimentation is the deposition and accumulation of detached soil particles. The emphasis in all NSTPW construction projects is to control erosion rather than treat sediment. The most effective way to

ensure that sediment does not affect the environment is to prevent erosion and transportation of sediment-laden run-off.

NSTPW's principles of erosion and sediment control include:

- minimize the amount of exposed soil;
- minimize the amount of time soil is exposed;
- avoid steep slopes;
- keep sediment on site (avoid sediment transport); and
- ensure that clean water remains clean.

To minimize the environmental risks associated with erosion and siltation during highway construction, the Project will be carried out according to NSTPW's Standard Specifications (1997 and revisions), NSDOE's Erosion and Sedimentation Control Handbook for Construction Sites (1988), and the Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al.* 1981).

NSTPW's work progression schedule will ensure construction in any work area is carried out continuously from initiation to completion thereby minimizing exposed soil on construction sites. Site specific Erosion Control Plans will be developed for the Project and will specify where the installation of erosion and sediment control features will be located. These will be approved by NSDEL under Part V Water Approval process prior to culvert installation. For more information on erosion and sediment controls, refer to Section 5.3.

2.5 Highway Operation and Maintenance

The maintenance activities described below will be conducted throughout the operational life of the proposed roadway. These activities are typical of maintenance activities on Nova Scotia highways. Mitigative measures and response to malfunctions and accidental events that may occur during highway operation and maintenance are discussed in Section 7.

Resurfacing

The rate of degradation of the pavement surface will be determined by the volume of traffic, proportion of heavy trucks, certain vehicle characteristics (*i.e.*, radial tires), structure and quality of pavement structure. The repair of the asphalt concrete surface may involve excavation or removal of the existing pavement and sub-grade, levelling, patching, surface treatment and asphalt concrete overlays. Disruption to the public from these repairs would be temporary and infrequent in nature.

Drainage

Periodic maintenance of roadway drainage systems may be required. This may involve the replacement or repair of culverts and re-establishment of the drainage ditches.

Clearing

Regrowth of vegetation within the RoW may interfere with the lines of sight required for safe use of the highway. Clearing along the RoW is part of NSTPW's regular maintenance to maintain sight lines and may involve both manual and mechanized cutting.

If herbicide application is required for the control of noxious weeds, trained personnel will apply herbicide subject to permit approval issued by the NSDEL pursuant to the *Pesticide Regulations* under the Nova Scotia *Environment Act*.

Winter Maintenance

NSTPW applies approximately 260,000 tonnes of road salts each year. An additional 500 staff are hired each winter, bringing the total work force on the Highways Operations Division to 1,400. The department uses approximately 400 plows for winter maintenance, including graders, trucks, and four-wheel drive vehicles. NSTPW already has several initiatives underway to help manage the use of road salts. These initiatives include:

- construction of several additional salt/sand storage structures to increase covered storage capacity;
- installation of Road Weather Information System (RWIS) sites (approximately 24 in operation by 2003);
- new winter maintenance standards to provide a consistent and measurable level of service for ice and snow removal to all areas of Nova Scotia; and
- upgrading of salt spread truck fleet through the installation of computerized salt controls, infrared pavement temperature sensors, and retrofitting of some trucks with pre-wetting capability.

In 2000, NSTPW implemented a pre-wetting trial on a section of 100 Series Highway in Halifax County. The pre-wetting operation involved the application of a sodium chloride (NaCl) brine solution to the road salts just prior to application on the highway. Pre-wetting was carried out in an effort to reduce the loss of road salts applied to highways due to wind and traffic disturbance. The trial proved that pre-wetting was a useful tool to reduce road salts. Savings in road salts of up to approximately 10-12 % were realized while the same level of service was maintained. The pre-wetting program was expanded in 2002 and is now being used in areas where RWIS sites have been established. Further reductions in road salts can be realized if placed just prior to a storm event. This is usually referred to as 'anti-icing' as opposed to 'de-icing'.

In response to Environment Canada's recent policy on road salt, NSTPW has developed a Salt Management Plan (SMP). The SMP provides a mechanism through which NSTPW can commit to implementing salt best management practices while fulfilling its obligation to providing safe, efficient, and cost effective roadway systems. Additional detail on NSTPW's SMP and a salt management strategy for this Project are included in Appendix L.

Other Maintenance Activities

Other road maintenance activities include shoulder grading, localized pavement repair, and line repainting. Disruption to the public from these repairs will be temporary and infrequent in nature.

2.6 Decommissioning

The highway will be maintained as necessary for an indefinite period of time. Decommissioning, if required in the future, will be undertaken in compliance with relevant laws, regulations and guidelines current at that time.

2.7 Project Alternatives

2.7.1 Alternatives to the Project

Alternatives to the Project are defined as functionally different ways of achieving the same end (CEA Agency 1994). Alternatives to the Project include: the 'do nothing' scenario (null alternative); upgrading the existing alignment (*i.e.*, widening the existing highway); or other modes of transportation *(i.e.,* rail, bus).

The objective of the Project is to provide a four lane divided controlled access highway to accommodate the high traffic volumes prevalent throughout the study area from west of Addington Forks Road to east of Taylor Road. Three alternatives to the Project are discussed briefly, however, there are no practical or possible alternatives that will satisfy the objective.

'Do Nothing' - If action is not taken, traffic volumes will continue to increase and the potential safety problems created by the mix of local and through traffic will continue. The existing uncontrolled access section of Highway 104 will continue to operate at reduced speeds and through traffic will not benefit from the improved levels of service that exist on other sections of improved 100 series highways. The 'Do Nothing' alternative is not acceptable since it does not address the objective of the Project

Upgrade the Existing Alignment - Sections of highway that do not have adjacent development, or where development is limited and well set back from the roadway, can often be upgraded as controlled access highways by constructing parallel service roads. It is also often practical in those situations to acquire

additional right-of-way to allow for construction of a four lane divided highway. Because of the amount and proximity of roadside development in the study area, it is not possible to upgrade the existing alignment to provide a four lane divided controlled access highway, without considerable cost and disruption to the public.

Other Modes - Air, rail, and bus are other efficient modes for long distance passenger travel. Air travel is prohibitively expensive for most travellers and has limited servicing capabilities with regards to origins and destinations. There has not been passenger rail service between Truro and Cape Breton for many years and transit or bus service there is limited. Although rail is often a realistic alternative to trucking for long distance goods movement, during the past 25 years there has been a shift from rail to trucking that is not expected to change in the near future. Other modes of transportation are not considered as effective or feasible alternatives to the proposed Project.

2.7.2 Other Methods for Carrying Out the Proposed Project

Alternative means of carrying out the Project are defined as methods of similar technical character or methods that are functionally the same (CEA Agency 1994). During the planning process of this Project, a number of alternative means for carrying out the Project have been considered.

In the winter of 1996/97, NSTPW conducted a preliminary environmental screening to identify and review potential environmental impacts associated with the upgrading of the existing Highway 104 in Antigonish. The NSTPW screening utilized the Highway Environmental Database Study (NSDOTC 1991) process that includes a review of 13 environmental categories comprising 63 potential environmental constraints (NSTPW 1997a). Information for an environmental screening study is based on existing recorded information and staff knowledge from various government departments, municipalities, organizations, businesses, interest groups and the general public.

Following completion of the environmental screening for highways, a single broad corridor along and south of the existing Highway 104 was identified for presentation at the first public open house. This corridor incorporated ten exclusion zones identified through the completion of the screening. The corridor, between approximately 1 and 3 km wide, extended west to east from approximately 1 km west of Addington Forks Road to just east of Taylor Road (Figure 2.2).

The northern boundary of the corridor followed the existing Highway 104 until it descended approximately 300 m south of the highway just west of Trunk 4 from Antigonish where the boundary continued south of the existing 104 as far as Dunn's Loop, where it crossed again and remained less than 1 km north of the highway to just past Taylor Road where it rejoined the existing alignment.

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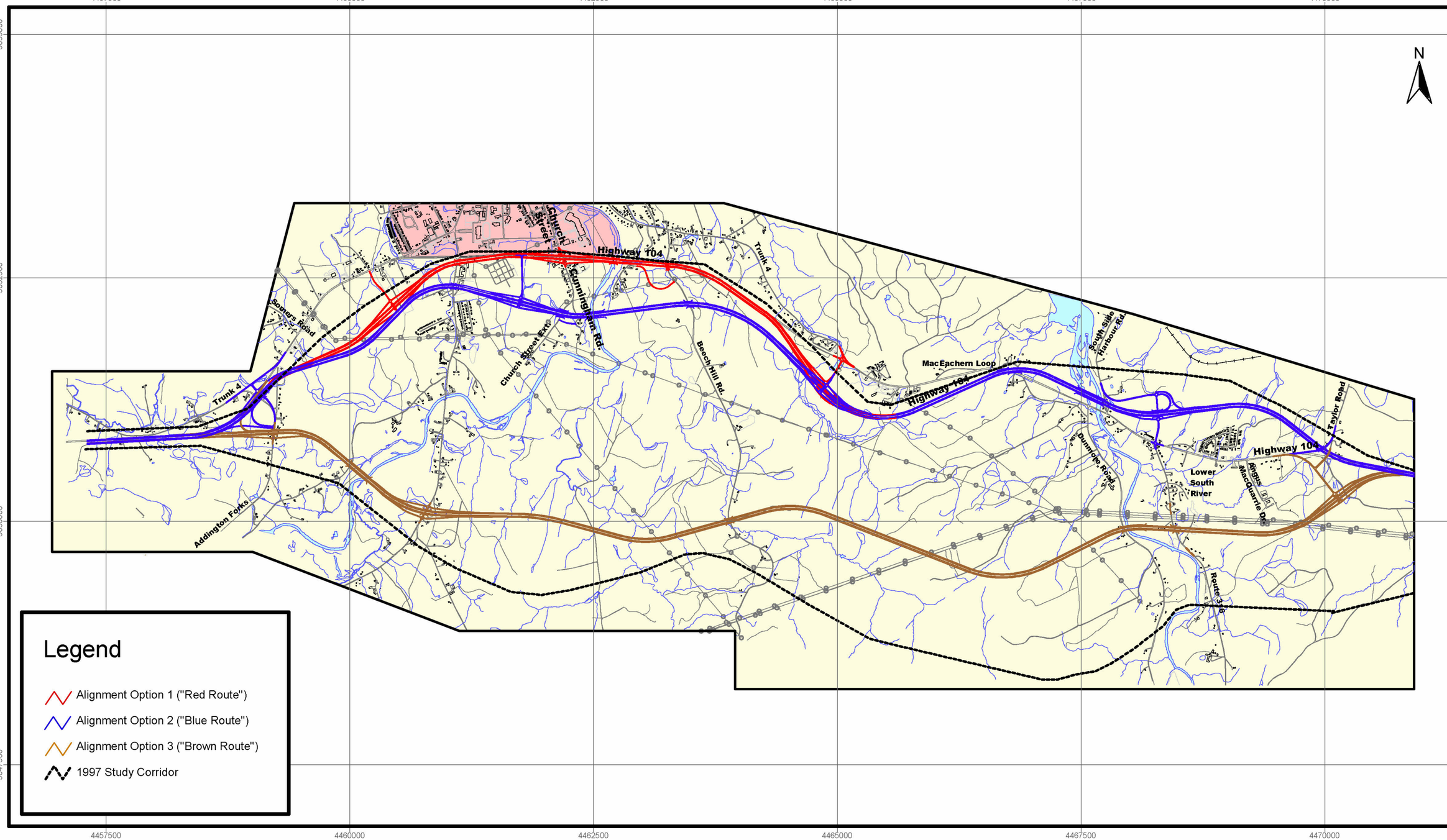

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Jacques Whitford

NOVA SCOTIA Transportation and Public Works

SCALE: 1 : 37 500

Date: 9/01/2004

Drawn By: GM

Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Alternatives Alignment Options

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.

NSD16949
FIGURE 2.2

The southern boundary of the corridor presented at the open house parallelled the northern boundary forming a narrow corridor of less than a kilometre from Addington Forks Road to just east of the West River Road where it expanded to form a corridor of between one to three kilometres as far west as just past Taylor Road where it ended.

Public consultation concerning the Project was initiated in May, 1997 with an open house public meeting held at the Saint Francis Xavier University in Antigonish. Over 300 area residents attended this meeting where the preliminary environmental screening results were presented and public opinions were solicited relating to broad corridors and potential access locations being considered by NSTPW.

The Preliminary Environmental Screening (NSTPW 1997a) revealed concern for constraints that either indicated the need for further study or the need to be aware of the constraints when locating the proposed highway alignment within the corridor. Several constraints, as listed below, were either noted in the screening process or were observed by members of the public.

- Mineral resources, sand and gravel deposits, karst terrain and highly erodible soils were noted as geological constraints. Potential karst development was identified as the most significant geological constraint.
- Components of the terrestrial environment that presented constraints included eagle and osprey nesting sites, a potential old growth hardwood stand, and the Dagger Woods Marsh (noted as a managed wetland and wildlife area). It is noted that following the selection of the current proposed alignment, the Dagger Woods Marsh was no longer included in the study area. A survey was recommended to determine the presence and location of rare plants and animals believed to exist in the area. The need to minimize impacts on wetlands was noted and avoidance, if possible, was recommended.
- In the aquatic resources component, fifteen streams were identified, five of which were considered to be major salmon streams, with an additional ten being identified as trout streams. It was noted that the West River and Brierly Brook were subject to salmonid restoration programs. Recommendations included adherence to work progression clauses, avoidance of sensitive areas and timely implementation of sediment and erosion control measures. Flood plains along the West and South Rivers were also identified as a potential constraint. Flood risk mapping within the boundaries of the study area showed flood north of the proposed alignment in the area between the Cunningham Road and West River.
- The South River estuary salt marsh was identified as a constraint under marine environment.
- Agricultural lands and one fox farm were noted as constraints under the agricultural land section while managed woodlots were noted under the Forestry component.

- Under the land/water use section the constraints identified included proposed residential developments, the Beech Hill Landfill site, kaolin clay and limestone mineral claims and navigable waters (South and West Rivers). It is noted that the landfill is outside the study area and that no indications of mineral claim development were given during discussions with the municipal planners.
- Recreation constraints identified by the Municipality were ball fields and snow mobile trails. The use of the West River as a canoe route was noted by a Fisheries and Oceans representative, however the route does not appear in provincial sources of data.
- Municipal wells located in Lower South River were identified as constraints under the water supply component.
- Utilities typical of municipal areas including power transmission and distribution lines, telephone lines, a telecommunication tower and water and sewer lines and the associated treatment plant in Lower South River were identified as constraints.
- Two cemeteries were noted as constraints, however, during field reconnaissance it was noted that these were outside the study area.

Using the information obtained through the environmental screening and public consultation, three potential alignments (Figure 2.2) were identified by NSTPW and AEC. A second open house meeting was held at the Saint Andrew Junior High School in Antigonish in May 1998 to present the options and to obtain public input regarding these and potential access locations. Prior to the consultation, efforts were made to contact, either by telephone or mail, all property owners directly affected by any of the three options. Information flyers consisting of a fact sheet and a small plan were sent to most homes and businesses in Antigonish County and advertisements were placed in the local paper. Over 700 residents of the area attended and 612 completed questionnaires were submitted (NSTPW 2001a). There was varied support for the three routes and interchange locations.

The three routes presented at the May 1998 open house were initially referred to as Options One, Two and Three and ultimately came to be known as the Red, Blue and Brown alignments, respectively. Option One was to replace the existing highway near the town of Antigonish while Option Two was up to 600 m south of the existing highway. The two alignments joined in the vicinity of Trunk 4. Option Three was located 2-3 km south of the existing Highway 104. An information flyer distributed at the meeting described the three options along with their advantages and disadvantages.

The red alignment (Option One) replaced a portion of the existing Highway 104 and maintained the visibility and access to local businesses, however it also entailed some damage to property and disruption of traffic flow during construction. The blue alignment (Option Two), quite similar to the red, was located between 300 and 600 m south of the existing highway, reduced property damage and minimized traffic disruption; however its proximal location to residential areas, potential impacts to farmland and reduced visibility to the town were considered negative features. The brown alignment (Option Three), located 2-3 km south of the existing Highway 104, provided for total separation of local and through traffic, minimized

disruption of residential areas and significantly reduced property acquisition costs; however it presented the most significant negative economic impact on the community.

A debriefing of staff following the meeting, subsequent correspondence received by NSTPW, and the local newspaper indicated strong support for the Blue and Brown routes, conflicting with the survey analysis, which identified the Red alignment as the preferred route. Further investigations including a safety review in 1999 (Beasy Nicoll Engineering Ltd. 1999), a peer review in 2000 (Scott and De Chiara 2000) and the South River Impact Study (Neill and Gunter Ltd. 2001) were undertaken. The Blue Route was ultimately selected based on an overall evaluation of constraints.

The final alignment proposed for EA registration of the Project was presented at a third open house meeting held in May 2001. Approximately 200 people attended this session with completed comment sheets handed in. Analysis of the comment sheets revealed 52% of respondents supported the Project, while 15% did not support the Project. Another 22% of respondents did not oppose the Project but had concerns over certain aspects of the proposed work.

In addition to alignment alternatives, other alternative means of carrying out the proposed Project may include buffer zones, alternative wetland and watercourse crossing methods/structures such as bridges, underpasses, and wildlife corridors (refer to Section 2.4.3). Specific alternatives and preferred options are discussed further in relevant sections in this report.

3.0 ENVIRONMENTAL SETTING

This section provides an overview of the existing biophysical, socioeconomic and regulatory environment in the study area. Table C1 (Appendix C) summarizes existing biophysical and socioeconomic characteristics, and provides relevant regulatory information for those constraints. Sub-categories in Table CB1 have been derived from a series of constraints specified in the Highway Environmental Database Study (NSDOTC 1991), and have been supplemented with additional categories according to the specific requirements of this study. A detailed description of relevant aspects of the existing environment is provided for Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) in Sections 5.0 and 6.0, respectively.

3.1 Biophysical Environment

The study area is located near the Town of Antigonish and community of Lower South River, extending from Addington Forks Road easterly approximately 15 km to Taylor Road. The proposed Highway 104 alignment is located within the Antigonish Basin. The alignment follows within 600 m of the current Highway 104 alignment at elevations ranging from sea level at Lower South River, to just over 50 m above sea level, and generally drains northwards through streams and watercourses into Antigonish Harbour (Figure 1.1).

The alignment is underlain by two geological formations: the Mabou and Windsor Groups. While there are no rock types associated with acid drainage problems in the area, a portion of the alignment may pass over Karst terrain near Lower South River. The Windsor Group presents potential for Karst development. Windsor Group rocks occurring along the alignment consist of the Hood Island Formation, which underlies approximately seven kilometres of the route. The rocks in this formation consist of red siltstone and sandstone with intercalated marine limestone and dolostone and minor gypsum.

Throughout Nova Scotia the formation of Karst Topography is typically associated with areas underlain by Carboniferous rocks of the Windsor Group which contain the rock types noted above. Geological mapping by R. C. Boehner and P. S. Giles, (1993) indicates minimal occurrence of soluble rock and limited outcropping of other sedimentary rock types along the proposed highway alignment.

Overburden consists of glacial deposits derived from the underlying and 'up-ice' bedrock units, and soil which is derived from the parent glacial tills. This till and glaciofluvial material was laid down by major ice sheets advancing across the area from northwest to southeast. Based on available geological mapping, two types of glacial overburden deposits are identified along the proposed alignment. The overburden can be subdivided into clay till and sand/gravel glaciofluvial deposits.

The proposed alignment passes through the Carboniferous Lowlands biophysical theme region (Davis and Browne 1996). The vegetation of this region is dominated by coniferous tree species the most abundant of which are black spruce (*Picea mariana*), jack pine (*Pinus banksiana*) white spruce (*Picea glauca*), red spruce (*Picea rubens*) and by red maple (*Acer rubrum*), a shade intolerant hardwood species. Hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are also not uncommon. Hemlock may occur in pure stands throughout, while extensive boggy areas are typically dominated by black spruce and tamarack (*Larix laricina*). American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) are found on slopes near the larger streams. Much of the area is farmed and old fields generally re-colonize in alders (*Alnus incana*) followed by white spruce (Davis and Browne 1996).

Terrestrial field studies conducted for the Project revealed the habitats in the study area to be relatively diverse and somewhat fragmented by secondary roads, woods roads, agricultural land, recent clear-cuts, and residential developments. Habitats present include: mixedwood, hardwood and softwood forest ranging in age from immature to mature, recent clear-cuts, treed swamps, tall shrub dominated swamps, low shrub dominated swamps, bogs, marshes, riparian habitats, abandoned pasture, active agricultural land, and residential areas. Forested habitats along the proposed route are generally young, typically less than 30 years old. Most of the residual older stands in the area visible on the most recent aerial photography, have been recently harvested. Forests along the route are composed largely of species characteristic of the early stages of forest succession in Nova Scotia including trembling aspen (*Populus tremuloides*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*), grey birch (*Betula populifolia*), white spruce, and balsam fir (*Abies balsamea*). No old growth forest, mature climax or climax dominated forests are present along the proposed route.

Twelve rare and uncommon plant species were found along the route during the field survey. One of these species, coffee-tinker's weed (*Triosteum aurantiacum*), is considered to be at risk in Nova Scotia (NSDNR 2002a). Three other species are considered to be sensitive to human activities in Nova Scotia, including Canada lily (*Lilium canadense*), wood nettle (*Laportea canadensis*) and black ash (*Fraxinus nigra*). All of these species, with the exception of black ash, were found in riparian habitat at the West River crossing site. The black ash was found in a recent clear-cut near 12 + 500. All of these species were found within the highway RoW. The remaining eight species are classed as uncommon in Nova Scotia (ACCDC 2002a) and their populations are considered to be secure in Nova Scotia (2002a). These include large purple-fringed orchid (*Platanthera grandiflora*), purple milkweed (*Asclepias incarnata*), hornwort (*Ceratophyllum demersum*), bloodroot (*Sanguinaria canadensis*), water loosestrife (*Lysimachia thyrsiflora*), pennsylvania smartweed (*Polygonum pensylvanicum*), marsh mermaid-weed (*Proserpinaca palustris* var. *creba*), and readhead grass (*Potamogeton richardsonii*). These species were found either in wetland habitats or riparian habitats at various locations along the route.

Twenty-one wetlands are found within the RoW of the proposed highway. One of the wetlands (Wetland 5) was infilled prior to the onset of the field surveys and was not evaluated. Wetland evaluations were conducted on the remaining wetlands. The wetland functional analyses completed in August 2002 revealed that five wetlands (Wetlands 1, 2, 10, 15, and 17) provided habitat for uncommon plant species. Four other wetlands (Wetlands 1, 6, 11, and 12) by virtue of their relatively large size were considered to have moderate value in regards to surface water flow regulation including augmentation of stream flow during low water periods and attenuation of flooding.

No rare herpetile species were identified within the study area however habitat suitable to the wood turtle, (*Glyptemys inscuplta*) listed by NSDNR as a sensitive species, was noted along the proposed alignment. No rare or sensitive mammal species were identified within the study area (refer to Section 5.5).

One provincially rare bird species, Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*) was found near the proposed highway in the tidal fresh marsh habitat on the South River. The Nova Scotia population of Nelson's Sharp-tailed Sparrow is considered to be sensitive to human activities or natural occurrences (NSDNR 2002a). Four uncommon species were also found along the route including Merlin (*Falco columbius*), Boreal Chickadee (*Parus hudsonicus*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), and Bobolink (*Dolichonyx oryzivorus*). The Nova Scotia Bobolink population is considered to be sensitive to human activities; however, the populations of the other three species are considered to be secure (NSDNR 2002a). Bobolinks were heard near the West River and South River outside of the proposed RoW. Other than Merlin, Osprey and Bald Eagle were the only raptor species believed to breed near the proposed highway RoW. Three Osprey nests have been recorded within 400 m of the RoW. The nearest osprey nest is located approximately 200 m from the RoW. The nearest Bald Eagle nest is an inactive nest, that is located approximately 430 m from the proposed highway.

Thirty watercourse crossings were identified using 1:10,000 mapping, however field reconnaissance identified only 16 crossings. Fish were observed in three brooks. Atlantic Salmon (*Salmo salar*), banded killifish (*Fundulus diaphanus*), white sucker (*Catostomus commersoni),* northern redbelly dace (*Chrosomus eos)*, creek chub (*Semotilus atromaculatus)*, three-spine sticklebacks (*Gasterosteus aculeatus*) and nine-spine sticklebacks (*Pungitius pungitius*) were the only fish caught or observed during the fish and fish habitat survey conducted for the Project. However, other fish species are reported to occur in some of the surveyed watercourses where they may be present for at least part of the year. Descriptions of fish and fish habitat are presented in Section 5.3 and Appendix D.

A hydrological study was completed for the Project (refer to Appendix B) on all watercourses to be crossed by the proposed alignment. The South River was evaluated in a separate study (Appendix E) conducted at the proposed crossing location. As discussed in Section 5.3, DFO identified watercourse crossings with significant fish habitat during the environmental screening and *Federal Coordination Regulations* processes.

These crossings are noted as follows with chainage shown in brackets):

- Brierly Brook, although not directly crossed by the alignment may be affected by crossings of its tributaries located at (0+100 and 0+275);
- West River (5+700);
- Unnamed tributary to Antigonish Harbour Station (8+150);and
- South River (11+350).

None of the crossings showed signs of active ice movement (ice scour, erosion, scarring, significant debris in channel).

Further detail on the biophysical environment in the study area is provided in Section 5.0, Environmental Effects Assessment.

3.2 Socioeconomic Environment

Antigonish is about 200 km from Halifax and is situated in the northeastern part of Nova Scotia with a total area of 1,463 km^2 or 2.8 % of the province's land mass. It is divided into two jurisdictions - the Town and County of Antigonish. The Town has a population of 4,754 based on 2001 data over a total land area of 5 km^2. The County has a population of 19,578 and a total area of 1,458 km^2. The combined population of the Town and County is 24,332.

According to the Antigonish Regional Development Authority (ARDA), the region's main economic advantage is the stability provided by the educational and health services in the Town. The region enjoys employment opportunities for professionals and non-professionals in St. Martha's Regional Hospital (300 employees) and Saint Francis Xavier (St. FX) University (500 employees). In general, the largest employers are public organizations, including St. FX, the hospital and the school board (ARDA 2002).

Employment by major industry classification includes: 74 % in service industries; 14 % in manufacturing and construction industries; and 12 % in agriculture and other resource-based industries. Based on 1996 data, retail trade employed most of the work force (15%) followed by educational services (12%) and health (12%) (ARDA 2002).

There is one serviced industrial park located east of the Town with direct access to Trans-Canada Highway 104. The Antigonish County Industrial Park consists of 41 hectares (101 acres) of land, serviced by a potable water distribution system, storm and sanitary sewers, and fire hydrants. Industries important to Antigonish include fishing, forestry, dairy and tourism (ARDA 2002).

In 1999, Antigonish contributed 1.6 % ($10 million) to the total landed value of fisheries in Nova Scotia. Lobster is the main fishery commodity in the region, followed by bluefin tuna, winter flounder, white hake, and American plaice (Nova Scotia Department of Agriculture and Fisheries (NSDAF) 2000). Based on 1997 data, there are 11 sawmills in Antigonish. Sawn fibre production (60,000 m^3) was 2% of total provincial harvest while roundwood yield (5400 m^3) was only 0.2%. Antigonish contributes 10% to Nova Scotia's total dairy production. Scotsburn Cooperative Dairy derives 25% of its milk from the Antigonish and Guysborough Counties. A total of 20.2% of the land area of Antigonish is farmland accounting for 6.9% of all agricultural farms in the province. About 33% of this land is for beef cattle, 22% for dairy cattle, 21% for Christmas trees, and 18% for other crops. There are a total of 247 farms in the County with total value of production of $19 million, which account for about 5% of Nova Scotia's gross farm income.

The Antigonish area is located along the Northumberland Strait and may be accessed by the scenic highway the Sunrise Trail. The Antigonish-Eastern Shore tourism area covers Antigonish County, Guysborough County, and the portion of Halifax County east of a line running from the mouth of the Little Salmon River at Cole Harbour to Gays River. Antigonish is the only community in that area that is located on a 100 series highway, with all other communities located on secondary highways.

Tourism and recreation areas in Antigonish include: supervised beaches in Bayfield and Pomquet; provincial parks; trails such as canoe waterways, coastal water trails, sea kayak routes, snowmobile, and the Trans Canada Trail; and nature sites including the Antigonish Harbour Wildlife Management Area, Arisaig Sea Cliffs, and Pomquet Beach Region. Another tourism and recreation area of interest is the newly built Keating Millennium Centre located in the Town of Antigonish, owned by St. FX University. It houses an IT training centre, two ice surfaces, convention facilities, and various fitness and water-related wellness activities. The Town also hosts the Antigonish Highland Games every July featuring Scottish traditions including language, music, dances and songs, along with feats of strength and excellence.

There are no registered archaeological sites within the study area, however, four heritage features were identified within the study area.

Further detail on the socioeconomic environment in the study area is provided in Section 6.0, Socioeconomic Effects Assessment.

3.3 Regulatory Environment

This Project is subject to numerous federal and provincial laws, regulations, and guidelines. NSTPW is required to register this Project as a Class II undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. The Project is also subject to approval under the *CEAA* as a screening level assessment. The following provides context for the regulatory requirements of the Project. While this is not intended to be an exhaustive list of pertinent federal and provincial legislation and policies,

it does provide an overview of key regulatory considerations for Project planning and implementation. Further detail on applicable legislation and guidelines is provided in Appendices B and E, and throughout the Report, with regard to specific activities (*e.g.*, blasting and acid generating rock) and VECs/VSCs.

3.3.1 Federal Legislation

Eligibility for federal funding for this Project is dependent on approval of the proposed Project under *CEAA*. In September 2001, the project description was distributed to Transport Canada, Environment Canada and DFO in accordance with the requirements of the *Federal Coordination Regulations (FCR)*. In the event that this Project is considered for federal funding, Transport Canada would require an environmental screening report under *CEAA*. Correspondence in the course of the *FCR* process (Appendix F) have indicated that Transport Canada will act as a Responsible Authority (RA) under *CEAA*. Some watercourses crossed by the alignment, in particular the South and West Rivers and possibly others, are likely to require approval under the *Navigable Waters Protection Act*, administered by Transport Canada. Although Environment Canada is not likely to have any power, duty or function in relation to the proposed Project that would trigger *CEAA*, it is in possession of expert and specialist information and is therefore recognized as an expert department for this environmental assessment. DFO is an RA since a *Fisheries Act* Authorization will likely be required for one or more of the proposed culvert installations that may result in the harmful alteration, disruption or destruction (HADD) of fish habitat. DFO also has relevant expertise regarding the assessment.

DFO has developed the *Policy for the Management of Fish Habitat* (1986), which applies to all projects and activities, in or near water, that could alter, disrupt, or destroy fish habitats by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The *Policy for the Management of Fish Habitat* is regulated by the following sections of the *Fisheries Act:* Section 20, 21, 22, 30, 32, 35, 37, 40 and 43, which are administered by DFO. Under the terms of a Memorandum of Understanding with Environment Canada, the Minister of Fisheries and Oceans continues to be legally responsible to Parliament for all sections of the *Fisheries Act*. However, for Sections 36 to 42, Environment Canada administers those aspects dealing with the control of pollutants affecting fish. DFO will co-operate with Environment Canada in the establishment of federal priorities for the protection of fish and their habitats from deleterious substances.

With respect to culvert installations and extensions, the *Fisheries Act* (Section 20) requires safe fish passage in all watercourses that bear fish. This is administered by DFO in close collaboration with NSDEL through the Water Approval process (formerly Watercourse Alteration Permit) under the provincial *Designated Activities Regulation*. This application process applies to new culvert installations and existing culverts which may require extensions and upgrading. DFO encourages all owners or occupiers to inspect existing culverts and upgrade these fishways, if necessary, to ensure adequate fish passage. Upgrades and new culvert installations will be completed as per the criteria presented in Conrad and Jansen (1994), or updates.

Under Section five of the *Navigable Waters Protection Act*, construction of works for activities below the high water mark in navigable waters must be approved in advance by Transport Canada. Examples of potential applicable activities include excavation, dredging, bridges, culvert installation, and construction of retaining walls. Under Sections 21 and 22, the *Act* prohibits the discharge of any waste or other material that may impair navigation in these waters.

Migratory birds are protected under the *Migratory Birds Convention Act* and Regulations which states that, "no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" without a permit. Section 35 of the *Migratory Birds Regulations* prohibits the deposit of oil, oil wastes or other substances harmful to migratory birds in any waters or any area frequented by migratory birds.

Other relevant federal legislation includes *CEPA, 1999* and the new *Species at Risk Act* (SARA). *CEPA, 1999* relates to the management of toxic substances (*e.g.*, road salt) and to the development of environmental quality objectives and guidelines. *SARA* is designed to protect plant and animal species at risk nationally and their critical habitat. *SARA* builds on existing laws and agreements and complements provincial initiatives to protect species at risk. It is noted that prior to the enactment of *SARA*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessments were the basis for the endangered species list. Under the new act, assessments of species at risk in Canada previously determined by COSEWIC will continue, however, COSEWIC assessments will now be published in the *SARA* public registry and the legal designation of these species will be achieved through the Governor-in-Council. Refer to Section 5.9 for more information on the specific implications of *SARA* to this Project.

3.3.2 Provincial Legislation

NSTPW is required to register this project as a Class II undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*.

The *Environment Act* promotes protection and prudent use of the environment. All provincial and federal departments, agencies, boards and commissions and the general public are subject to prosecution, ministerial orders and other remedies under the *Act*. Twenty-two sets of regulations have been passed under the *Environment Act* to help deal with the practical application of the *Act*. Regulations most relevant to this Project include: *Activities Designation Regulations*; *Environmental Assessment Regulations*; *Air Quality Regulations*; *Dangerous Goods Management Regulations*; *Solid Waste-Resource Management Regulations*; and *Sulphide Bearing Material Regulations*.

Under the *Activities Designation Regulations*, a Water Approval is required for watercourse alteration activities proposed during the construction phase (*e.g.*, culvert installation). Also requiring approval under the *Activities Designation Regulations* is the disposal of sulphide bearing material. The *Sulphide Bearing*

Material Regulations contain provisions for sampling, criteria for site excavation and requirements for disposal of sulphide bearing materials (*i.e.*, acid producing bedrock).

In addition to the *Environment Act* and Regulations, other relevant provincial laws include, but are not limited to: the *Dangerous Goods Transportation Act*; *Occupational Health and Safety Act; Special Places Protection Act*; *Endangered Species Act* and *Wildlife Act*.

All Project work will be conducted in accordance with applicable provincial legislation.

3.3.3 Policies and Guidelines

The construction of the proposed alignment will follow specifications prepared by NSTPW, including Highway Construction and Maintenance Standard Specifications (NSTPW 1997 and revisions) and Approval Process for Pits Containing Slates (NSDOTC 1990), and by NSDEL, including the Pit and Quarry Guidelines (NSDOE 1999), and the Erosion and Sedimentation Control Handbook for Construction Sites (NSDOE 1988). Other relevant NSDEL guidelines and specifications include the Guideline for Environmental Noise Measurement and Assessment (NSDOE 1989) and the Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996).

Joint provincial-federal publications include Guidelines for Development on Slates (NSDOE and Environment Canada 1991), and Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al.* 1981). Relevant federal guidelines include Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979).

In Nova Scotia, wetlands are protected by the Wetlands Directive (NSDOE 1995a). Any loss of wetland requires a wetland evaluation to establish the value of the wetland in relation to the merits of the development. Wetlands under 2 ha in size are evaluated using the NSDEL 10 step wetland evaluation procedure. Wetlands larger than 2 ha are evaluated using the North American Wetland Conservation Council wetland evaluation procedure. The Federal Policy on Wetland Conservation (1992) promotes wetland conservation, and specifically, no net loss of wetland functions on federal lands and waters.

The Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996) describe the process to manage land that has potential for unacceptable impacts or risks associated with the presence of contaminants (refer to Section 2.4.14).

Project work will adhere to all applicable policies and guidelines.

4.0 ENVIRONMENTAL ASSESSMENT METHODOLOGY

4.1 Overview and Approach

The environmental assessment methodology for the Project has been developed to satisfy regulatory requirements for a screening level assessment pursuant to the *CEAA* and an environmental assessment for a Class II Undertaking under the Nova Scotia *Environmental Assessment Regulations*.

The approach and methodology used are based largely on the work of Beanlands and Duinker (1983), the Canadian Environmental Assessment Agency (1994, 1997, 1999a,b) and Barnes *et al* (2000), as well as the study team's expertise in conducting environmental assessments. The approach and methods used have proven very effective for assessments conducted under federal, provincial, joint federal-provincial and multi-party processes, as well as for environmental assessments in various jurisdictions throughout the world. The assessment focusses on environmental components of greatest concern (to potentially affected parties).

Assessing all of the potential issues associated with a proposed undertaking is impractical, if not impossible (Beanlands and Duinker 1983). It is therefore generally acknowledged that an environmental assessment should focus on those components of the environment that are valued by society and/or that serve as indicators of environmental change. These components are known as VECs and VSCs. The environmental assessment for the Project evaluates the potential effects, including cumulative effects, of each Project phase (construction and operation) with regard to each VEC or VSC. The cumulative effects assessment, including details on methodology and approach is included in Section 8.

4.2 Issues Scoping and Selection of Valued Environmental and Socioeconomic Components

A scoping exercise was conducted by the study team to identify an appropriate list of VECs and VSCs. This exercise included a review of: the Environmental Assessment Registration Document for the Highway 104 at Antigonish (NSTPW 2001a); Terms of Reference as required by the *Environment Act* (NSDEL 2002a); and Comments Submitted on the Proposed Terms of Reference and Environmental Assessment Registration Document (NSDEL 2002b). The latter included comments from provincial and federal regulatory agencies, as well as public comments. Preliminary research, stakeholder consultation, field investigations and the study team's professional judgement were also used in the issues scoping process.

Table 4.1 lists Project stakeholders contacted by the study team during the scoping process.

Table 4.1 Stakeholders Contacted by the Study Team for the Environmental Assessment Report

Name	Title	Organization
Michael Julien	Chief	Afton First Nation
Jocelyn Gillis	Curator	Antigonish Heritage Museum
Aaron Applin	Technical Intern	Antigonish Regional Development Authority
Don Cameron	Development Officer	Antigonish Regional Development Authority
Veronica Gillies	Development Officer	Antigonish Regional Development Authority
Cameron McKenzie	Chairman	Antigonish Regional Development Authority
John Parker	Executive Director	Antigonish Regional Development Authority
John Tramble	Member of the Board	Antigonish Regional Development Authority
Stefen Gerriets	Data Manager	Atlantic Canada Conservation Data Centre
Ken Simms	Owner	Casket Publishing
Dorothy Westmon	Reporter	Casket Publishing
Danielle Goth	Habitat Management Officer	Department of Fisheries and Oceans Canada
Inez Grant	N/A	Landowner
Elizabeth O'Neill	N/A	Landowner
J. Oostyogels	N/A	Landowner
George Lerikos	Owner	Lobster Treat Restaurant
Roderick Ian MacPherson	Owner	MacPherson's New To You Furniture
David Miller	Owner	McDonald's Restaurant
Alan J. Bond	Municipal Clerk/Treasurer	Municipality of the County of Antigonish
Kemp MacDonald	Municipal Planner/Development Officer	Municipality of the County of Antigonish
Mike O'Leary	Director of Public Works	Municipality of the County of Antigonish
Ken Proctor	Engineer	Municipality of the Town of Antigonish
Mark Pulsifer	Regional Biologist	Nova Scotia Department of Natural Resources
Donald Carter	Construction Manager	Nova Scotia Department of Transportation and Public Works
Phil Corkum	Manager, Highway Planning and Design	Nova Scotia Department of Transportation and Public Works
Mike Croft	Engineer, Highway Planning and Design	Nova Scotia Department of Transportation and Public Works
Lester Hanley	Senior Traffic Engineering Technician	Nova Scotia Department of Transportation and Public Works
Paul Smith	Road Safety Engineer	Nova Scotia Department of Transportation and Public Works
Andrew Hebda	Curator of Zoology	Nova Scotia Museum
Marian Munro	Curator of Botany	Nova Scotia Museum
Robert Oglive	Curator, Special Places	Nova Scotia Museum
Stephen Powell	Assistant Curator, Archaeology	Nova Scotia Museum
John Gilhen	Curator of Ichthyology and Herpetology (Retired)	Nova Scotia Museum (formerly of)
Minke Inglis	Member	Profile Antigonish
Paul MacLean	Chair	Profile Antigonish
Brian Segull	Owner	Redgull Incorporated
Fraser Dunn	Local Historian	Resident of Antigonish
Heather Magotiaux	Advancement	St. Francis Xavier University
Ron Bantjes	Chair, Department of Sociology	St. Francis Xavier University
Tiiu Poder	Executive Director	St. Francis Xavier University
David Fullerton	Small Business Training and Development Manager	St. Francis Xavier University - Enterprise Development Centre
Mary McLellan	Town Councillor	Town of Antigonish
Gary Cusack	Owner	Welcome Inns

Table 4.2 summarizes the issues identified during the scoping process and their respective sections, where they are addressed in the EA Report.

Table 4.2 Issues Identified During the Scoping Process

Issue Identified	Where Addressed in EA Report
Atmospheric conditions	Sections 5.1, 9.0
Potential for micro-climate modifications	Section 9
Blasting effects	Sections 2.4.6, 5.2.1, 5.2.8, 5.2.7, 5.3.4
Acid generating rock and impact of acidic runoff	Sections 2.4.12, 5.2.4, 5.3.4
Karst topography	Sections 2.4.13
Fish habitat evaluation	Section 5.3
Impacts on wetlands	Section 5.8
Impacts on fauna	Sections 5.4, 5.5, 5.6, 5.8
Impacts on flora	Sections 5.7, 5.8
Impacts associated with contaminated soils and runoff	Sections 2.4.14, 5.2.2
Noise impacts (including human and wildlife)	Section 5.1
Groundwater impacts	Section 5.2
Significant wildlife habitat, management areas and corridors	Sections 5.4, 5.5, 5.6, 5.8
Local economy	Section 6.1
Landowner access	Sections 6.2, 6.4
Impacts on land use	Section 6.2
First Nations current or historical land use	Section 6.2, 6.3
Future development options	Section 6.2
Impacts on residential property values	Section 6.1
Archaeological and palaeontological sites	Section 6.3
Effects on safety	Section 6.4
Impacts on transportation	Section 6.4
Alternative transportation infrastructure	Section 2.7
Fragmentation of landholdings	Section 6.2

Based on a review of issues identified (Table 4.2) and the professional judgement of the study team, the following VECs/VSCs have been identified for the purpose of this EA Report (Table 4.3).

Table 4.3 Identified VECs and VSCs

VECs	VSCs
••Atmospheric Resources	••Local Economy
••Groundwater Resources	••Land Use
••Fish and Fish Habitat	••Archaeological and Heritage Resources
••Rare Herpetiles	••Transportation Infrastructure
••Rare Mammals and Critical Habitat	
••Rare and Sensitive Birds	
••Rare Plants and Plant Communities	
••Wetlands	

Table 4.4 provides the rationale for the selection of the chosen VECs and VSCs. Public/stakeholder concerns included comments submitted during the open house public meetings, public review of the EA Registration document (NSTPW 2001a) and Terms of Reference (NSDEL 2002a), and through individual landowner/stakeholder consultation by JW. Regulatory considerations include those raised by government regulatory officials and relevant legislation. Professional judgement was based on the opinion and experience of the study team.

Table 4.4 Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) and Selection Rationale

VEC/VSC	Terms of Reference	Public/Stakeholder Concerns	Regulatory Considerations	Professional Judgement	Where VEC/VSC is addressed in EA Report
Atmospheric Resources	•		•	•	Section 5.1
Groundwater Resources	•		•	•	Section 5.2
Fish and Fish Habitat	•	•	•	•	Section 5.3
Rare Herpetiles	•		•	•	Section 5.4
Rare Mammals and Critical Habitat	•	•	•	•	Section 5.5
Rare and Sensitive Birds	•	•	•	•	Section 5.6
Rare Plants and Plant Communities	•		•	•	Section 5.7
Wetlands	•		•	•	Section 5.8
Local Economy	•	•		•	Section 6.1
Land Use	•	•		•	Section 6.2
Archaeological and Heritage Resources	•		•	•	Section 6.3
Transportation Infrastructure	•	•		•	Section 6.4

4.3 Potential Interactions Between Project Activities and Valued Environmental and Socioeconomic Components

Tables 4.5 and 4.6 summarise the potential interactions between Project activities and the selected VECs and VSCs, respectively. The specific nature and extent of these interactions with each VEC/VSC are discussed and evaluated in the biophysical and socioeconomic effects assessments (Sections 5.0 and 6.0).

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Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
CONSTRUCTION									
Site Preparation: surveying; clearing; grubbing	•		•	•	•	•	•	•	Removal of vegetation leading to soil erosion and runoff; damage to streambanks and beds; loss and fragmentation of terrestrial habitat; disturbance of wildlife; air, noise, and dust emissions from construction equipment
Roadbed Preparation: blasting; ripping; placement of fill; grading	•	•	•	•	•	•	•	•	Soil compaction and rutting; damage to streambanks and beds; runoff; disturbance of wildlife; air, noise and dust emissions from construction equipment; and dust and noise emissions and groundwater disturbance from blasting
Watercourse Crossing: site preparation; stream diversion; culvert installation; restoration	•		•	•	•	•	•	•	Habitat/watercourse disruption and/or degradation; release of contaminants; disturbance of wildlife; erosion and sedimentation; fish mortality; stormwater runoff; soil mixing and compaction; air and noise emissions from construction equipment

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Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Surfacing and Finishing Activities: paving; line painting; guard rail installation	•					•	•		Air and noise emissions from construction equipment; disturbance of wildlife;
OPERATION AND MAINTENANCE									
Road and RoW maintenance: asphalt repair; repainting; shoulder regrading; mowing	•		•	•	•	•	•	•	Air and noise emissions from equipment; disturbance to existing vegetation; erosion from shoulder regrading
Winter maintenance: salt application; snow plowing		•	•	•	•	•	•	•	Surface and groundwater contamination; vegetation disturbance
Highway operation: presence of RoW; vehicular traffic	•				•	•	•		Permanent habitat alteration; fragmentation; air and noise emissions from traffic; and vehicle/wildlife interactions

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Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
MALFUNCTIONS AND ACCIDENTAL EVENTS									
Hydrocarbon spills or leaks: spills or leaks of fuels, hydraulic fluid during construction	•	•	•	•	•	•	•	•	Soil/groundwater contamination; contaminated runoff; spill into surface water; ingestion/uptake of contaminants by wildlife
Vehicular accidents: collisions; spills of hazardous materials (cargo)		•	•	•	•	•	•	•	Soil/groundwater contamination; contaminated runoff; spill into surface water; ingestion/uptake of contaminants by wildlife
Fires	•	•	•	•	•	•	•	•	Destruction to habitat; disruption and potential mortality to wildlife; smoke emissions; runoff associated with fire-fighting materials

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Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
CONSTRUCTION					
Site Preparation: surveying; clearing; grubbing	•	•	•	•	Disturbance to existing and anticipated land uses due to property acquisition and fragmentation; loss of forestry resources and/or limited access to forestry lands; disruption of recreation activities; noise and dust emissions from construction equipment; disturbance to archaeological resources where present; disruption of current traffic patterns; employment opportunities due to construction activities.
Roadbed Preparation: blasting; ripping; placement of fill; grading	•	•	•	•	Disturbance to existing land uses due to noise and dust emissions; disturbance to archaeological resources where present; disruption of current traffic patterns; employment opportunities due to construction activities.
Watercourse Crossing: site preparation; stream diversion; culvert installation; restoration	•	•		•	Disturbance to existing land uses due to air and noise emissions from construction equipment; disruption of recreational fishing activities; disturbance to archaeological resources where present; employment opportunities due to construction activities.
Surfacing and Finishing Activities: paving; line painting; guard rail installation	•	•	•	•	Disturbance to existing land uses due to air and noise emissions from construction equipment; disruption to existing traffic patterns; employment opportunities due to construction activities.

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Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
OPERATION AND MAINTENANCE					
Road and RoW Maintenance: asphalt repair; repainting; shoulder regrading; mowing	•	•	•	•	Noise and air emissions from equipment; temporary disruption to existing traffic patterns; employment opportunities due to construction activities.
Winter Maintenance: salt application; snow plowing	•		•		Public safety and transportation improved through road condition improvement; noise emissions and heavy machinery; employment opportunities due to construction activities.
Highway Operation: presence of RoW; vehicular traffic	•	•	•	•	New limited access highway will alter existing traffic patterns, alleviating existing heavy traffic conditions and improving driver safety; reduction in pass-by customers in commercial establishments; build up of commercial activities near interchange locations; opening of new areas for residential, industrial and commercial development; improvement in overall regional transportation system; faster access to recreation and tourism areas; increased access to market; disturbance to adjacent land use by noise, lights, and air emissions from highway use; limited access to forestry lands; disruption of recreation activities alteration of community land use pattern due to road development access limitations; vehicle/wildlife interactions.

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Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
MALFUNCTIONS AND ACCIDENTAL EVENTS					
Hazardous Materials Spills: spills or leaks of fuels, hydraulic fluid during construction		•		•	Soil/groundwater contamination; effects on property values; interference with enjoyment of property; disturbance to archaeological and heritage resources; offsite
Vehicular Accidents: collisions; spills of hazardous materials (cargo)		•	•	•	Temporary effects on traffic flow ; effects on public safety; soil and/or groundwater contamination; disturbance to offsite archaeological and heritage resources where present
Fires		•	•	•	Effects on public safety; disturbance to property; disturbance to above-grade archaeological and heritage resources; temporary effect on traffic flow

4.4 Environmental Effects Assessment Framework

The following subsections describe how the environmental effects assessment for each VEC/VSC is organized in Sections 5.0 and 6.0 respectively. Figure 4.1 illustrates the standard sequence of steps followed in the assessment for each VEC/VSC.

4.4.1 VEC Identification and Description of Ecological and Socioeconomic Context

To ensure that the assessment is holistic, the CEA Agency guidance documents (1994) require a description of the ecological and socio-cultural context for each VEC/VSC. The consideration of the current state of a VEC/VSC and any Project-related effects requires an evaluation of the relationship of each VEC/VSC with other components of the ecosystem or human systems (*i.e.,* trophic relationships). This section also describes each VEC/VSC to be assessed and the rationale for its selection.

4.4.2 Boundaries

An important aspect of the effects assessment process is the determination of the boundaries of the assessment. Temporal and spatial boundaries encompass those periods during, and areas within which, the VECs/VSCs are likely to interact with, or be influenced by, the Project. These boundaries may extend well beyond the limits of direct disturbance (*e.g.,* migratory species whose range extends beyond the area of physical disturbance associated with the Project). Other boundaries to be considered as appropriate include administrative and technical boundaries imposed by factors such as finite resources of data, time, cost, and labour, as well as technical, political, or administrative considerations or jurisdictions.

An important temporal consideration for this assessment is that the Project schedule is subject to the regulatory approval of the Project and completion of design and property acquisition and ultimately prioritisation of the Project itself. Some of these VECs/VSCs may change over that time (*e.g,* land use) possibly necessitating a review of aspects of the assessment pertaining to these VECs/VSCs to ensure currency of the information as the Project nears development.

4.4.3 Description of Existing Conditions

Existing conditions (*i.e.*, pre-Project) are described for each VEC/VSC. The description is restricted to a discussion of the status and characteristics of the VEC/VSC within the boundaries established for the assessment. This information is contained in Section 3, Environmental Setting, for each VEC/VSC in Section 5 and 6 respectively, and in Appendix C in varying levels of detail. In order to improve the focus and readability of the assessment, the description centres on aspects that are relevant to potential Project interactions; additional information is compiled as appendices and/or background studies, as necessary.

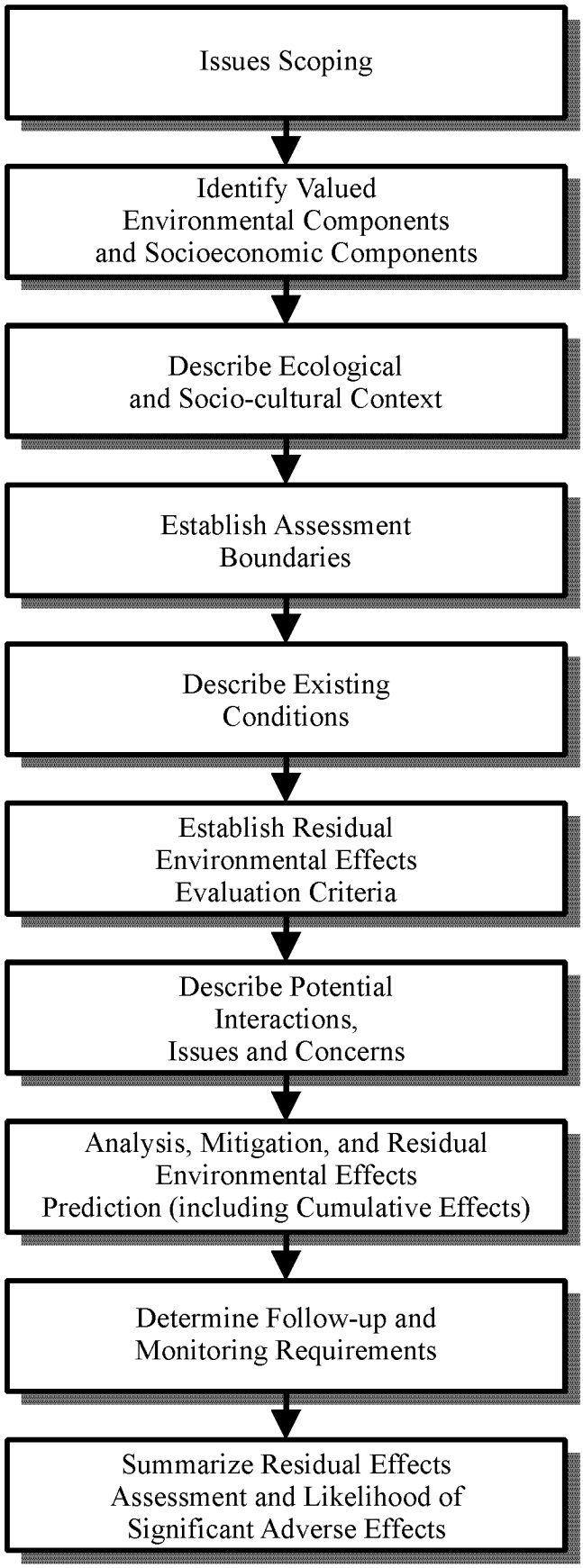

Figure 4.1 Environmental Effects Assessment Methodology

4.4.4 Establishment of Residual Environmental Effects Evaluation Criteria

Section 16(1)(b) of the *Canadian Environmental Assessment Act (CEAA)* specifically requires that the significance of environmental effects be determined. Accepted practice in meeting this requirement involves establishing evaluation criteria for the determination of significance.

The CEA Agency (1994) lists criteria that should be taken into account in deciding whether adverse environmental effects are significant. These criteria include, among other factors:

- magnitude;
- geographic extent;
- duration;
- frequency;
- reversibility; and
- ecological and/or socio-cultural context.

These criteria have been considered in this assessment with regard to the determination of significance for each VEC/VSC. It is also necessary to define the threshold beyond which an effect is considered, for the purpose of this assessment, to be significant. For each VEC/VSC, a definition is provided for 'significant adverse environmental effect' and 'positive effect'. These significance definitions are generally population- or community-based, but may be based on regulatory standards or limits, where these exist for a particular VEC/VSC.

4.4.5 Potential Interactions, Issues and Concerns

Potential interactions with VECs/VSCs (*i.e.*, a description of the degree to which the VECs/VSCs are exposed to each Project activity as indicated in Tables 4.5 and 4.6), are described in the assessment. Where appropriate, the assessment includes a summary of major concerns or hypotheses of relevance regarding the effect of each Project activity on the VEC/VSC being considered. Where existing knowledge indicates that an interaction is not likely to result in an effect, certain issues may not warrant further analysis.

4.4.6 Analysis, Mitigation, and Residual Environmental Effects Prediction

The assessment focuses on the evaluation of potential interactions between the VECs/VSCs and the various Project activities outlined in the Project Description. A standard evaluation system has been developed to

ensure that potential effects are clearly and completely evaluated. The prediction of residual effects follows three general steps, as outlined by the CEA Agency (1994):

- determining whether the environmental effects are adverse;
- determining whether the adverse environmental effects are significant; and
- determining whether the significant adverse environmental effects are likely to occur.

The effects assessment analysis conducted for each VEC/VSC is summarised in a template matrix. The residual environmental effects assessment matrix summarizes the effects by Project activity for construction, and operation and maintenance phases, and describes the mitigation for each activity (Table 4.7). The modifiers used to characterize the various criteria considered in the determination of effect significance (based on magnitude, geographic extent, duration, frequency, reversibility, and ecological and/or socio-cultural context) may vary for different VECs/VSCs.

Determining Whether Environmental Effects are Adverse

The effects evaluation for each VEC/VSC is conducted by Project phase (construction, operation and maintenance). For each phase, the study team selects those Project activities that may result in a positive or adverse effect.

To determine if there are adverse effects, the study team considers a number of factors, including those recommended in the CEA Agency guidance documents (1994):

- negative effects on the health of biota;
- loss of rare or endangered species;
- reductions in biological diversity;
- loss of critical/productive habitat;
- fragmentation of habitat or interruption of movement corridors and migration routes;
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- toxicity effects on human health;
- reductions in the capacity of renewable resources to meet the needs of present and future generations; and
- loss of current use of lands and resources for traditional purposes by Aboriginal persons.

Where adverse or positive effects are identified, the Project activity and the effects are listed in the matrix.

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Table 4.7 Residual Environmental Effects Assessment Matrix VEC/VSC (Project Phase)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Socio-cultural and Economic Context		

KEY

Magnitude: 1 =Low: *i.e.,* within the normal variability of baseline conditions; 2 = Medium: *i.e.,* increase/decrease with regard to baseline but within standards and objectives; 3 =High: *i.e.,* singly or as a significant contribution in combination with other sources causing exceedances or impingement upon standards and objectives beyond the property line of the project

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Determining Whether the Adverse Environmental Effects Are Significant

Analysis and Residual Environmental Effects Prediction

The analysis evaluates the interactions between Project activities and the VEC/VSC and determines the significance of any residual adverse environmental effects (*i.e.*, effects that may persist after all mitigation strategies have been implemented). The study team evaluates possible residual environmental effects according to the evaluation criteria established for the VEC/VSC. These effects are assigned a rating of significant adverse, non-significant adverse, or positive. The team's evaluation includes consideration of specific mitigation strategies and the residual environmental effects evaluation criteria mentioned above. Supporting discussion in the text highlights particularly important relationships or data identified in the matrix.

To comply with the requirements of Section 16(1)(a) of the *CEAA*, cumulative environmental effects of past, present, and likely future projects are considered. The concept of cumulative environmental effects also recognizes that the environmental effects of different human activities can combine and interact with each other to cause cumulative effects that may be different in nature or extent from the effects of individual activities. Cumulative effects assessment has been undertaken in this screening based on projects scoped and assessed for each VEC/VSC. The residual environmental effects prediction in the assessment incorporates cumulative effects.

Level Of Confidence

The significance of the residual environmental effects of the Project on a VEC/VSC is evaluated based on review of relevant literature, consultation with experts, and professional judgement. In some instances, limitations in the available data make effect predictions difficult. Ratings are therefore provided to indicate the level of confidence with which the study team makes each prediction.

Overall Residual Effects Rating by Phase

After completing the assessment of specific Project activities, the study team evaluates the residual effects by Project phase. This overall rating considers all residual adverse effects, including cumulative effects.

Determining Whether the Significant Residual Adverse Environmental Effects are Likely to Occur

The CEA Agency (1994) has provided criteria for determining the likelihood of significant residual adverse environmental effects including:

- probability of occurrence; and
- scientific uncertainty.

Where possible, the assessment can apply statistical methods to determine the likelihood of significant residual effects. Where such methods are not feasible, a qualitative approach based on non-statistical analyses or professional judgement is used.

4.4.7 Follow-Up and Monitoring

Section 16(2)(c) of the *CEAA* require consideration of the need for, and requirements of, any follow-up studies. These are evaluated for each VEC/VSC. Requirements for follow-up and monitoring are linked to the sensitivity of a VEC/VSC to both Project-related and cumulative environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with the adverse residual effects rating, are also taken into consideration.

4.4.8 Summary of Residual Effects Assessment

This section summarizes the adverse environmental effects on each VEC/VSC by Project phase. It also addresses the likelihood of all predicted significant adverse effects. The likelihood of a significant adverse environmental effect is based on scientific knowledge with reference to statistical significance, quantitative risk assessment, or professional judgement.

5.0 ENVIRONMENTAL EFFECTS ASSESSMENT

5.1 Atmospheric Resources

Atmospheric Resources are considered to be a VEC due to their intrinsic importance to the health and well-being of humans, wildlife, and vegetation. This section addresses the potential for airborne pollutants and the potential local effects on air quality. It also considers the potential effects of noise generated by the Project.

Noise is defined as unwanted sound. Air and noise emissions are of most concern for potentially sensitive receptors such as residential land uses (discussed in Section 6.2). Air emissions and noise are also generated by traffic, which is discussed further in Section 6.4.

5.1.1 Boundaries

Spatial boundaries for the assessment of atmospheric resources consider the area of the proposed alignment for Highway 104 and surroundings. Project related effects on air quality are not expected to extend beyond approximately 200 m of the RoW. Spatial boundaries for the assessment of Project-related noise include all sensitive receptors (*e.g.*, residential areas, schools, hospitals, retirement homes, chronic care facilities, designated parklands, and recreational facilities) within 300 m of the Project area. The 300 m range is the distance at which the noise output from a typical piece of heavy machinery under load will attenuate to below the NSDEL night-time guideline of 55 dBA.

Temporal boundaries for this assessment include the construction and operation phases of the Project. The temporal boundary for the assessment is continuous during Project construction and operation as the adjacent area is populated and active year-round. Residential areas are the most sensitive receptors for noise impacts at night. In residential areas, noise levels are usually dominated during the day by traffic, property maintenance and recreational activities. At night, local traffic is greatly reduced so that noise from the nearest arterial roads and industry may be the most dominant perceived source. Other temporal issues include seasonal considerations when residents of the study area may be engaged in a greater number of outdoor activities and potentially subject to a greater amount of noise and dust.

5.1.2 Description of Existing Conditions

Air Quality

The Project area, and Nova Scotia in general, has good air quality due to the combination of maritime climate and relatively small population and industrial bases (NSDOE 1998). Climatic conditions provide good dispersion of air contaminants. The ambient air quality also benefits from the infusion of relatively

clean polar and arctic air masses. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transport contaminants into the area, causing poorer air quality.

Ambient air quality is monitored in Nova Scotia with a network of 28 sites, operated by NSDEL, Environment Canada, and Nova Scotia Power Inc. (NSPI). The NSDEL monitoring site nearest the study area is located at the Pictou Museum and monitors sulphur dioxide (SO_2), total reduced sulphur, and total suspended particulates (TSP). Monitoring sites in Halifax and Point Tupper are the nearest to the Project which monitor nitrogen dioxide (NO_2), carbon monoxide (CO), Hydrogen Sulphide (H_2S) and ground level ozone (O_3). These sites are jointly operated by NSDEL and Environment Canada.

In general, the air quality of Nova Scotia meets the desired federal ambient air quality criteria, with one-hour maximums below maximum acceptable limits for CO, NO_2 and TSP (refer to Table 5.1). Occasional hourly exceedances for SO_2 and H_2S occur in localized areas with high industrial activity (*i.e.*, Point Tupper) (NSDOE 1995b) (Table 5.1). Hourly exceedances of ground level ozone have occurred on an occasional basis over the entire province, but are the most severe in southwestern Nova Scotia. The ozone is associated with long range transport of pollutants from central Canada and the US (NSDOE 1998).

The proposed Project is located in an area of northern Nova Scotia which has some heavy industry present in the form of an NSPI power plant and the Trenton metal works near New Glasgow (approximately 60 km). In the *1995 Ambient Air Quality in Nova Scotia* (NSDOE 1995b), the Pictou Region had only one exceedance of the air quality objectives. This was a high TSP result which had been due to unusual helicopter activity in the vicinity of the sampling equipment. It may therefore be assumed that ambient air quality of the study area generally meets the desired criteria, except when long-range transport results in high levels of ozone.

Table 5.1 Maximum Values for Air Quality Parameters Measured at Monitoring Stations in Nova Scotia

Parameter	Reported Maximum	NSDEL Limit	Time Period	Location
SO_2	33.5 pphm	34 pphm	hourly	Pictou (NSPI)
TRS[1]	13 ppb	30 ppb	hourly	Pictou
TSP	187 µg/m^3	120 µg/m^3	24 hours	Pictou
H_2S	84 ppb	30 ppb	hourly	Point Tupper
CO	3.8 pphm	31 pphm	hourly	Halifax
NO_x	7.8 pphm	21 pphm	hourly	Halifax
O_3	2 exceedance events	82 ppb (objective)	hourly	Halifax

[1]Total Reduced Sulphur (TRS)
Source: NSDOE 1995b

Noise

Noise Guidelines

The regulation of noise in Nova Scotia is established through the Nova Scotia Department of Environment Guidelines for Noise Measurement and Assessment (Noise Guidelines) (NSDOE 1989) as follows.

- Leq 65 dBA between 0700 h and 1900 h
- Leq 60 dBA between 1900 h and 2300 h
- Leq 55 dBA between 2300 h and 0700 h

Since the effect on land use may be significantly influenced by noise from highway construction and operation, the Noise Guidelines recommend values for residential or sensitive areas defined as "areas where people normally live, work, or take part in recreation". This does not apply to company work forces, which are protected under the *Occupational Health and Safety Act*.

Ten sites were identified to be monitored for a baseline noise study and are identified on Figure 5.1. The locations were selected to provide sufficient baseline data coverage of potentially sensitive receptors and enable noise prediction for all these properties. For example, one sample station is considered adequate for several homes closely situated together. Factors affecting noise propagation (*i.e.*, trees, topography) at particular properties have been observed and recorded.

Field Conditions

Meteorological conditions, particularly wind, may affect recorded noise levels. Baseline noise readings were taken between August 12 and 17, 2002. Conditions during which monitoring was performed were hot, with clear to partly cloudy skies and calm to light winds (20 km/hr or less). Relative humidity ranged between 75 and 100 % during the monitoring dates.

Measurement

Sound levels were taken using Larson Davies Model 824 and Bruel & Kjaer Model 2236 integrating sound level metres. These instruments average the energy level of sound over a selected period of time and express this as L_{eq} in dBA (A-weighted decibels). An L_{eq} is the expression of equivalent level of sound energy over the referenced time period and is the most commonly used environmental noise descriptor (Cowan 1994). Each measurement session was comprised of data logged one minute L_{eq} readings over defined time periods. Measurements were then used to calculate hourly L_{eq} values. Pursuant to the Noise Guidelines, measurements were taken during portions of three daily periods: day (07:00 to 19:00), evening (19:00 to 23:00) and night (23:00 to 07:00).

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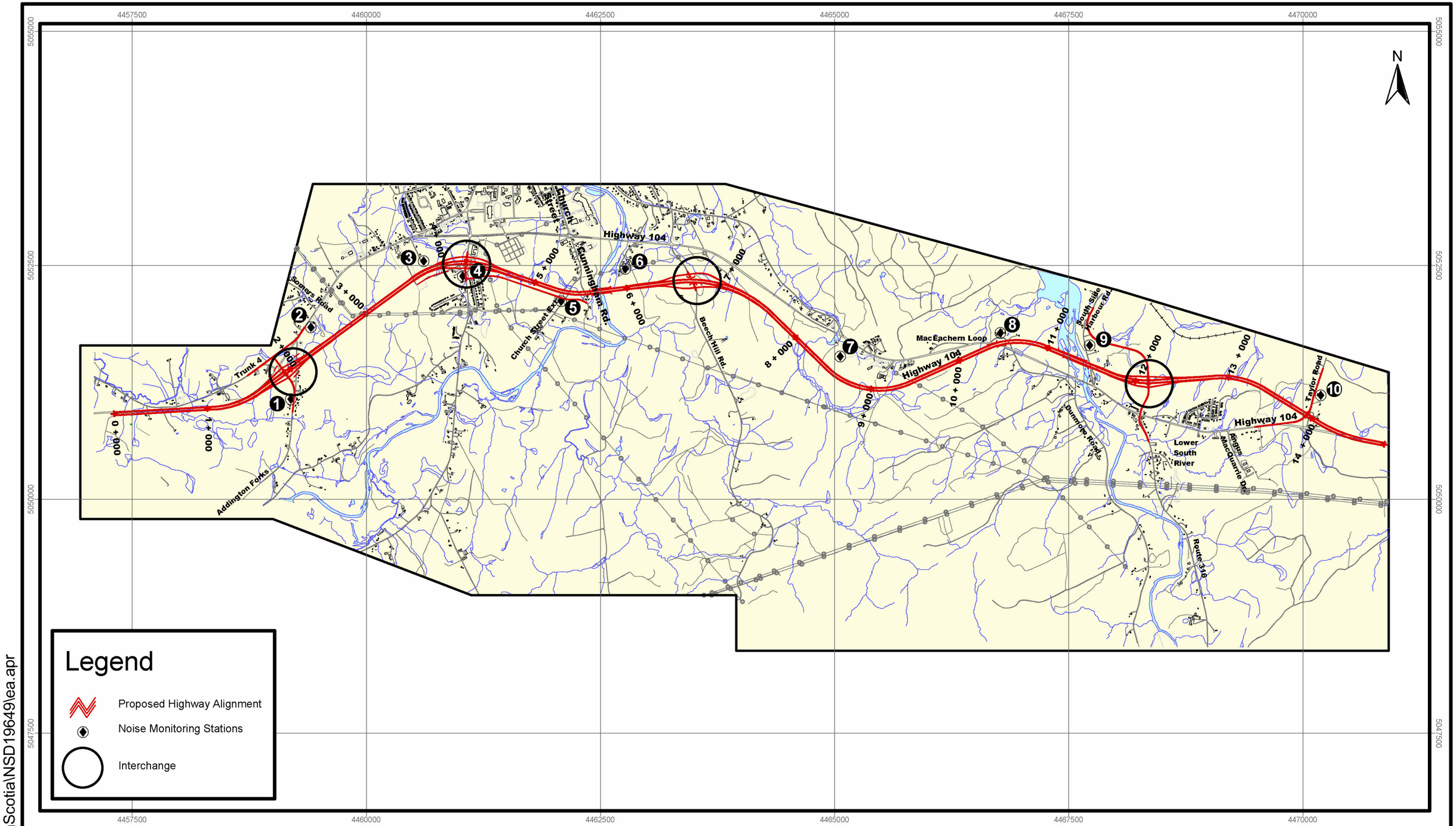

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Jacques Whitford

NOVA SCOTIA Transportation and Public Works

SCALE: 1 : 37 500

Date: 9/01/2004

Drawn By: GM

Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Noise Monitoring Stations

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.

NSD16949
FIGURE 5.1

Baseline noise levels were tabulated and compared with the Noise Guidelines. Where noted by field staff, area noise sources have also been listed. A summary of field measurements is presented in Table 5.2.

The values recorded at all baseline locations demonstrate typical levels expected in rural communities. The main sources of noise noted during the survey were traffic along the existing Highway 104 or local roadways, and normal residential outdoor activity. The data shows there is no existing exceedance of the Noise Guideline levels for any time of day (Table 5.2). Location 6 does show hourly levels near the Guideline limit during the morning hours (between 8:00 and 9:00 am) but the raw data indicates this is due to a series of short noise events which are not typical for residential areas.

Table 5.2 Baseline Noise Monitoring Hourly Summary

Time of Day	Monitoring Station										Guideline
	1	2	3	4	5	6	7	8	9	10	
12:00:00	51.1										65.0
13:00:00	51.9										65.0
14:00:00	52.2										65.0
15:00:00	52.9		47.0								65.0
16:00:00	51.9		46.6		50.8	48.9	51.1	51.1	53	50.9	65.0
17:00:00	49.2	51.9	47.5	55.7	47.7	46.8	50.8	50.2	54.2	50.3	65.0
18:00:00	50.1	52.0	46.3	54.7	43.6	44.9	50.4	49.3	51.9	50.4	65.0
19:00:00	47.3	50.8	46.4	53.6	42.1	44.7	51	45	52.5	50.5	60.0
20:00:00	44.5	51.8	44.5	52.7	43.7	46.5	50.2	38.3	52.6	50.5	60.0
21:00:00	41.2	49.4	43.2	51.9	45.6	44.8	47.7	37.4	52.8	48.6	60.0
22:00:00	45.4	49.3	43.9	50.3	39.4	44.6	46.5	36.8	53.9	46.7	60.0
23:00:00	36.7	48.3	41.4	49.4	38.8	43.2	45.2	36.3	53.6	46.1	55.0
0:00:00	36.6	49.1	39.3	46.9	34.8	42.6	43.0	36.5	53.3	43.5	55.0
1:00:00	45.3	47.2	43.8	43	31.8	42.3	42.7	34.5	52.8	42.8	55.0
2:00:00	51.7	45.9	39.3	42.7	39.2	42.2	43.1	33.3	51.6	43.7	55.0
3:00:00	50.5	45.2	41.0	45.9	32.9	41.6	41.2	34.8	54.2	42.2	55.0
4:00:00	50.9	46.8	43.2	46.0	30.5	40	40.0	35.7	53.7	40	55.0
5:00:00		48.5	46.2	50.9	38.6	44.3	40.4	39.6	51.8	40.3	55.0
6:00:00		48.6	47.7	53.2	41.9	49.1	45.3	39.7	51.9	45.7	55.0
7:00:00		48.4	46.7	54.8	54.1	62.1	48.3	48.3	52	48	65.0
8:00:00		49.3	42.1	54.4	57.3	65.0	49.2	47.1		48.6	65
9:00:00										56.1	65

5.1.3 Residual Environmental Effects Evaluation Criteria

Air Quality

Total suspended particulate (TSP) has been the air quality parameter of most concern for highway construction in Nova Scotia. The TSP guideline is therefore the principal parameter considered in the determination of the significance of potential air quality impacts.

A **significant** adverse environmental effect is defined as one that would reduce air quality, such that the level of TSP matter exceeds 120 $\mu g/m^3$ over a 24 hour averaging period or 70 $\mu g/m^3$ over an annual averaging period. These limits are specified as the 'maximum permissible ground level concentrations' under the Nova Scotia *Air Quality Regulations* and as the 'maximum acceptable' limits under the *Canadian Environmental Protection Act (CEPA)* Ambient Air Quality Objectives.

A **positive** effect occurs when there is a predicted or expected improvement in ambient air quality and mitigative measures in the area affected by Project activities.

Noise

A **significant** adverse environmental effect with respect to noise may be defined by any of the following:

- a noticeable change in noise level (approximately 5 dBA) which results in exceedance of the Noise Guideline levels;
- a noticeable change in noise level (approximately 5 dBA) above existing noise levels in areas where the guideline levels are already exceeded; or
- a change in noise level of approximately 10 dBA above existing noise levels in areas where the Guideline levels are not exceeded.

The severity of change combined with the resulting overall L_{eq} (equivalent continuous sound level measurement) will determine mitigation requirements and residual effect.

A **positive** effect occurs when Project-related activities result in a reduction in ambient noise level (*i.e.*, through the construction of sound barriers).

5.1.4 Potential Issues, Interactions and Concerns

Air Quality

The main potential interaction of the proposed Project with atmospheric resources is through dust generation from construction activities, and emissions such as sulphur compounds, carbon dioxide, carbon monoxide and nitrogen oxides from vehicles during construction and operation of the highway. Potential effects associated with malfunctions and accidental events are discussed in Section 7.0. Weather conditions and their effect on highway operation is also a potential issue of concern.

Noise

Depending on the number and location of sensitive noise receptors (*i.e.*, residential properties, schools, hospitals, etc.), and factors affecting the distance over which noise travels (*i.e.*, vegetation, topography, meteorological conditions), the effects of noise will vary. In general, noise due to construction and noise due to operation of a highway are different, and may affect receptors differently.

Noise due to construction is usually louder than normal highway operation, but is of relatively short duration and is also very localized. It can affect land uses directly adjacent to the RoW. Highway construction will involve typical road building activities such as clearing and grubbing, roadbed preparation and grading, and paving operations. Table 5.3 lists the noise outputs of construction machinery commonly used for these activities. The level of activity on construction sites will always vary with the level of activity on the site.

Table 5.3 Typical Construction Equipment Noise

Equipment Powered By Internal Combustion Engines	Noise Level dBA at 4.5 m (15 ft)
Earth Moving	
Compactors (Rollers)	75-87
Front Loaders	72-93
Backhoes	72-99
Tractors	76-96
Scrapers, Graders	80-94
Pavers	86-88
Trucks	82-94
Materials Handling	
Ashpalt Paver	80-86
Concrete Mixers	77-85
Concrete Pumps	82-84
Cranes (Moveable)	75-86
Cranes (Derrick)	86-88
Stationary	
Pumps	68-72
Generators	72-82
Compressors	75-91
Impact Equipment	
Jack Hammers and Rock Drills	82-98
Impact Pile Drivers (Peaks)	95-105
Source: May 1978; Cowan 1994	

Operational traffic noise from the Project will affect sensitive receptors adjacent to the new alignment, and may also result in a positive effect for receptors adjacent to the existing Highway 104. The new alignment will remove some traffic noise from the existing Highway 104, and add a new roadway to areas less accustomed to highway noise. The traffic on the new highway will be travelling at higher speeds, and may therefore generate more noise; however the noise levels would be more consistent due to the removal of stop and go patterns (*i.e.*, less acceleration/deceleration).

5.1.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.1.5.1 Construction

Air Quality

There is potential for dust generation from construction activities, particularly during site preparation and sub-grade development. Grubbing operations generally create few dust problems since the exposed soil is usually moist and the grubbed areas are seldom left exposed for extended periods. The removal of existing structures and roadways may create some particulate emissions. Blasting, handling of fill, dumping, grading and compaction are potential sources of airborne particulates which may affect any residences within sight of the activity. Until the roadbed is paved, the movement of construction vehicles over unconsolidated fill may generate suspended particulate matter, especially where these vehicles cross from the exposed area to a paved roadway. Dirt or mud clinging to the vehicles will be dispersed into the air as the vehicle accelerates or will fall onto the public roadway to be stirred up by other vehicles. In general, the dust is expected to disperse within 200 m of the generation point.

Residential properties within 200 m of the proposed alignment include those located: along Trunk 4 where it nears the proposed alignment; Addington Forks Road; along Trunk 7; Kell Road; Silver Birch Drive; Dunn's Loop; South Side Harbour Road; and Taylor Road. These homes may be exposed to dust from heavy vehicles within the construction area.

Heavy equipment used in highway construction are typically powered by diesel engines. Exhaust from this equipment includes sulphur dioxide, sulphate particles, carbon dioxide, carbon monoxide and nitrogen oxides (AP-42). The number and distribution of the equipment during typical construction practices will allow for sufficient dispersion of these emissions to prevent significant impact on local air quality during most atmospheric conditions.

Adherence to standard practices as outlined in the Environmental Code of Good Practice for General Construction (Environment Canada 1979) and the Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979) will reduce the potential impact of dust on air quality. Dust control, when needed, will be achieved by application of water spray on exposed areas, and the cleanup of mud and dirt from paved roadways at access points to the site. Use of chemicals for dust control will be prohibited unless approved by the Project Engineer. By ensuring compliance with the above codes of good practice, in addition to procedures in the EPP, there is not likely to be any significant adverse residual environmental effects on air quality due to Project construction.

Forest and agricultural ecosystems have the ability to remove carbon from the atmosphere (as CO_2), and incorporate this carbon into plant biomass. The decay of this biomass leads to increases in the amount of carbon in soils. Preservation of these carbon 'sinks' is now recognized as an important measure in reducing

atmospheric levels of CO_2. The Project will result in the disturbance of approximately 190 ha of forested land and 35 ha of agricultural land, and the potential loss of all carbon in the standing biomass on this land area. Construction activities may also lead to the loss of carbon from soils as a result of the disturbance of soils on the RoW. Loss of soil carbon occurs whenever soils are disturbed, and manipulated, and results from increased activity of soil micro-organisms.

Loss of carbon from standing forest biomass is considered to be insignificant in consideration of the extent of forest harvesting and re-forestation which now occurs in Antigonish County. During clearing operations, salvageable wood resources become the property of the landowner or clearing contractor and could be allocated for other processing, such as for use as fiber or lumber, in order to preserve some of this carbon in a non-atmospheric form. Minimizing the area of soil and vegetation disturbance during construction will help to mitigate losses of carbon from standing biomass and from soils.

Following construction activities, all areas with the exception of the road surfaces and shoulders, will be revegetated. Soil carbon that is lost during construction will therefore be replenished over time once roadside vegetation becomes established and is maintained.

Noise

Roadbed preparation and grading is the activity of longest duration and therefore will have the most potential for affecting nearby residents. Construction noise, for the purpose of this assessment, has been assumed to be generated by three machines (grader, loader and dump truck), working in a group. Based on the median output levels described in Table 5.3, this would give a combined sustained source level of about 92 dBA at a distance of 15 m and would attenuate 6 dBA for each doubling of distance as the source is localized (May 1978). As a result, any receptor within 400 m of the activity with no other mitigation present for noise would exceed the Noise Guidelines of 65 dBA for daytime noise levels. Any receptor within 80 m of the activity would exceed 80 dBA which is the level at which hearing protection is required by the Nova Scotia *Occupational Health and Safety Regulations*. Land clearing and roadbed paving are construction operations which are generally quieter and of shorter duration than roadbed preparation.

As shown on Figure 5.1, there are residences within 100 m of the RoW, particularly at Addington Forks Road, the trailer park near the Oasis Motel, Dunn's Loop and Taylor Road (Baseline stations 1, 7, 8, and 10 respectively). Mitigation of the potential construction noise will be considered for these residences, if necessary.

Residences are located within 400 m of the RoW, but further than 100 m, in the remaining areas identified for baseline monitoring (Stations 2, 3, 4, 5, 6 and 9), and the mobile home park in Lower South River. While construction noise in these areas is expected to exceed the daytime Noise Guideline of 65 dBA, the duration of these exceedances is expected to be relatively short (in the order of 1 to 2 hours at a time on any

particular day). Consideration of mitigation for these residences will be made if conditions noted during construction activity are louder than expected or requires more than a normal amount of heavy equipment.

Mitigation of the noise during construction for the most directly affected areas (<100 m from construction site) can be accomplished by reducing the equipment working in these areas to either two or one units and keeping the equipment in good working order including mufflers. This may not bring levels to within Guidelines at all times; however, actual levels are expected to be lower than the maximum predicted most of the time as the machines will be constantly moving around and will not always be at the nearest point to any particular residence. Other mitigative options to reduce effects on the closest homes include landowner notification, restricting working hours and reducing the amount of continuous time spent by machinery in close proximity.

The use of physical barriers to block noise is the most common method to control noise where scheduling or otherwise reducing noise at the source is not possible. This is not practical in this case based on the expected short duration of construction, the physical location of these areas in relation to the corridors, and the expense of constructing barriers on a temporary basis.

Occasional, momentary noise sources such as the dumping of rock may be significantly louder than the working machinery (>125 dBA at the source); however these high sound levels attenuate quickly due to their short duration. The overall effect of these noise events on the average L_{eq} for the residents cannot be accurately determined due to the randomness and uncertainty of these events.

Provided that the above mitigation measures are adhered to, no significant adverse residual effects are predicted for land uses during construction.

5.1.5.2 Operation and Maintenance

Air Quality

The impact on air quality from traffic during operation of the new highway is expected to be low. The proposed alignment has been planned as an express corridor, with free flowing traffic. Exhaust from vehicles will therefore disperse quickly and there will be a reduced potential of local effects from stopped and idling traffic as is the present case near Antigonish. Improved traffic flow, on a regional scale, will reduce the overall emissions to the atmosphere. No mitigation is necessary for air emissions from highway traffic.

There is therefore not likely to be any significant adverse residual environmental effects on air quality as a result of Project operations.

Noise

To determine the overall environmental effects on land use in the study area, noise output from the highway in operation must be considered. This was accomplished by using the AAMA Constant Speed Community Noise Model V5.0, based on the US-FHWA Stamina model. Model inputs include the proposed and existing roadway locations, traffic types, speed and volumes for each roadway, baseline noise levels, locations of sensitive receptors and any terrain or elevation effects.

The potential traffic noise outputs from the new alignment were calculated based on the following assumptions/data:

- Annual Average Daily Traffic (AADT) volume for the new highway are as per Table 6.20 AADT Volumes (Section 6.4.2);
- average Nova Scotia highway vehicle mixes (cars vs transport trucks) in this area is 9 % heavy trucks, 8 % medium trucks, and 83 % passenger cars;
- the distribution of traffic over a 24-hour period along all roadways in the study area is 80 % between 0700 h and 2300 h and 20 % between 2300 h and 0700 h. Ten percent of the total AADT occurs during an unknown peak hour (represents a worst case scenario for traffic volumes);
- summer peak traffic volumes are 137% of the AADT; and
- vehicle speeds are 110 km/hr on the proposed alignment.

Expected volumes for the proposed alignment were established for each of the Noise Guideline time periods, as well as for the peak traffic hour for input into the model. These calculations do not account for daily or weekly variations in traffic volumes, but were calculated for maximum expected volumes. The model results are used to indicate the potential for significant increases in noise at sensitive receptors identified as residences represented by the 10 baseline monitoring stations. Each location was identified in the model in relation to the proposed alignment.

The model results, as presented in Table 5.4, indicate potential significant impact areas from traffic on the new highway.

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Table 5.4 Traffic Noise Predictions Compared to Baseline Noise

Station	Peak Hour (10 % of AADT)	Daytime (65 dBA)			Evening (60 dBA)			Late Night (55 dBA)		
	Predicted	Baseline	Predicted	Difference from Baseline	Baseline	Predicted	Difference from Baseline	Baseline	Predicted	Difference from Baseline
1	51.5	52.9	52.5	-0.4	47.3	52.5	5.2	51.7	49.7	-2.03
2	53.8	52.0	54.4	2.4	51.8	54.4	2.6	49.1	51.8	2.7
3	54.2	47.5	54.6	7.1	46.4	54.6	8.2	46.2	51.9	5.7
4	52	55.7	52.9	-2.83	53.6	52.9	-0.7	50.9	51.2	0.3
5	57.3	50.8	56.6	5.8	45.6	57.3	***11.72***	38.6	55.2	***16.6***
6	53.2	48.9	54.3	5.4	46.5	54.3	7.8	44.3	53.5	9.2
7	53.3	51.1	54.4	3.3	51.0	54.4	3.4	45.3	53.4	8.1
8	49.1	51.1	54	2.9	45.0	54	9.0	39.7	52.2	***12.5***
9	50	54.2	54.4	0.2	53.9	54.4	0.5	54.2	52.2	-1.1
10	50	50.9	55	4.1	50.5	55	4.5	46.1	53.7	7.6

Notes:
Expected traffic volumes used for Daytime and Evening predictions were the same, so one set of results was used.
Predicted significant effects have been bolded and italicized. Significance Criteria is defined as:
* a noticeable change in noise level (approximately 5 dBA) which results in exceedance of the Noise Guidelines;
* a noticeable change in noise level (approximately 5 dBA) above existing noise levels in areas where the Guideline levels are already exceeded; or
* a change in noise level of approximately 10 dBA above existing noise levels in areas where the Guideline levels are not exceeded.
Margin of error for this model is ± 2 dBA.

The model results predicted no Noise Guideline exceedances would occur during any of the NSDEL designated time periods, including during a daytime peak traffic hour condition. The worst case condition identified on Table 5.4 shows the highest expected Hourly L_{eq} due to highway operation is approximately 57 dBA near Site 5. While the peak hour for traffic in this area cannot be guaranteed to be similar to more urbanized areas, it is assumed the peak would occur during daytime hours.

Sites 3, 5 and 6 show the potential for significant noise increase at times of day due to the increased proximity of the highway, although Sites 3 and 6 are close enough to the existing Highway 104 for traffic noise to be presently audible. The sound of the new highway will appear louder for residences near Sites 3 and 6. Residents near Site 5 do not presently hear highway noise, and will find the change noticeable during daytime and evening hours.

There are significant increases of 10 dBA over baseline conditions expected at two locations (Sites 5 and 8), particularly at night. The traffic flows used for the nighttime period may not reflect the present volumes of traffic on the existing Highway 104 during these hours, but represent a probable worst case. Sites 6 and 7 will also have noticeable increased noise levels at night, but these increases are not considered significant when the predicted value is compared to the Noise Guideline. Sites 1 and 9 are not expected to change significantly at night, based on their locations relative to the existing and new alignments.

Site 5 along Kell Road will be particularly affected at night as residents in this area currently only experience traffic noise on the local roadway in addition to the normal noises due to residential land usage. Highway noise will be new to these homes, the nearest of which is within 200 m of the proposed RoW. Some form of standard mitigation such as an earth berm combined with minimising the elevation of the highway, may be considered for this location.

Site 8 at Dunn's Loop is also expected to have significant increased noise levels at night. The difference between baseline and predicted values may partly be due to the fact that the night the baseline monitoring was performed at a time which happened to have low traffic volumes. This does not diminish the potential for significant impact at this location, particularly since the highway is expected to pass over the existing roadway near this location. Natural attenuators, such as soft ground or heavy vegetation, will not significantly reduce the expected traffic noises. With the source of noise higher than the elevation of the residences in this area, standard mitigation such as earth berms or simple barriers may not be feasible. Construction of the highway as an underpass to the existing roadway to utilize the embankments as barrier may not be cost effective; however it will be considered an option for reduction of noise levels. An engineered barrier on the overpass structure is also an option for consideration.

In general, increases in traffic noise are expected along the entire alignment. These increases will likely be significant (>10 dBA above baseline conditions) at night, except where residences are presently very close to (within 200 m) the existing Highway 104. Increases are due to the proximity of the alignment to residential properties, and the general quiet found in the area, particularly those areas where no highway

alignment has been present in the past. While noise levels are predicted to increase, none of the model results show the potential for noise levels at the residences to exceed the provincial Noise Guidelines limit for any of the defined time periods. There is expected to be a reduction in ambient noise levels along the existing Highway 104 with the diversion of through traffic to the proposed highway.

This assessment is generally broad-based, with the intent on identifying the potential for noise impact. The results above use a conservative approach by incorporating future predicted traffic volumes and vehicle balances that are likely higher than reality.

Standard mitigation for highway noise is through engineered solutions. Engineering solutions are generally to build a physical barrier, either an earth berm or solid structure, to block the line of sight (and thus propagation of noise which is generally linear) from the receiver to the source of the noise. Implementation of physical mitigation generally considers economic feasibility, effectiveness of the mitigation, and sensitivity of receptors.

Based on the above results, detailed examination of mitigation options will be considered near Sites 5 and 8, based on the expected increase in nighttime noise levels. Mitigative measures can be effectively applied to those areas where significant noise increases are predicted. Assuming effective application of mitigation at the locations noted, no significant adverse residual effects with respect to noise are anticipated during operation.

5.1.6 Follow-Up and Monitoring

Air Quality

If the proposed mitigative actions are taken, it is not anticipated that routine monitoring of dust from construction is required. However, dust monitoring may be required to address any complaints from residents received by NSTPW. If required, air sampling will be conducted in accordance with NSDEL and Environment Canada methodologies for High-Volume air sampling of total suspended particulate matter.

Noise

Specific post-construction noise monitoring is not proposed at this time. NSTPW maintains a practice of addressing community issues and concerns, including noise on an ongoing basis.

5.1.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative actions are implemented, no significant adverse residual effects from airborne dust on air quality during construction are anticipated. No adverse residual environmental effects from traffic on local air quality during Project operation are predicted. It is anticipated that most direct and indirect effects from Project construction noise can be effectively mitigated through giving early notification to potentially affected residents residing in proximity to the RoW and through restricting working hours. There is a potential for significant adverse effects related to increases of noise levels at several locations due to the operation of the new highway. Implementation of mitigative measures, including engineered solutions, can reduce these effects to non-significant levels. Noise along the existing Highway 104 will be reduced from its current levels. Tables 5.5 and 5.6 summarise the residual environmental effects assessment for atmospheric resources.

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Table 5.5 Residual Environmental Effects Assessment Matrix
Atmospheric Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Construction of Highway	Air Quality ••Dust generation and construction vehicle exhaust (A) ••Air and dust emissions (A)	••Standard dust control procedures ••Complaint Resolution Policy ••Clean up mud and dirt from paved roadways	1	1	1 / 2	R	2	N	3
	Noise ••Noise emissions (A)	••Noise controls (*e.g.*, reducing amount of equipment and/or continuous time working in one place, landowner, notification) ••Restricted working hours	2	4	3 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*, within the normal variability of baseline conditions; 2 = Medium: *i.e.*, increase/decrease with regard to baseline but within standards and objectives; 3 = High *i.e.*, singly or as a significant contribution in combination with other sources causing exceedances or impingement upon standards and objectives beyond the property line of the project
Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect
Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.6 Residual Environmental Effects Assessment Matrix
Atmospheric Resources (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Highway traffic	Air Quality ••Vehicle emissions (A)	••No mitigation proposed for vehicle emissions	1	1	5 / 6	R	2	N	3
	Noise ••Increased noise levels at residences, businesses and recreational areas (A)	••Noise mitigation at Sites 5 and 8	1	2	5 / 6	R	2	N	2

Refer to Table 5.5 for Key.

5.2 Groundwater Resources

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

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

The groundwater resource is a VEC because it provides potable water supply to approximately half of the total population of Nova Scotia, and to all of the unserviced residences adjacent to the proposed highway corridor.

5.2.1 Boundaries

Spatial boundaries for the assessment of groundwater resources are based on a combination of aquifer hydraulic properties, expected groundwater flow directions, and the distance between potential road cuts and wells that may be affected by Project activities. For example, the area of influence or capture area of a typical low yield domestic water well is usually less than about 100 m, and generally in a direction hydraulically up-gradient of the well. Project-related contamination (*i.e.,* road salt) within this capture area could potentially affect well water quality. Vibration damage to a drilled or dug well is generally a function of distance between the energy source and the well, and seismic properties of the aquifer materials. With respect to rock type, risk is greater for fractured crystalline bedrock than for overburden wells or sandstone wells. Based on experience, the risk from blasting or major excavation is considered to be greatest within 50 m, moderate from 50 to 200 m, and expected to be minimal beyond about 200 m.

To be conservative, blasting effects are considered for drilled wells within 500 m on both sides of the RoW in those areas found to require blasting for excavation. Potential effects of accidental spills are within 500 m hydraulically down-gradient of the RoW in areas of highly permeable media (*i.e.,* sand and gravel

aquifers), or mineralized bedrock. Road salting effects are considered for all wells located hydraulically down-gradient of the alignment. The extent of the area potentially affected is dependent on surface drainage and surficial geology. In areas of poor drainage, prone to pooling, effects can reach an extent of 200 m in sand and gravel, and up to 50 m in till.

With respect to temporal boundaries, most physical and chemical effects on groundwater resources are likely to be temporary and to occur during the construction phase. Residual effects from road de-icing materials could occur throughout the operation phase of the Project.

A technical limitation for this assessment is that a well water inventory was not undertaken for this study. This preliminary assessment identifies areas of potential concern. A residential well water survey will be conducted of proximal wells prior to implementing blasting operations in specific areas at risk, or major excavations requiring de-watering. Refer to Appendix G for a typical residential well survey protocol.

5.2.2 Description of Existing Conditions

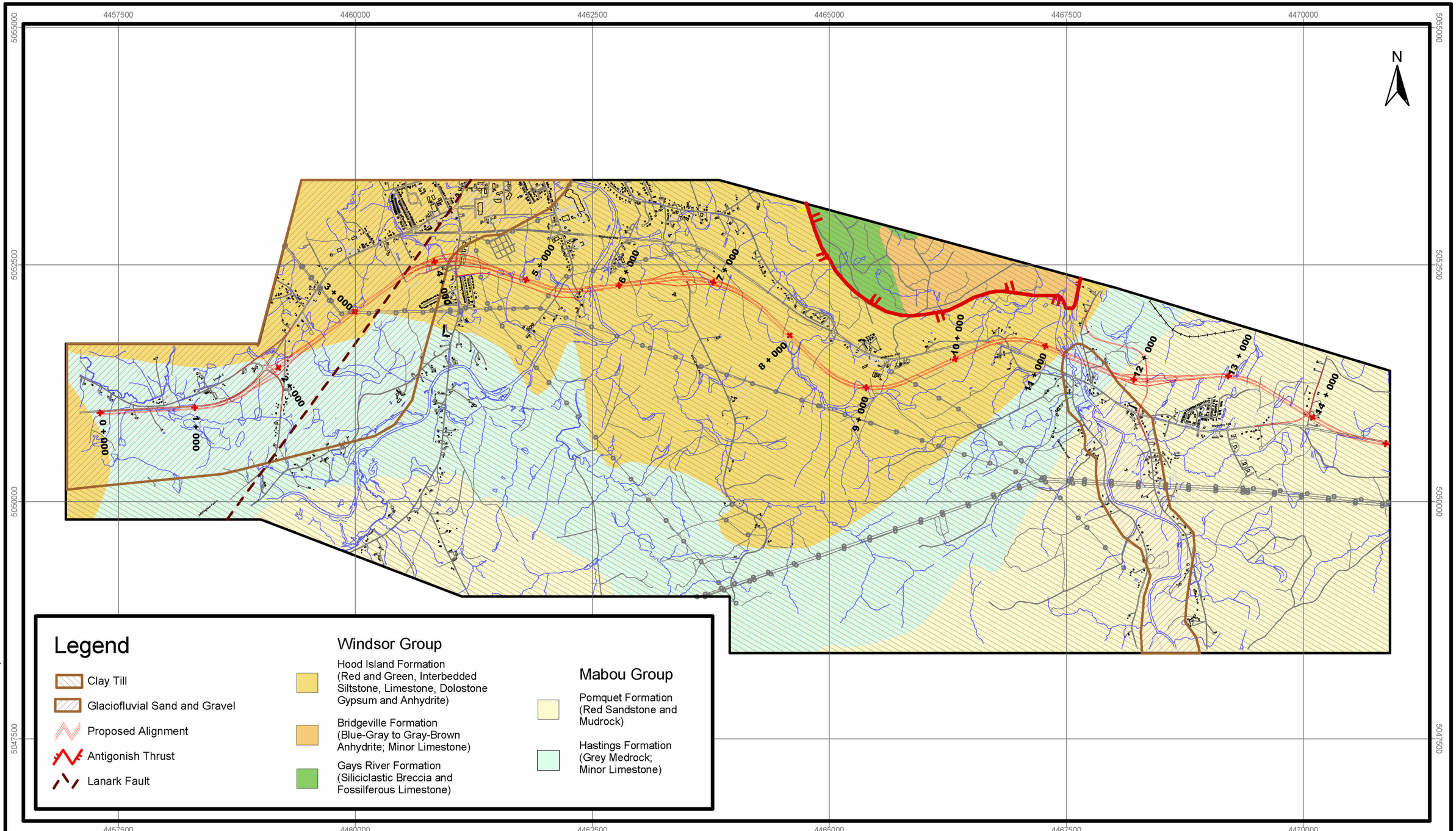
An assessment of the hydrogeological features of the Project alignment was performed using previously published mapping and hydrogeologic reports. A reconnaissance field trip was carried out on October 10 and 11, 2002 by a JW hydrogeologist to assess terrain and probable hydrogeological conditions on the site, and to provide a preliminary assessment of water well distribution along roads that will be traversed by the RoW.

Topography and Drainage

The Project alignment is located within the Antigonish Basin. The alignment follows within 600 m of the current Highway 104 alignment at elevations ranging from sea level at Lower South River, to just over 50 m above sea level, and generally drains northwards through streams and watercourses into Antigonish Harbour.

Overburden Geology

Overburden consists of glacial deposits derived from the underlying and 'up-ice' bedrock units, and soil which is derived from the parent glacial tills. This till and glaciofluvial material was laid down by major ice sheets advancing across the area from northwest to southeast. The overburden can be subdivided into clay till and sand/gravel glaciofluvial deposits (Figure 5.2). Based on available geological mapping, two types of glacial overburden deposits are identified along the proposed alignment.



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Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Surficial and Bedrock Geology

.5 0 .5 1.0 1.5 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

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FIGURE 5.2

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The clay till underlies the majority of the proposed alignment from the intersection of Trunk 7 and Highway 104 to the eastern end of the proposed alignment. These deposits are described as clay to silt till of varying depths and are generally considered to be a poor groundwater source.

The glaciofluvial sand and gravel deposits comprise poor to well sorted stratified sands and gravels. These deposits are located between the western end of the proposed alignment and the intersection of Trunk 7 with the current 104 Highway, and in the Village of Lower South River. These deposits are considered to be highly permeable and have a good potential as an excellent source of groundwater with yields of 20-100 L from shallow wells (Maritime Resource Management Service 1975a).

Bedrock Geology

Based on available geological mapping, the study area is underlain by 305 to 345 million year old, sedimentary bedrock of Early to Late Carboniferous age. In the study area (500 m north and south of the RoW), this bedrock forms a syncline made up of five geological formations; the Pomquet and Hastings formations of the Mabou Group (formerly the Canso Group) and the Hood Island and Bridgeville formation of the Windsor Group. The RoW traverses three of these bedrock units. In close proximity to the study area (600 m north of the RoW) is the Gays River formation of the Windsor Group (Boehner and Giles 1993) (Figure 5.2). A borehole investigation conducted at South River revealed that the contact between the Mabou and Windsor Group underlies the South River. The majority of the RoW over the central part of the alignment is underlain by red and green interbedded siltstone, limestone, dolostone, gypsum and anhydrite of the Hood Island Formation. Potential sinkholes (*i.e.*, Karst topography) could occur within this unit although none were identified during field investigations. The eastern and western ends of the alignment are underlain by mudstone and limestone of the Hastings Formation. The extreme eastern end of the alignment is underlain by sandstone and mudrock of the Pomquet Formation.

The study area intersects several faults including the Lanark Fault and the Antigonish Thrust as indicated on Figure 5.2. No bedrock outcrops were observed within the area at the time of the field reconnaissance, due to presence of thick glacial overburden. Bedrock exposures could however occur at stream crossings where the overburden has been eroded.

Occasional mineralized zones of lead and copper are known to occur as stratabound deposits within the study area (Boehner and Giles 1993). However, these formations are not typically associated with acid drainage problems and the geochemical nature of the bedrock and thick overburden deposits suggest a negligible potential for acid drainage risk.

Hydrogeology

The hydrogeology and hydraulic properties of the various hydrostratigraphic units underlying and within 500 m of the alignment are presented below in order of age and occurrence below ground surface. The capacity of each unit to store and transmit groundwater to wells and potential for impact from construction of a highway alignment is discussed.

Glacialfluvial Sand and Gravel

Areas of poor to well-sorted, stratified sand and gravel glacial outwash deposits with potentially higher permeability than till or bedrock occur in the vicinity of the western end of the alignment to approximately the Trunk 7 intersection of the proposed alignment, and near South River on both sides of the watercourse. These deposits are an excellent source of groundwater which is extracted via dug wells from the junction of Addington Forks Road and the existing 104 Highway to the western end of the proposed alignment along Trunk 4. The NSDEL inventory indicated only two dug wells, which were in the Trunk 4 area, and had depths of 8.2 and 4.9 m, water levels of 3.0 and 4.1 m, and one of the wells had a listed well yield of 568 L/min. Dug wells in glacial deposits are typically constructed by backhoe or excavator, and usually 4.5 to 6.1 m in depth, and generally provide sufficient water for single family needs. Depending on location, topography, and permeability of the overburden, some wells experience seasonal loss of water due to annual water table fluctuations in the order of 3 m or greater.

Based on twelve pumping tests in Antigonish County (Table 5.7), dug wells completed in the sand and gravel have an average transmissivity of 395 m^2/day, and a well yield ranging from 120 to 1027 L/min, and averaging 602 L/min (NSDEL Pumping Test Inventory (NSDEL 1973-2001)). Water quality within the glacialfluvial deposits is expected to be good, although concentrations of iron, manganese and hardness may locally exceed the Guidelines for Canadian Drinking Water Quality (Health Canada 1999) aesthetic criteria of 0.3, 0.05 and 120 milligrams per litre (mg/L), respectively. Depending on age, location and construction method, dug wells are highly prone to coliform bacteria and road salt impact. Approximately two-thirds of the residential water supply wells observed during the field reconnaissance were dug wells, which suggests a shallow water table within 3 to 4 m of ground surface.

Glacial Till

Stoney, gritty clay and silt till deposits of various depths typically underlies the majority of the proposed alignment and may locally underlie the sand and gravel deposits. This unit typically has a low hydraulic conductivity (K) in the order of 10^{-5} to 10^{-6} cm/sec, however, properly constructed dug wells may yield sufficient water for domestic supplies.

Mabou Group (Pomquet and Hastings Formations)

Mabou Group bedrock occurs over approximately one third of the proposed realignment RoW at both the eastern and western ends. The Mabou Group is made up of two principal formations which are the grey mudrock (minor limestone) dominated Hastings Formation, which is overlain by the younger red sandstone and mudrock dominated Pomquet Formation (Boehner and Giles 1993).

Based on six pumping tests in Antigonish County (Table 5.7), wells completed in the shale and sandstone bedrock have an average transmissivity of 7.4 m^2/day, and a typical well yield ranging from 15 L/min in shale to 250 L/min in sandstone, and averaging 124 L/min (NSDEL Pumping Test Inventory (NSDEL 1973-2001)). Groundwater quality from these formations can be expected to be of good chemical quality with a tendency toward hardness and a low degree of total dissolved solids (TDS).

Areas underlain by Mabou Group bedrock would be the most likely area for potential supply development.

Windsor Group (Hood Island, Bridgeville and Gays River Formations)

Windsor Group bedrock occurs over approximately the central two-thirds of the proposed RoW. The Group is a complete succession of interstratified evaporates and include two formations within the RoW: interstratified red and green beds of siltstone, limestone, dolostone, gypsum and anhydrite of the Hood Island Formation; and poorly stratified blue-grey to grey-brown anhydrite with scattered beds of light-brown to yellow-brown limestone of the Bridgeville Formation. Siliciclastic breccia, highly fossiliferous limestone and light to dark grey micritic limestone of the Gays River Formation is not known to be located within the study area (Boehner and Giles 1993). However, the formation is in close proximity to the RoW (approximately 600 m to the north) so there is a possibility of it being intercepted.

Only one pumping test was listed for the Windsor Group (Table 5.7). The tranmissivity for this well is 6.7 m^2/day and the well yield is 205 L/min (NSDEL 1973-2001). However, more commonly wells in this Group produce 23 L/min. The water is generally hard and alkaline, and contains a high degree of sulphate and TDS when it has been in contact with gypsum deposits (Maritime Resource Management Service 1975b).

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Table 5.7 Summary of Well Water Pumping Test Information, Antigonish County, NS

	Well Depth (m)	Well Diameter (m)	Test Hours	Water Level (m)	Pumping Rate (igpm)	Transmissivity (m^2/d)	Specific Capacity ($m^3/d/m$)	Safe Yield (igpm)	Aquifer Transmissivity (m^2/d)	Aquifer Storage Coefficient (units)
Sand and Gravel										
Minimum	3.7	72	3	0	26.4	22.3	69.2	4.2	254.6	0.00033
Maximum	21.3	203	666	4.1	226	1551.5	633.6	1079	1417.3	0.01
Mean	12.3	169.3	97.6	2	132.4	394.6	244.5	314.1	770.6	0.00355
Median	12.2	155	72	1.9	142.5	261.1	161.9	168.8	640	0.00033
Number	12	11	12	12	12	10	10	12	3	3
Mabou (Canso) Group										
Minimum	41.8	155	72	-0.3	3.3	1.1	0.6	3.9	-	-
Maximum	109.7	203	90	29.6	55	21.7	79.9	55	-	-
Mean	60.2	174.2	75	8	27.2	7.4	27.7	24.5	-	-
Median	49.8	155	72	4.1	27.5	4.8	15.2	19.4	-	-
Number	6	5	6	6	6	6	4	6	0	0
Windsor Group										
Value	77.7	155	16	16	45	6.67	9.02	37.3	-	-
Number	1	1	1	1	1	1	1	1	0	0

Source: NSDEL Pumping Test Inventory (1973-2001)

Domestic Water Supply

Six County of Antigonish municipal water supply wells are identified within 500 m of the proposed alignment in Lower South River (Figure 5.3). Three of these wells were included in the Mabou Group pump test summary shown in Table 5.7. The Town of Antigonish's main water supply comes from James River (5 km from the RoW) and two backup wells are located at Rights River flood plain north of the Town of Antigonish (1.6 km from the RoW) and therefore the town water supply is not a concern with respect to this Project. The Municipal Town and County water distribution systems service the majority of the study area. Those areas not supplied by Municipal Town or County water supplies receive water from individual or shared on-site dug or drilled wells. Table 5.8 summarizes the general density and frequency of wells within the proposed alignment along existing roads and highways, and indicates the areas supplied by Municipal Town or County services.

A review of NSTPW mapping and the field reconnaissance indicates that there are up to 62 domestic water supply wells, one non-potable surface water reservoir and six County of Antigonish municipal supply wells located within 500 m of this alignment, predominantly along cross roads, and at the two ends of the alignment. Approximately half of these are distributed along Trunk 4 and Taylor Road at the east and west ends of the alignment, respectively.

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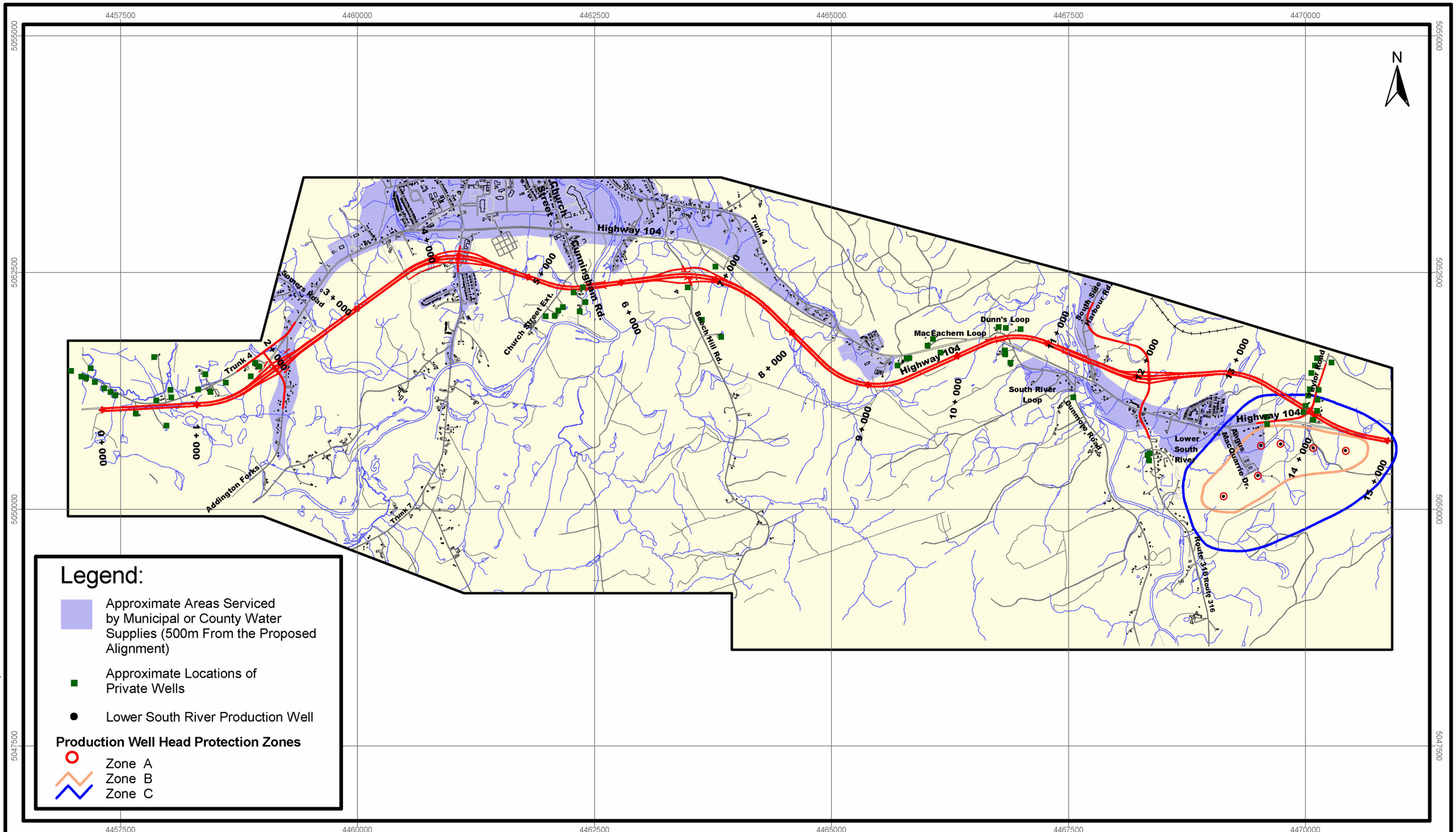

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NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

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FIGURE 5.3

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Table 5.8 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
RoW from the Western End of the Alignment to Addington Forks Rd.	0+000 to 1+900							
Existing Highway 104	0+000 to 1+900	0	0	0	0	2	No	2
Trunk 4	1+900	10	5	0	0	5	No	20
Addington Forks Rd.	1+900	0	0	0	0	0	Yes	0
RoW from Addington Forks Rd. to West River	1+900 to 5+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Sommers Rd.	North of RoW	0	0	0	0	0	Yes	0
Town of Antigonish	North of RoW	0	0	0	0	0	Yes	0
Trunk 7	4+200	0	0	0	0	0	Yes	0
Church Street Extension	5+400	3	0	0	0	1	Partial: Existing Highway 104 to Cunningham Rd.	4
Cunningham Rd.	5+550	2	0	0	0	2	No	4
RoW from West River to Beech Hill Rd.	5+700 to 6+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Willowdale Lane	North of RoW	0	0	0	0	0	Yes	0
Beech Hill Rd.	6+700	1	1	0	0	1	Partial: North of Existing Highway 104	3
Beech Hill Rd. to Existing Highway 104	6+700 to 10+400							
Existing Highway 104	North of RoW	3	0	0	1	0	Yes: North Side Partial: South Side	4
Trunk 4	North of RoW	0	0	0	0	0	Yes	0
MacEachern Loop	North of RoW	1	0	0	0	1	No	2
Existing Highway 104 to the Eastern End of the Alignment	10+400 to 14+825.65							
Existing Highway 104	South of RoW	0	2	0	0	0	Yes	2
Dunn's Loop	10+550	0	0	0	0	3	No	3
South River Loop	South of RoW	2	0	0	0	1	Partial: East End	3

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Table 5.8 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
Dunmore Rd.	South of RoW	0	0	0	0	1	Partial: 100 m off Existing Highway 104	1
South Side Harbour Rd.	11+500	0	0	0	0	0	Yes	0
Route 316	South of RoW	2	1	0	0	0	Partial: 100 m Off Existing Highway 104	3
Lower South River Wellfield (Wells and Protected Area)	South of 12+200 to 14+827.65	0	0	6	0	0	County Wellfield	6
Lower South River Mobile Home Park	South of RoW	0	0	0	0	0	Yes	0
Angus MacQuarrie Drive	South of RoW	0	0	0	0	0	Yes	0
Taylor Rd.	13+950	2	8	0	0	2	No	12
Total Wells		**26**	**17**	**6**	**1**	**19**	**N/A**	**69**

5.2.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is defined as one in which the Project causes one or more of the following:

- yield from an otherwise adequate well supply decreases to the point where it is inadequate for intended use;
- the quality of groundwater from an otherwise adequate well supply deteriorates to the point where it becomes non-potable or cannot meet the Guidelines for Canadian Drinking Water Quality (Health Canada 1999); and/or
- the aquifer is physically or chemically altered to the extent that interaction with local surface water results in stream flow or chemistry changes that adversely affect aquatic life or surface water supply.

A **positive** effect is defined as one on which the quantity or quality of well or spring water is improved as a result of Project activities.

5.2.4 Potential Issues, Interactions and Concerns

A review of NSTPW mapping and the field reconnaissance indicates that there are up to 62 domestic water supply wells, one non-potable surface water reservoir and six County of Antigonish municipal supply wells located within 500 m of this alignment. Approximately half of these are distributed along Trunk 4 and Taylor Road at the east and west ends of the alignment, respectively.

The main issues with respect to impacts on residential water supply wells from highway alignments during various stages include:

- blasting and vibration damages, with consequent temporary siltation (dug and drilled wells) and possible permanent reduction in well yield (drilled wells) during construction;
- aquifer 'beheading', with consequent drop in water levels or loss of yield at dug wells during and after construction (dug well effects);
- accidental releases of fuel chemicals during construction (both types of wells); and
- salt contamination during highway operation (both types of wells).

The potential for well contamination from acidic drainage is considered very low based on the area geology (Section 2.4.12) and is therefore not considered a risk to groundwater supplies.

The severity of these impacts is a function of well type (dug, drilled, spring), age of the well, well construction method (rocked versus crocks; grouting, etc.), distance from the highway, overburden thickness between the highway and the well, and the hydraulic properties of both the overburden and the bedrock. With respect to groundwater quantity, the main concerns related to this project are:

- potential loss of well yield or lowered water level in dug wells during excavation; and
- possible damage to, or loss of drilled wells during blasting operations.

With respect to groundwater quality, the main concerns related to this Project are:

- chemistry changes in down-gradient aquifers or wells due to uncontrolled road runoff near overpasses and interchanges (*i.e.,* salt);
- temporary siltation of dug wells during heavy equipment operations; and
- accidental releases of hazardous materials (*i.e.,* hydrocarbons), up-gradient of a well.

Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

Preliminary Risk Analysis

The following comments and assessment of potential risk of well damage from this alignment are based on a field reconnaissance survey on October 10 and 11, 2002, published water well information for each area, and the proposed cut and fill operations planned for the RoW (Table 2.1). The survey indicated side roads and access points to the general area of the alignment to identify proximity and type of water supply wells, and also to identify any other constraints such as rock outcrops. No inspection or sampling of wells was done, and no bedrock outcrops were observed. A summary of NSDEL Well Drillers Logs for dug and drilled wells listed for these areas are shown in Tables 5.6 and 5.7 respectively. From west to east along the proposed alignment, observations and comments relevant to each subdivision follows.

Existing Highway 104 (North and South of 0+000 to 14+825.65)

The majority of the existing Highway 104 is serviced by either Municipal Town or County Water with the exception of seven properties with civic addresses on the highway that were either confirmed or suspected of having a drilled or dug well. These properties include: two with drilled wells (Smith & Fraser Homes and Softspray Car Wash (Civic Nos. unknown)); three with dug wells (Civic Nos. 3770, 4278 and one unknown civic number); and two unknown wells at the western end of the alignment (Civic Nos. 2416 and 2448).

The two drilled wells are not likely to be affected by the re-alignment. The dug well at 3770 Highway No. 104 is discussed in the Beech Hill Road (6+700) section, and the unknown wells at 2416 and 2448 Highway

No. 104 are discussed in the Trunk 4 (North of 0+000 to 1+900) and Addington Forks Road (0+000 to 1+900) section.

The two dug wells at 4278 Highway No. 104 and Kent Mobile Homes are located north and downgradient of the 9+300 to 9+550 where a filling operation of up to 23 m will take place. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages. The closest dug well will be monitored during construction of the highway and underpass.

County of Antigonish municipal water lines exist in the approximate area of 10+400 where the proposed alignment meets the existing alignment of Highway 104. Construction in this area will plan for the presence of underground services in this area.

Trunk 4 (North of 0+000 to 1+900) and *Addington Forks Road (0+000 to 1+900)*

Eighteen residences or commercial properties on Trunk 4 west of Antigonish and immediately north of the proposed western connection to Highway 104 are served by both drilled wells (Civic Nos. 2376, 2388, 2456 and two unknown civic numbers) and dug wells (Civic Nos. 2354, 2547, 2573, 2647, 2667 and five unknown civic numbers). In addition, the presence of a well could not be confirmed but is suspected at four properties (Civic Nos. 2406, 2428 and two unknown civic numbers). The closest observed drilled and dug wells are approximately 100 m and 50 m north of the RoW, respectively. Two properties within 50 m on the south side of the RoW (Highway 104) could not be accessed during field reconnaissance, but would also have a drilled or dug well.

Seven domestic well logs for this area (Tables 5.9 and 5.10) indicate that dug wells have an average well depth of 6.6 m and a well yield of 568 L/min. Drilled wells had an average depth of 40.4 m, casing length of 28.1 m; well yield of 47.9 L/min (1.1 to 113.6. L/min), and overburden thickness averaging 38.5 m (range 23.0 to 65.6 m), which suggests deep glacial deposits in this vicinity.

The underpass does not involve a major cut (*i.e.*, is not greater than 6 m); therefore the dug wells which are within 50 m down gradient along Trunk 4 are not likely to be dewatered. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent downgradient dug wells to the north of the RoW. The closest dug well will be monitored during construction of the highway and underpass in this area.

Residences along Addington Forks Road within the study area are serviced by Antigonish County water. The proposed underpass must accommodate underground services in this area.

Table 5.9 Summary of Dug Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells (Trunk 4)						
Minimum	4.9	4.9	914.4	567.8	3	4.9
Maximum	8.2	8.2	914.4	567.8	4.1	8.2
Mean	6.6	6.6	914.4	567.8	3.5	6.6
Median	6.6	6.6	914.4	567.8	3.5	6.6
Number	2	2	2	1	2	2

Table 5.10 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells						
Minimum	16.4	0	0	1.1	-0.3	0
Maximum	122.7	54.1	200	567.8	34.4	67.7
Mean	42.8	19.1	143.5	61.2	10.9	18.2
Median	40.4	19.7	152.4	37.9	9.8	16.4
Number	61	61	61	60	59	61
Residential Drilled Wells in the Vicinity of 0+000 to 1+900						
Minimum	23	13.8	152.4	1.1	-0.3	23
Maximum	65.6	54.1	152.4	113.6	13.1	65.6
Mean	40.4	28.1	152.4	47.9	8.2	38.5
Median	34.4	23.3	152.4	30.3	9.2	25.3
Number	5	5	5	5	5	5
Residential Drilled Wells in the Vicinity of 1+900 to 5+700						
Minimum	16.4	0	101.6	11.4	0.3	0
Maximum	122.7	37.1	152.4	219.6	34.4	32.8
Mean	45.9	18.5	139.7	42.5	16.5	17.6
Median	41.8	22	152.4	28.4	13.5	19.7
Number	16	16	16	16	16	16
Residential Drilled Wells in the Vicinity of 5+700 to 10+400						
Minimum	23.3	6.6	101.6	7.6	4.9	0.7
Maximum	64	36.1	152.4	567.8	32.8	29.5
Mean	42.9	19.2	145.1	98.7	10.6	15.1
Median	41.8	20	152.4	37.9	7.5	18.9
Number	14	14	14	13	13	14
Residential Drilled Wells in the Vicinity of 10+400 to 14+825.65						
Minimum	24.6	6.6	0	7.6	0	1.3
Maximum	72.2	30.8	152.4	151.4	19.7	45.9
Mean	37.8	17.8	136.7	43.2	8.5	13.4
Median	34.4	16.4	152.4	26.5	9.2	9.8
Number	21	21	21	21	21	21

Table 5.10 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish						
Location	**Well Depth (m)**	**Casing (m)**	**Diameter (mm)**	**Est., Yield (L/min)**	**Water Level (m)**	**Overburden Thickness (m)**
County of Antigonish Water Supply Wells (South of 13+000)						
Minimum	41.8	12.2	152	50	-1	4.5
Maximum	67.7	27.4	200	200	10.5	67.7
Mean	55.9	16.9	171.2	113	4.1	29.2
Median	61	13.4	152	90	1.5	26.8
Number	5	5	5	5	5	5
Sources: NSDEL Well Drillers Logs 1969-2000 and C.J. MacLellan & Associates Inc. 2002.						

Sommers Road (Northwest of 2+600)

Residences along Sommers Road within the study area are serviced by Antigonish County water. The proposed RoW passes south of Sommers Road.

Town of Antigonish (North of 3+800 to 5+900)

The residential and commercial buildings of the Town of Antigonish are supplied by municipal services. The proposed RoW passes south of the town and does not enter into the town limits.

Trunk 7 (4+200)

Residences along Trunk 7 within the study area are serviced by Antigonish County water. The proposed underpass will plan for underground services in this area.

Church Street Extension (5+400) and Cunningham Road (5+550)

Five residences or commercial properties situated along Church Street Extension and Cunningham Road are served by dug wells (185 Church Street Ext. and two unknown civic numbers, and 280 Cunningham Road and an unknown civic number). In addition, the presence of a well could not be confirmed but is suspected at three properties (155 Church Street Ext., 73 Cunningham Road and one unknown civic number on Cunningham Road). Wells in this area are within 50 m of the RoW. The street is serviced by County water north of the junction of Church Street extension and Cunningham Road. Well logs were not available for this area.

Work at this crossing will involve placement of a service road and discontinuing a portion of Church Street Extension and Cunnington Road. The RoW will pass over top of two wells listed above (dug well at 280 Cunnington Road and the suspected well at the unknown civic number on Cunningham Road and

commercial operation). There is also major fill planned for 5+630 to 5+870. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Willowdale Lane (North of 5+950 to 6+100)

Residences along Willowdale Lane are serviced by Antigonish County water. The proposed RoW passes south of Willowdale Lane.

Beech Hill Road (6+700)

Beech Hill Road is serviced by County of Antigonish municipal services north of the existing Highway 104. South of the existing Highway 104 are three wells within the study area. One drilled well (County of Antigonish building), one dug well (Department of Natural Resources building) and one unknown well. The proposed highway overpass here will have to take into consideration potential for water quality impacts to these wells as well as the dug well at Civic No. 3770 along the current Highway 104.

The work here will involve the placement of up to 9.5 m of fill during the construction of the overpass. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Trunk 4 (Northeast of 7+000 to 8+300)

Residences along Trunk 4 East of Antigonish are serviced by Antigonish County water. The proposed RoW passes south of Trunk 4 in this location.

MacEachern Loop (North of 9+650 to 10+100)

Two residences and one commercial property are situated along MacEachern Loop. The MacEachern Collision Centre is served by a surface water reservoir. One dug well and one assumed well serve the two residences on MacEachern Loop. These wells are at least 150 m north and downgradient of the proposed RoW so the 11 m deep road cut in this area is not likely to de-water these wells. However, there is risk of temporary siltation of the dug well from vibration during the construction stage. The surface water reservoir is not currently considered potable, so minor degradation of this source is not a significant concern. Well logs were not available for this area.

Dunn's Loop (10+600)

The RoW passes over Dunn's Loop at 10+555. Three residential properties here have unconfirmed wells. Two of the houses owned by Dunn will be within 50 m of the proposed RoW. The third property contains a dilapidated home which may need to be removed during construction. Any well on this property is not currently in use.

The work at this location includes a major road cut up to 18.5 m. If the indicated wells are dug wells, there is risk of de-watering and temporary siltation from vibration during the construction stage. Drilled wells this close to the alignment would be at risk from blasting.

The potential wells in this location will be monitored during construction across Dunn's Loop.

South River Loop (South of 10+650), Dunmore Road (South of 11+350) and Route 316 (South of 12+150)

These roads include partial service by County of Antigonish municipal water, four dug wells (10 and 24 South River Loop, and 4667 and 4669 Route 316), one drilled well (4665 Route 316) and two assumed wells (12 South River Loop and 5285 Dunmore Road). The RoW does not cross these roads but the noted wells are within the study area.

The dug wells along South River Loop are within 50 m upgradient of the RoW, so the proposed 18.5 m deep road cut across Dunn's Loop could result in dewatering of these wells. In addition, there is risk of temporary siltation of the dug wells along South River Loop from vibration during the construction stage. The closest of these wells will be monitored during construction of the highway. The closest wells along Dunmore Road and Route 316 are 200 m and 500 m upgradient of the RoW, respectively, are not expected to be affected by construction of the RoW.

South Side Harbour Road (11+500)

Residences along South Side Harbour Road within the study area are serviced by Antigonish County water. A portion of this road will be discontinued, and relocated, and a highway underpass will be constructed at 12+150.

Lower South River Wellfield Protected Area (South of 12+200 to 14+827.65)

The Lower South River water supply wellfield consists of six production wells. However, information was only available on five of these wells during the preparation of this report. The supply wells have an average depth of 55.9 m, an average casing length of 16.9 m, an average well yield of 113 L/min (50 to 200 L/min), and overburden thickness averaging 29.2 m (range from 4.5 to 67.7 m), which suggests deep glacial deposits

in this vicinity. The closest of these wells is within 100 m and upgradient of the RoW which passes through the Zone C protection zone for the wellfield. The location of the wells and protection zone are shown on Figure 5.3.

The Lower South River Wellfield has a well head protection area made up of three protection zones, each with a different level of protection progressively more stringent as the zones move in closer to the wells. The zones were established to roughly correspond with groundwater travel times of three months for Zone A, the closest protection zone, one year for Zone B and twenty-five years for Zone C, the protection zone with the furthest extent (C.J. MacLellan & Associates Inc. 2002). The recommended activity restrictions, or proposed control measures, for each of these zones are shown in Table G.4 in Appendix G. Restrictions are focussed on limiting the storage and use of petroleum fuels and solvents, chlorinated solvents, pesticides, fertilizers to varying degrees within the protection zones. Activities such as sewerage disposal, groundwater production, groundwater heat pumps, forestry development and mining and aggregate removal are also prohibited or limited within these zones.

The proposed RoW passes through Zone C. Because the construction period for the highway in this location is anticipated to be less than one year, impacts to the wellfield are not anticipated from construction activities. Development of associated off-RoW works (*i.e.*, pits and quarries, refuelling areas, disposal areas) will have to consider the proposed wellfield control measures (C.J. MacLellan & Associates Inc. 2002) in this area during construction. Post construction controls for road salting and salt storage in this area will need to be in accordance with the proposed control measures for the wellfield outlined in Table G.4.

Blasting in the area of Taylor Road could damage these wells so ripping techniques will be utilized for bedrock removal (if necessary). Since these wells supply a vast area of the county, they will be monitored during construction of the Route 316 connector between 13+500 to 14+827.65.

Lower South River Mobile Home Park (South of 12+500 to 12+950)

The mobile home park in Lower South River is serviced by Antigonish County municipal water. The proposed RoW passes north of the Mobile Home Park.

Angus MacQuarrie Drive (South of 13+000)

Angus MacQuarrie Drive is serviced by the County of Antigonish municipal water and the RoW passes north of this road.

Taylor Road (13+950)

Nine residences or commercial properties on Taylor Road are served by both drilled (Civic Nos. 8, 21, 47, 59, 65 and three unknown civic numbers (owners: Benoit, Landry and one unknown)) and dug wells (Civic Nos. 59 and unknown (owner: MacPherson)). Note that Civic No. 59 has both a drilled and dug well. In addition, the presence of a well could not be confirmed but is suspected at two properties (Civic Nos. 112 and 139). The RoW passes over three of these properties (Civic Nos. 8, 21 and 47) and both drilled and dug wells will be within 50 m of the RoW.

Nine domestic well logs for this area indicate that drilled wells had an average depth of 34.3 m, casing length of 18.7 m; well yield of 4.4 L/min (1.2 to 12.1. L/min), and overburden thickness averaging 16.5 m (range from 1.2 to 42.7 m), which varied depths of glacial deposits in this vicinity.

A major cut is not planned for the underpass at Taylor Road. However, one of the wells on Taylor Road encountered less than 2 m of overburden. Therefore even a minor cut in this area may encounter bedrock. It should be noted that blasting here could damage drilled wells on Taylor Road close to the RoW. The highway underpass at Taylor Road is also within 100 m of Antigonish County's nearest water supply wells. Work in this area will involve ripping techniques if bedrock removal is necessary. A moderate road cut in this area could de-water dug wells. There is risk of temporary siltation of drilled and dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells. The nearest dug wells will be monitored during construction.

5.2.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.2.5.1 Construction

The main potential adverse effects on groundwater resources during the construction phase include changes in groundwater quantity or quality in nearby or down-gradient water wells. Physical changes in groundwater flow and quantity may be caused by deep overburden cuts. Changes to groundwater quality could occur due to blasting or ground vibration.

Water Level Lowering

While drilled wells typically exhibit a wide range of deep water table depths depending on location and topography, dug wells completed in dense glacial till or sand and gravel units could have shallower, possibly perched water tables, which would be vulnerable to regional water table lowering caused by a major road cut in thick overburden.

Major excavations though glacial tills could lead to a drop in groundwater table elevation in proximity to the cut. The degree of water level lowering will be proportional to the depth of the cut below natural water table level, the distance between the well and the cut, and the hydraulic properties of the overburden materials (*i.e.,* larger and faster decline in higher permeability sand and gravel than poorly permeable till). Dug wells near the edge of a cut could suffer sufficient water level decline to become dry. These wells are already susceptible to seasonal water level declines of 2 to 4 m in Nova Scotia. Drilled wells are not likely to be adversely affected by overburden cuts.

Major road cuts are expected along the RoW to depths of 7.5 to 18.5 m. There is a risk of aquifer dewatering adjacent to these areas and dug wells in these locations could become dry. In addition, two more likely and less permanent hazards to nearby dug wells are temporary siltation from vibration, or erosion runoff during construction.

Any dug wells located within 50 m of a major highway cut, underpass or overpass will therefore be inspected by the contractor, measured for water level and depth, and inventoried for possible future reference. Dug wells within 50 m are noted along Trunk 4, Church Street Extension, Cunningham Road, Beach Hill Road, Dunns Loop and Taylor Road.

Blasting Effects

Blasting can cause effects in adjacent wells ranging from minor temporary turbidity to rare complete collapse of the well. Wells completed within 500 m of the proposed RoW could theoretically be affected to some degree. Severity of effect is proportional to distance, physical and seismic properties of the bedrock being excavated, age and construction method of the well, well yield, and blast magnitude. Other mitigating factors include thick overburden and 'soft' bedrock. Based on 61 drilled well logs (Table 5.7) the median overburden thickness is 16.4 m, which implies a low probability of encountering bedrock. The bedrock is comprised of relatively 'soft' sandstone, mudstone, and limestone which should require much less blasting energy to excavate than other areas of Nova Scotia.

A significant amount of the alignment passes through populated areas. Assuming careful attention to the possible bedrock cuts, blasting damage risk to water wells and critical aquifers is considered to be low except in the area of the Lower South River Wellfield where damage to a supply well would be more problematic. Ripping techniques will be used where possible in lieu of blasting, in proximity (*i.e.*, within 500 m) to residential water wells and at the eastern end of the alignment in the vicinity of the County of Antigonish Lower South River Wellfield. Development of associated off-RoW works, *i.e.*, pits and quarries, refuelling areas, disposal areas will have to consider the proposed wellfield control measures (Appendix G) (CJ MacLellan & Associates Inc. 2002) in this area.

5.2.5.2 Operation and Maintenance

The main potential adverse effects on groundwater resources during the operation and maintenance phase of the Project include changes in groundwater quality due to road-runoff *(i.e.,* salt), and accidental spills of hazardous substances on the highway. The areas of clay and silt (low permeability overburden cover) and drainage of salt laden runoff away from nearby wells along ditching will likely mitigate this effect on wells. However, the area most likely to be affected may be areas underlain by highly permeable sand and gravel overburden in the vicinity of the west end of the alignment (Trunk 4) and Lower South River as well as the Antigonish County Wellfield. Post construction controls for road salting and salt storage in this area will have to be in accordance with the proposed control measures for the wellfield outlined in Table G.4.

5.2.6 Follow-Up and Monitoring

Several wells are located within the 500 m assessment boundary, particularly where the alignment crosses existing roads. NSTPW's Construction Contractor will complete an inventory of residential water wells. This would include an interview of the well owner, documentation of well construction specifics, collection of a water sample for chemical and bacteria analysis, and photographic documentation of the well location. Appendix G presents a typical procedure for a pre-construction residential well survey. A contingency plan will also be developed for the area of the wellfield protection zones to ensure that any potential malfunctions or accidental events are addressed appropriately and in a timely manner to minimize potential impacts to the wellfield that could arise from highway operations.

In the event that any residential wells are found within 500 m of any blasting excavation areas (road cut or quarry), or if dug wells are located within 50 m of a major (> 5 m) overburden cut, these wells will be inspected (measuring depth, yield and water level in dug wells), and sampled for baseline water quality (Rcap-MS and bacteria). Where several drilled wells are present within the proposed 500 m blast monitoring radius, selected representative proximal wells will be inspected, baseline sampled, and closely monitored during the construction phase. The Contractor will implement a contingency plan to provide temporary water during construction, and to repair or replace any wells found to be permanently damaged, in the event that wells are adversely or permanently affected by the Project.

Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is proposed for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects. The suggested duration of any post-construction monitoring would be the lesser of two years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

5.2.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant adverse residual environmental effects on groundwater resources are likely to occur. Possible increases in sodium and chloride concentration in wells in close proximity and downgradient of the proposed highway is the most likely potential effect, although this effect is not considered to be significant. Tables 5.11 and 5.12 provide a summary of the residual environmental effects assessment for groundwater resources.

Mitigation measures during highway operation include remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed. Drainage controls (*e.g.*, ditching) may be applied as needed to divert salt or contaminant laden run-off away from potentially affected wells.

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Table 5.11 Residual Environmental Effects Assessment Matrix
Groundwater Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Blasting	•• Loss of well yield (A)	•• Avoidance of blasting to the extent possible within 500 m of residential wells and the Lower South River wellfield; use ripping techniques where possible •• Pre-blast survey •• Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	3	2 / 1	R	2	N	3
Excavation	•• Water level lowering in shallow dug or drilled wells (A) •• Temporary siltation (A)	•• Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	3	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: i.e., temporary localized effects on aquifer that do not adversely affect well users; 2 = Medium: i.e., temporary effects on aquifer to adversely affect water wells, require treatment or modification of wells; 3 = High: i.e., permanent damage to aquifer supplying wells or interacting with surface water resources, well water supplies need to be replaced

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.12 Residual Environmental Effects Assessment Matrix Groundwater (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Road De-Icing	•• Water quality degradation (A)	•• Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed •• Apply drainage controls	2	4	2 / 1	R	2	N	3
Road Repairs	•• Water quality degradation; siltation (A)	•• Drainage and vibration controls •• Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	4	2 / 1	R	2	N	3

Refer to Table 5.11 for Key.

5.3 Fish and Fish Habitat

Fish and fish habitat is included as a VEC because suitable fish habitat is of vital importance to Nova Scotia's fish populations. Chemical, physical and biological factors are variables that determine a stream's suitability as fish habitat. The proposed RoW crosses16 watercourses located in the Antigonish area. The proposed South River crossing was evaluated in a separate impact study (Neill and Gunter Ltd. 2001). The results are incorporated in this section and the impact study is appended to this report (Appendix E). Fish and fish habitat are protected by federal legislation and are vital, dynamic components of a healthy ecosystem. Water quality in the watercourses is also discussed in the context of this VEC since the quality of the water directly affects the quality of the aquatic habitat.

5.3.1 Boundaries

The spatial boundaries for this VEC include all streams crossed by the proposed RoW, and receiving and terminating waterbodies, that potentially influence stream dynamics or provide or enhance fish habitat. Standard procedures include assessing fish habitat 100 m downstream and 250 m upstream of the proposed crossing which, coupled with stream site information, provides baseline information for subsequent habitat evaluations and monitoring.

Temporal boundaries for the assessment includes the construction and operation phases of the Project, focussing on periods of greater fish sensitivity such as fall spawning, the emergence and success of fry in the spring, and potentially high stress periods in low-water summer conditions.

5.3.2 Description of Existing Conditions

5.3.2.1 Fish and Fish Habitat

DFO Information

Of the watercourse crossings along the proposed RoW, there are significant watercourses and wetlands which have been identified as having particular significance to salmonid and other species. DFO has twice reviewed the study area for the proposed Highway 104 and identified several concerns. In response to the environmental screening and the *Federal Coordination Regulations* process, letters from both Charles MacInnis and James Leadbetter (DFO) were received by NSTPW, in February 1997 and October 2001. These letters highlighted concerns with regard to potential impacts on Brierly Brook, West River, and South River. Concern was also expressed regarding the erodible soils found in the study area and potential changes to the hydraulic regimes.

Brierly Brook was noted as having been the focus of a highly successful five-year project geared toward restoration of spawning and rearing habitats for Atlantic salmon and brook trout. The result has been an eightfold increase in salmon spawning in the brook since 1992.

The West River was noted as having the highest juvenile Atlantic salmon densities per unit area of any watershed in the Maritimes and has also undergone habitat restoration work. The proposed crossing site is a critical migration route and holding area. Site specific concerns DFO had with the crossing of West River were: ice jamming at the proposed bridge location with associated bank and bottom substrate scouring; sedimentation from sub-grade; and interference with existing fisheries.

The South River was noted for the diversified fish population it contains including Atlantic salmon, sea trout, brown trout, rainbow trout, striped bass and gaspereau. The area of the river north of the existing highway crossing is a highly productive salt marsh, critical to marine and freshwater fisheries resource. DFO required a detailed assessment for this crossing, which was undertaken by NSTPW (Neill and Gunter Ltd. 2001).

Also of concern, are two wetlands potentially impacted by the proposed highway. One is located at 1+000 while the other one is located at 4+150 (at Trunk 7). The concerns associated with the construction of the highway would be the loss of overwintering habitat at the 4+150 wetland and potential impacts to the lower parts of the tributaries and Brierly Brook, into which both wetlands drain. These wetlands are described in Section 5.8.

The nature of the soils and the rolling terrain adjacent to the proposed watercourse crossings greatly increase the potential for adverse effects on the fisheries resource during construction of the highway. One last concern identified was hydraulic changes to the streams. The tributaries and ditches located downgradient of the alignment will have to be stabilized in order to account for higher flows as a result of road construction to prevent scour and increased sediment loading downstream.

Methodology

Based on existing 1:20,000 NTS mapping and 1:10,000 air photos, 30 potential watercourse crossings were identified. In walking the length of the proposed highway route, the field crew found sixteen crossings, including South River (Figure 5.4). Due to low water levels at the time of the survey (June 24, 2002), electrofishing was possible at only four watercourses, three of which were found to contain fish. Although water levels were low at the time of the survey, only four of the eleven dry streams would, at times of normal or high water, be considered fish habitat. The area surveyed revealed a number of streams with negligible flow where electrofishing was not possible due to fish safety parameters. Despite low water and a lack of data for species composition of some of the brooks, this assessment considered the seasonal dynamics of the watercourses and the life history of the species present. Despite dry conditions, the habitat

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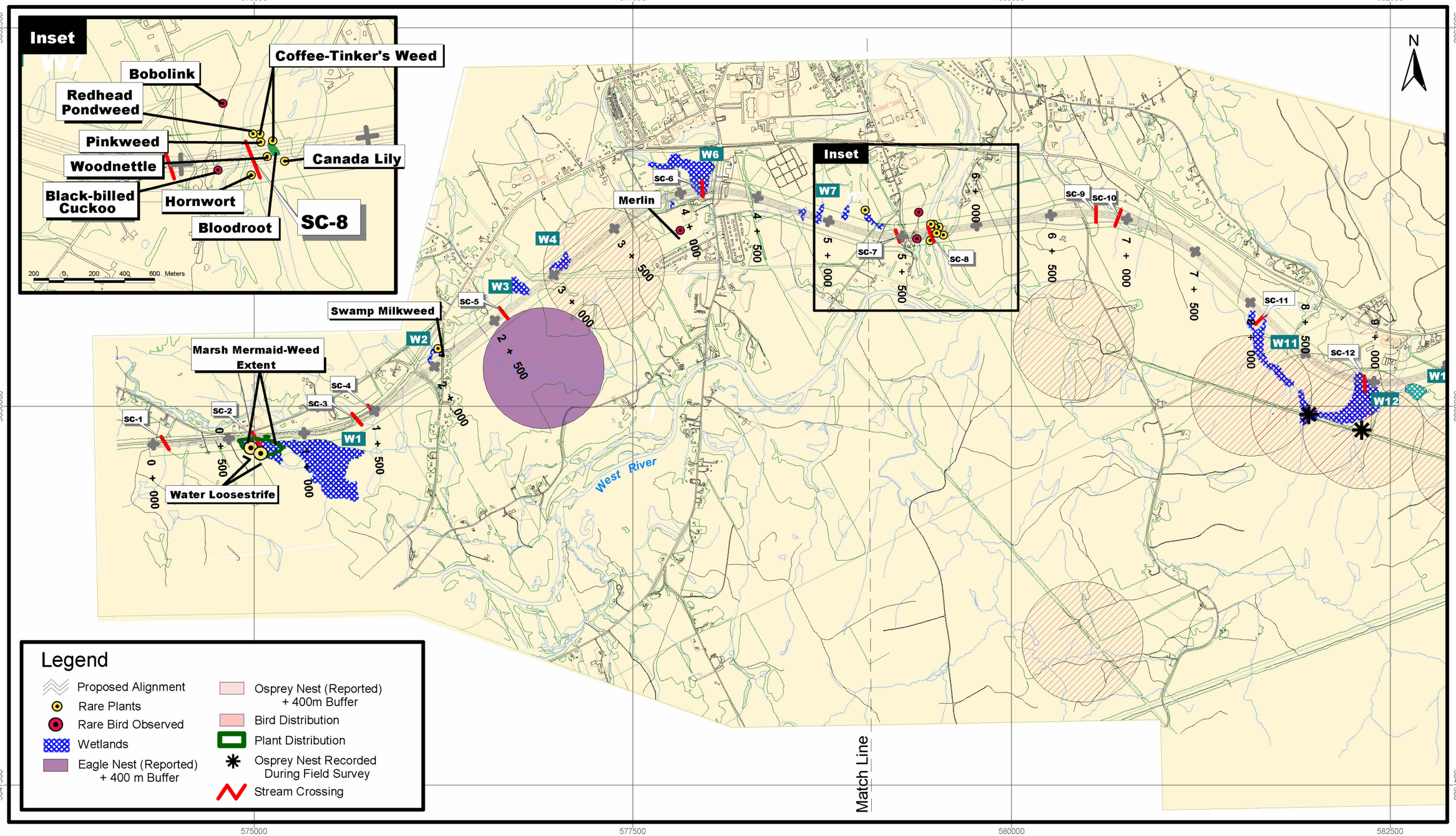

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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500

Date: 9/01/2004

Drawn By: GM

Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Biophysical Features (West)

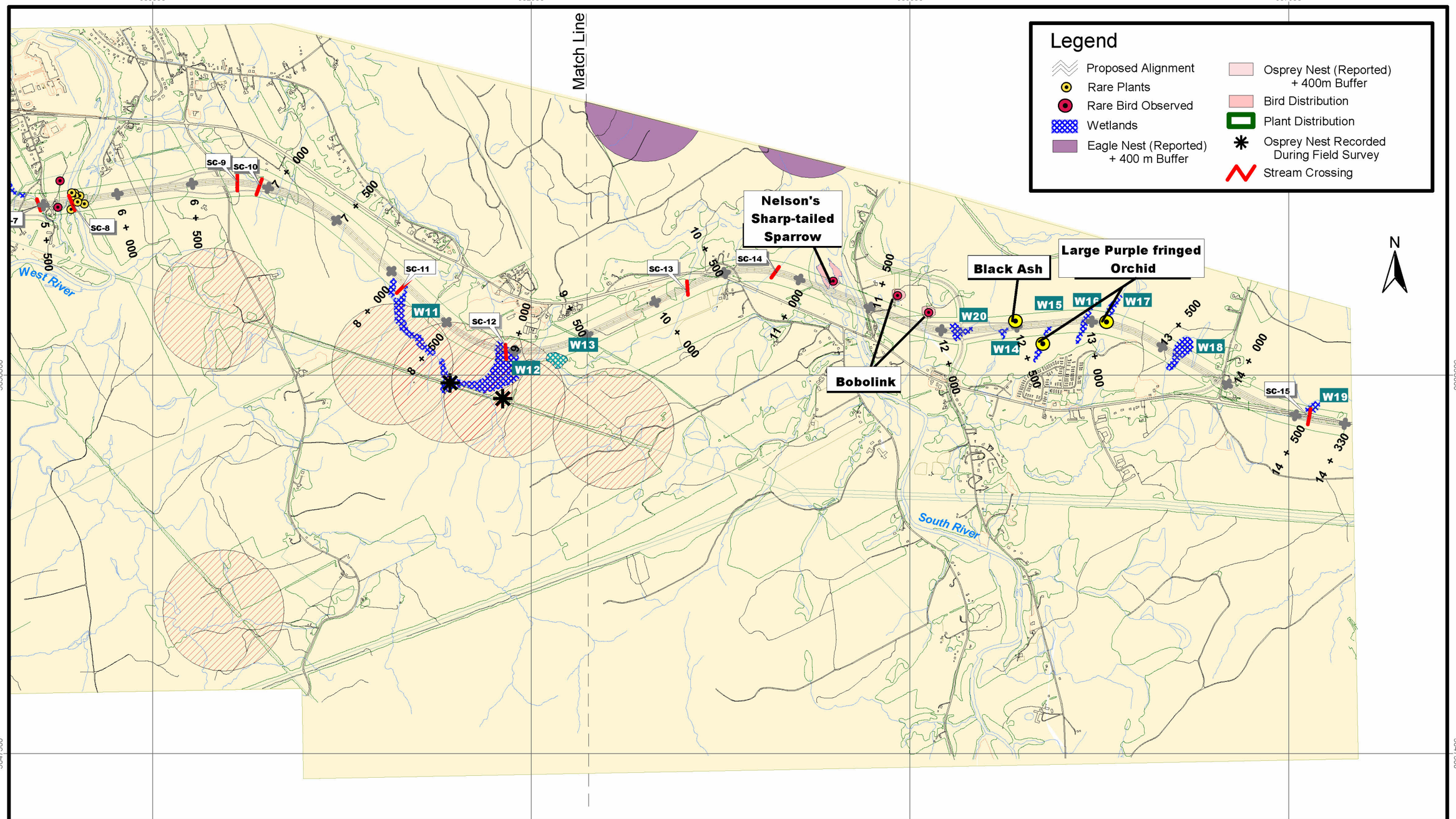
0.5 0 0.5 1 1.5 Km

Map Parameters: UTM, NAD27, Zone 20

DRAWING NO.

NSD16949
FIGURE 5.4a

C1442-116



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Date: 9/01/2004
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NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Biophysical Features (East)

0.5 0 0.5 1 1.5 Km

Map Parameters: UTM, NAD27, Zone 20

DRAWING NO.

NSD16949
FIGURE 5.4b

was also evaluated as it would be during conditions of normal flow taking into consideration channel width, wet width and stream substrate. Minnow traps were set for the South River study (September 29, 2000) and the river was also found to contain fish (refer to Appendix E).

Information collected to complete the assessment is not limited to field survey (*e.g.*, electrofishing) data but also includes input from a variety of sources. It is necessary to consult various sources as stream flow, despite rainfall amounts being at 87% of maximum rainfall for the season at the time of the survey (Environment Canada 2003), is naturally low in some of these watercourses which excludes electrofishing. While all stream crossings are visited during the survey, interviews conducted with DFO prior to the field survey identified streams with fish habitat potential and the types of fish recorded in these watercourses. Other sources of information include local and aboriginal recreational fishers, special interest groups and existing background information.

Preliminary evaluations of the proposed watercourse crossings were based on 1:20,000 mapping and 1:10,000 air photos. Consistent with the standard approach used in Nova Scotia, habitat characterizations at potential watercourse crossings were conducted 250 m upstream and 100 m downstream of the proposed RoW centreline. The South River survey was conducted the week of September 29, 2000, under separate contract, and the balance of crossings were surveyed during the week of June 24, 2002 by a qualified aquatic biologist and two field technicians. Combinations of stream flow, water depth, and substrate are major determinants of the quality of fish habitat for rearing and spawning. The aquatic habitat characterization included identification of the physical units (*i.e.*, riffles, pools, runs), instream cover, substrate composition, stream depth and width, water velocity, overhead cover, and water colouration. To assess water quality, water samples were collected during the fish habitat surveys. Collected water samples were analysed for general chemistry parameters and trace metals. Results of water quality analysis are presented in Appendix D. The results of salinity, conductivity and temperature measurements taken at the South River crossing are included in Appendix E of the impact study (refer to Appendix E of this report).

Much of the discussion of fish habitat is focussed on salmonids (*i.e.*, trout, salmon) due to their societal value. Rearing and spawning habitat for salmonids along the proposed route was classified using a rating scale. Five general categories are used to differentiate predominant salmonid habitat. These categories are based on quality of substrate, water flow, and stream morphology as follows:

Type 1:	Good salmonid spawning and rearing habitat
Type 2:	Good salmonid rearing habitat with limited spawning, usually only in small, isolated gravel pockets
Type 3:	Good rearing habitat with no spawning capabilities, or used for migratory purposes
Type 4:	Poor juvenile salmonid rearing habitat with no spawning capability; may provide shelter for older salmonids
Type 5:	No habitat available for rearing or spawning; usually too steep for fish access or intermittent streams.

The location of each proposed watercourse crossing is presented on Figure 5.4. Habitat summaries for each proposed stream crossing are presented below. Appendix D contains a detailed description of habitat and related habitat mapping, and includes information on stream bank slopes and erosion potential. Appendix B contains the hydrotechnical evaluation of the proposed highway. Appendix E contains the South River Impact Study (Neill and Gunter Ltd. 2001).

Habitat Summaries

Unnamed Tributary to Brierly (Stream Crossing No. 1) 0+100

This unnamed tributary to Brierly Brook is an intermittent headwater stream that had a channel width of 100 cm. No water was flowing through the brook at the time of the survey. The depth of a pool situated upstream of the culvert underneath Highway 104 measured 12 cm. At the time of survey the upstream habitat included a series of riffle areas with no flow. The RoW is located upstream of the existing Highway 104. After the brook crosses the highway in a box culvert, the channel is ill defined. Upstream substrate was composed of gravel and cobble while the substrate downstream of the RoW was composed of organic and silts. Embeddedness was high (>50 %) (embeddedness being defined as the degree that gravel and larger particles are surrounded or covered by fine sediment). The riparian vegetation was dominated by black spruce, sphagnum moss and brackenfern upstream and downstream of the RoW, while sedges and rushes dominated the banks of the stream at the RoW. Water temperature was 14°C, and had a pH reading of 6.7. Overall erosion sensitivity levels varied from moderate-low to moderate. These levels are based on particle size/class/ texture of sample collected 10 cm deep, 5 m from stream bank.

No fish were observed in Stream Crossing No. 1, and the crossing was rated as a Type 5 salmonid habitat for reasons such as its lack of flow, silty downstream substrate, and small size. In periods of high water this tributary may have flow, but it is unlikely that it is ever used extensively by any fish species as there is no defined channel downstream of the RoW. However, this brook flows into Brierly Brook which is a salmonid bearing stream.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 2) 0+800

This unnamed tributary had an average channel width of 4.04 m at the RoW. Upstream of the RoW, the stream becomes an extensive marshy area. Downstream of the RoW, the stream flows along Highway 104 and flows into a culvert underneath the highway. Mean depth of the channel at the RoW was 40 cm. The substrate was composed of 100 % silt and therefore embeddedness was high at the RoW and upstream of the RoW while it was moderate (20-35 %) downstream of the highway. Bank vegetation contained grasses, cattails and water horsetail. Water temperature was 15.9°C and a pH of 5.54.

This stream is likely Type 3 salmonid habitat based on morphology, substrate and habitat characteristics. Electrofishing was attempted at the culvert but no specimens were obtained. Poor footing and heavy vegetative cover limited electrofishing access in the marsh area located upstream of the ROW. The banks are natural and contain a sandy-silty soil, based on textural of soil samples collected approximately 5 m from the edge of the stream, at a depth of approximately 10 cm. Overall erosion sensitivity of the banks was low on the left bank (looking downstream) and high on the right bank.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 3) 1+400

This headwater tributary flows into the brook associated with Stream Crossing No. 2. No water was flowing in the brook except for a pool located downstream of a culvert underneath Highway 104. This brook had no defined channel at the RoW at the time of the survey . The substrate at the RoW was composed of 100 % silt. Embededdness was high (> 50 %) at the proposed crossing. The brook sprawled upstream of the RoW, becoming undefined and difficult to follow, and preventing further assessment of stream criteria. Downstream of the RoW, the brook regains a defined channel and substrate was composed of sand, gravel and a few cobbles. Bank vegetation contained cattails, rushed and grey alders. Water temperature was 16.4°C and a pH of 6.8. Overall erosion sensitivity levels were moderate.

Electrofishing was not possible on this stream due to limited morphological dimensions of the stream and lack of water at the time of the survey. Due to morphology and habitat characteristics this brook is rated as Type 5 salmonid habitat.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 4) 1+500

This headwater tributary also flows into the brook associated with Stream Crossing No. 2. This unnamed tributary was dry at the time of the survey except for a pool of water located downstream of the culvert underneath Highway 104. The substrate was mostly silt and organic matter at the proposed crossing and upstream, with sand and gravel upstream. Embeddedness was high (> 50%) both upstream and downstream. Bank vegetation contained gramminoid spp., buttercups, water horsetails and grey alders. Water temperature was 16°C and a pH of 6. Overall erosion sensitivity levels were moderate.

As with Stream Crossing No. 3, electrofishing was not possible on this stream due to limited morphological dimensions of the stream and lack of water at the time of the survey. Due to morphology and habitat characteristics this brook is rated as Type 3 salmonid habitat.

Unnamed Tributary to West River (Stream Crossing No. 5) 2+600

Stream Crossing No. 5 had an average wet width of 0.6 m and a channel width of 1.5 m. The substrate was composed of boulders and rubble. Embededdness was moderate (20-35 %) at the proposed crossing and

both upstream and downstream. Bank vegetation contained black spruce, grey alders, club moss, sensitive ferns. Water temperature was 12.2°C and a pH of 6.6. Overall erosion sensitivity levels were moderate-low and moderate-high. Flow was negligible and not calculable, due to low water levels.

No fish were observed at Stream Crossing No. 5 and it is rated as Type 3 salmonid habitat. No electrofishing was conducted due to lack of water. At times of high water, this stream would probably be unsuitable as salmonid spawning habitat. However some salmonid may migrate through this stream into the West River which has a well known salmonid population.

Unnamed Tributary (Stream Crossing No. 6) 4+150

Stream Crossing No. 6 was a pool of standing water at the time of the survey . It had a mean channel width of 25 cm. The substrate was composed mostly of silt. The substrate contained gravel and cobbles upstream of the RoW while the substrate remained silty downstream of the RoW. Bank vegetation was composed of bracken ferns, gramminoid, grey alders and club moss. Embededdness was high both at the proposed crossing and downstream (50 %), but was moderate upstream (20-35 %). Bank vegetation contained gramminoid spp., sensitive ferns and grey alders. Water temperature was 15°C and a pH of 6.5. Overall erosion sensitivity levels were low.

Stream Crossing No. 6 is rated as Type 4 salmonid habitat. One nine-spine and four three-spine sticklebacks were caught during electrofishing at this crossing.

Unnamed Tributary of West River (Stream Crossing No. 7) 5+500

This unnamed headwater tributary contained little water in pools located on the RoW. It had a mean wet channel width of 0.85 m channel width of 1.45 m. The substrate at the RoW was composed of silt while 100 m downstream the substrate is composed of cobbles and a few boulders as the slope of the stream channel is increased. Bank vegetation was composed of grey alders and thistle. Embededdness was high both at the proposed crossing and upstream (>50 %), but was low downstream (<20 %) . Water temperature was 16.1°C and a pH of 7.1. Overall erosion sensitivity levels were low.

Salmonid habitat at the crossing site was marginal but this brook is considered Type 3 habitat.

West River (Stream Crossing No. 8) 5+700

West River had an average wet widths at the RoW of 24 m and a channel width of 29 m. The average depth was 30 cm at the time of the survey. The habitat included riffles, runs, and a few deep pools. The substrate is predominantly cobble with smaller amounts of boulder and gravel. Embededdness was low (0-20%). Flow is approximately 4.39 m^3/s. The water had a pH of 5.85, a temperature of 15.7°C and was colourless.

Bank vegetation included gramminoids and alders. Overall erosion sensitivity levels were moderate to moderate-high.

Stream crossing No. 8 is rated as Type 1 salmonid habitat since it is one of Nova Scotia's premier fall season salmon recreational fishery rivers. Nine-spine stickleback, three-spine stickleback, creek chub, northern red-belly dace, banded killifish, white sucker and Atlantic salmon were caught in West River during the electrofishing survey. Brook trout and brown trout also inhabit the system.

Unnamed Tributary to West River (Stream Crossing No. 9) 6+750

This unnamed headwater tributary of the West River had an average channel width of 1.5 m upstream. No water was flowing at the time of the survey and mean depth of a pool of standing water was 3 cm. The habitat types present included riffles, runs, and pools. The substrate is predominantly cobble, with some sand and boulders. At the RoW, the channel runs in a channel 2-3 m lower than the forest floor creating steep banks on each side of the channel. The water was clear, with a pH of 6.88 and temperature of 13.6°C. Overall erosion sensitivity levels were moderate-high to high. Embeddedness was approximately 25 %, upstream and downstream of the RoW. Black spruce, ferns and mosses dominated the bank vegetation.

Stream Crossing No. 9 is rated as Type 5 salmonid habitat. This tributary is intermittent and probably only flows after rain events for a short duration. A poorly designed culvert is situated 70 m downstream of the RoW and at the time of the survey was completely blocked off by vegetation.

Unnamed Tributary to West River (Stream Crossing No. 10) 6+950

This unnamed headwater tributary of the West River was completely covered by wood debris from a previous logging operation in the area. No riparian vegetation was left from 40 m downstream of the RoW to 100 m upstream. No water was flowing at the time of the survey. Channel width was approximately 1 to 1.5 m wide. Downstream of the logged zone, the habitat includes runs, riffles, and pools. The substrate is mostly of cobble and gravel, with smaller amounts of sand. The water had a pH of 7.2, a temperature of 16°C and was colourless. Embeddedness was high at the RoW (>50 %) and erosion sensitivity was rated as moderate-high on both sides of the ROW. There are steep slopes on the right and left bank of this stream.

Stream Crossing No. 10 is rated as Type 4 salmonid habitat. In times of greater discharge, this stream could potentially provide marginal habitat for salmonid species, especially if the logging slash was removed from the streambed. However, the section of stream affected by the RoW does not have any remaining bank vegetation and it is probable that the stream temperature will increase and become inhospitable to salmonid species.

Unnamed Tributary to West River (Stream Crossing No. 11) 8+150

This unnamed tributary had a channel width of approximately 15 m at the RoW due to a beaver dam located 40 m downstream of the RoW. The substrate was composed of 100% organic matter and silt. Embeddedness was high (>50 %) and erosion sensitivity was rated as moderate-high and low-moderate. Bank vegetation and approaching slopes have been logged extensively and few mature trees are left. Water temperature had a pH of 6.38, a temperature of 18.6°C and a brown colour.

Electrofishing was conducted downstream of the RoW in several morphological features (riffles, pools and runs). During electrofishing, it was noted that loss of habitat had occurred because of the increased sediment loads in the stream. It is probable that the increase of sediment in the stream is a direct result of the loss of riparian vegetation along the stream. Stickleback and cyprinide species were caught in the electrofishing survey, however no brook trout were caught in the stream section electrofished. This is probably due to the increased water temperature and lower dissolved oxygen levels in that section. In areas with less human disturbance and groundwater discharge, it is probable that this stream affords good fish habitat and would be rated Type 2.

Unnamed Stream (Stream Crossing No. 12) 9+000

This portion of the stream was very difficult to distinguish as there was no defined stream channel but just a few pools of standing water dispersed in the area. The area showed signs of logging activities in the last ten years as most of the vegetation is considered early successional. The pool located at the RoW had a wet width of 1.1 m and a channel width of 1.4 m. Bank vegetation was composed of gray alders, gramminoids, raspberry and cattails. The water had a pH of 6.8, a water temperature of 19.3°C and was yellow-brown in colour. Embeddedness was high (>50%) and erosion sensitivity levels were classified as low-moderate for both banks. The major component of the substrate was silt.

Stream Crossing No. 12 is rated as Type 5 salmonid habitat. This stream was not electrofished due to lack of water and high water temperature. No fish were observed during the survey.

Unnamed Tributary to South River (Stream Crossing No. 13) 10+200

This headwater stream had no water flowing in the time of the survey. Approximately 40 m downstream of the RoW, a culvert is located underneath the old portion of the highway. This culvert is not well designed as it plunges approximately 1 m from the upstream streambed into the culvert. The substrate was predominantly boulder and cobble. Embeddedness was relatively low (0-20 %) at the RoW. Bank vegetation at the RoW consisted of black spruce, choke berry and grey alders. Erosion sensitivity levels were rated as high on the left bank and moderate on the right bank.

Although this brook was dry at the time of survey this brook it is certainly a Type 5 salmonid habitat when flows are normal or high. The poorly designed culvert downstream of the RoW impedes fish passage which makes it a candidate for habitat compensation.

Unnamed Tributary to South River (Stream Crossing No. 14) 10+850

This watercourse could be described as a drainage ditch as it runs parallel to a field. At the time of the survey there was no water flowing into the tributary and terrestrial vegetation had invaded the streambed. This watercourse had an average channel width of 1.5 m at the proposed crossing. The substrate was predominantly silt and organic matter. The watercourse is overgrown by grasses and cattails. The banks are composed of silty and sandy topsoil and have an erosion sensitivity level rated as high and high-very high. This watercourse probably does not provide fish habitat at any time of the year and is rated as Type 5 salmonid habitat.

Unnamed Stream (Stream Crossing No. 15) 14+600

This unnamed stream had an average channel width of 1.5 m and a mean depth of 3 cm at the proposed crossing. This stream is parallel to the existing highway and crosses underneath the highway in a culvert. The substrate was composed predominantly of silt. It is rated as Type 5 salmonid habitat.

South River Crossing 11+100

Aquatic habitat consists of the river channel to the east, a backwater channel entering the island area from the north and a backwater channel to the west. Since construction of the existing crossing, backwater channel has accumulated a 10 cm layer of organic/silt deposits over an original substrate of medium to fine gravel (Neill and Gunter Ltd. 2001). Water depths vary between 0.3 m and 2 m at near tide.

During the survey, temperatures in the channels ranged from 16°C to 20°C, conductivity ranged from 0.4 millimohs (mmohs) to 27 mmohs and salinity ranged from 0.1 parts per thousand (ppt) to 18 ppt. Minnow traps set during the survey yielded mummichogs and a white sucker.

Summary

Seven of the 15 stream crossings evaluated in 2002 were rated by the field crew as Type 5 with no habitat available for rearing or spawning for reasons such as lack of flow, silty substrate and banks that contain silty or gravelly sandy topsoil. Steam Crossings No. 4, 6, 7 and 10 were rated as Type 4 habitat, poor spawning/rearing habitat but providing shelter for older salmonids. Two streams were rated as Type 3 habitat while one stream crossing was rated as Type 2 habitat, which is described as good salmonid rearing habitat with limited spawning capacity. West River was the only stream rated as a Type 1 salmonid habitat.

Despite low flow conditions encountered at the time of the survey, the study team is confident that the habitat evaluations are applicable to average conditions throughout the year.

The South River evaluation found that the main and back channels are equally productive in terms of fish habitat; however, the primary function of the crossing area is fish passage, as spawning habitat is not present for game species such as brook trout, brown trout and Atlantic salmon at this site.

5.3.2.2 Water Quality

Four rounds of surface water sampling were conducted on watercourse crossings along the proposed highway RoW. The first sampling event occurred in June 2002, the second in October 2002, the third in February 2003 and the final sampling event was conducted in April 2003. Surface water sampling was conducted at the South River crossing in October 2000.

South River Crossing

Water quality parameters investigated during the South River Impact Study (October 5, 2000) included salinity, conductivity and temperature. Salinity ranged from 0.1 ppt to 18 ppt while conductivity ranged from 0.4 mmohs to 27 mmohs. Temperature ranged from 16°C to 20°C. Salinity and conductivity results were consistent with brackish water indicating that the area is an intertidal zone.

June 2002 Sampling Event

Water quality chemistry results are included in Appendix D. Three of the crossings (12, 13 and 14) did not contain water at the time of the survey. Of the 15 parameters listed in the Freshwater Aquatic Life (FWAL) Guidelines (CCME 1999), analytical results indicated exceedances of five metals, namely copper, lead, chromium, iron and aluminum. While some of these exceedances may be attributable to natural rock weathering, elevated metals concentration in surface water can also be attributed to anthropogenic (human) sources (especially coal burning).

The current guideline for copper is 2 • g/L, and 92 % of the samples had copper levels higher than the CCME guideline. Lead concentrations exceeded the CCME guideline in 42% of the samples while chromium concentrations exceeded the guidelines in 25 % of the samples obtained in the June survey. Maltby *et al.* (1995) recognised that deicing salts can contribute chromium and copper to streams.

For the protection of freshwater aquatic life, the concentration guideline for iron is 300 • g/L. Elevated concentrations of iron were detected in 66% of the samples. In aerated surface waters, the oxidation state

of iron is the ferrous state (Fe^{2+}) which oxidizes and precipitates as ferric iron, forming a colloidal suspension of ferric hydroxide particles (CCME 1987). This orange floc was observed sporadically during the habitat survey.

The FWAL Guidelines for aluminum are based on pH, calcium and dissolved organic carbon and range from 5 to 100 • g/L. Aluminoscillicate minerals are particularly abundant in clays and are released to surface waters from soils and sediments by natural weathering and accelerated acidification processes (CCME 1987). Based on the these guidelines it appears as though the concentration of aluminum is elevated at 66% of all locations. In the Atlantic Region, surface water aluminum concentrations range from 10 to 1250 • g/L (CCME 1987).

October 2002 Sampling Event

Exceedances of the CCME FWAL guidelines were registered for ammonia (one stream), aluminum (14 streams), copper (10 streams), iron (seven streams) and zinc (one stream). These results are generally consistent with the results from the June sampling event. Of note are the higher levels of nutrients in Stream Crossing No. 13 and the non-detectable levels of chromium in the surface water samples in October. Part of the upstream catchment area of Stream Crossing No. 13 is made up of an agricultural field which may have been fertilized in late summer or fall. Total suspended solids (TSS) were assessed and levels were between <2 mg/L and 6 mg/L, indicating low erosional impacts in these streams.

February 2003 Sampling Event

Stream Crossing Nos. 3, 12, 14 and 15 did not contain any water at the time of the survey as the water in their channels was completely frozen. Exceedances to the CCME FWAL guidelines were registered for ammonia (one stream), aluminum (all streams), pH (two streams), copper (all streams), iron (four streams) and lead (two streams). No exceedances were registered for nitrite, arsenic, cadmium, chromium, molybdenum, nickel, silver and zinc. Results from the February survey closely reflect results from the summer and autumn sampling events. Water colouration in the streams was remarkably clearer than it was during the previous sampling events. Total suspended solids (TSS) levels in the streams were below 10 mg/L at all but one stream crossing. Stream Crossing No. 4 registered a TSS level of 26.8 mg/L, which may be a reflection of the source of water in this stream as this crossing receives drainage water from Highway 104.

April 2003 Sampling Event

All crossings contained water at the time of the survey. Exceedances to the CCME FWAL guidelines were registered for pH (one stream), aluminum (nine streams), copper (all streams), iron (three streams) and lead (one stream). This is similar to results from the previous sampling events. While the number of aluminum

exceedances were lower in April 2003 than in February 2003, levels were similar to those registered in summer of 2003. As in the February sampling event, copper levels in all streams exceeded the guidelines. While summer sampling results revealed that all but one stream had copper levels above the guidelines, only 10 streams registered copper exceedances during the autumn sampling event. The number of iron exceedances were similar to the number registered in the February sampling event and lower than the number registered in autumn and summer of 2002. The number of lead exceedances to the guideline was lower in the April sampling event compared to the summer and winter sampling event. No lead exceedance was registered in the autumn sampling event. No exceedances were registered for nitrite, arsenic, cadmium, chromium, molybdenum, nickel, selenium, silver, thallium and zinc. Total suspended solids (TSS) levels in all streams were below 5 mg/L at all but one stream crossing. Crossing # 11 registered a TSS level of 20.2 mg/L.

5.3.2.3 Fish

Presence or absence of fish species was determined, where possible, through qualitative electrofishing using a Smith-Root 12 electrofisher. This spot-check method was employed in various habitat types such as pools, riffles, and runs. Fish captured were anaesthetised using a clove oil and ethanol solution to reduce stress and injury while the fish were identified, enumerated, and measured. Electrofishing was possible in only four watercourses due to low water levels (Stream Crossing Nos. 2, 6, 8, and 11). Anecdotal information regarding the presence of fish in the streams crossed was gathered through discussions with local residents and the local DFO office by the field crew and was also used to determine the presence or absence of fish species.

Presence or absence of fish at the proposed South River crossing was determined by setting minnow traps at six locations throughout the marsh on September 29, 2000 which were collected October 5, 2000. Fish were identified, counted and measured on-site and several specimens were taken back in a cooler for identification by John Gilhen at the Nova Scotia Museum.

The marsh upstream of Stream Crossings No. 2 and 6 has been identified as important overwintering habitat for brook trout (D. Goth, pers. comm. 2002; and C. MacInnis, DFO from Taylor and Juurlink, 2004). Electrofishing in open water at the culvert yielded no specimens; poor footing and heavy vegetative cover limited electrofishing access in the marsh.

Only one individual of nine-spine stickleback and four three-spine stickleback were present at Stream Crossing No. 6 (Appendix D). Four spine stickleback and northern redbelly dace have been observed in the stream in the vicinity of the crossing (Taylor and Juurlink, 2004).

Eleven Atlantic salmon (*Salmo salar*) were caught at Stream Crossing No. 8 (West River). These fish ranged from a total length of 3.6 cm to 13.0 cm (Appendix D). Five white suckers (*Catostomus commersoni*), four

banded killifish (*Fundulus diaphanus*), four northern redbelly dace (*Chrosomus eos*), three three-spine stickleback (*Gasterosteus aculeatus*), one nine-spine stickleback (*Pungitius pungitius*) and six creek chub (*Semotilus atromaculatus*) were caught in the West River. The white suckers, creek chub and banded killifish were abundant in a still-water connected to the West River. The electrofishing was confined to the RoW and the results did not show the presence of either brown or brook trout. This could possibly be explained because of the dominance Atlantic salmon parr at the RoW. Both brown and brook trout do however have strong populations in the river (D. Goth, pers. comm. 2002)

Nine-spine stickleback and three-spine stickleback were present at Stream Crossing No. 11. Only one individual of each stickleback species was caught while ten creek chub and six northern redbelly were caught (Appendix D).

Stream Crossing Nos. 1, 3, 9, 12, 13, 14 and 15 were all rated as Type 5 watercourses for salmonid habitat. Even in times of normal or high flow it is unlikely that these watercourses would be extensively used by any species of fish.

Fish species were present in Stream Crossing Nos. 6, 8, and 11. Species located by the field crew included: Atlantic salmon, white sucker, creek chub, northern redbelly dace, banded killifish, three-spine stickleback and nine-spine stickleback. Various other species are known to occur in the watercourses surveyed including: American shad, alewife, sea-run brook trout, rainbow smelt, sea-run brown trout, and American eel. These species have varying social and minor commercial value.

Six minnow traps set at the proposed South River crossing yielded between 62 and 115 mummichog *fundulus heteroclitus* and one white sucker. Large numbers of mummichogs were visible in the central island channel during trap collection.

5.3.2.4 Benthic Invertebrates

Benthic invertebrates were sampled by gently brushing invertebrates from five rocks at each sampling location. All rocks were obtained from a riffle zone upstream and downstream of the RoW. All invertebrates were preserved in a plastic sampling bag with ethanol until they could be identified.

Only Stream Crossing Nos. 5 and 8 had enough water and the proper substrate to complete the benthic invertebrate survey. Ten invertebrate families were obtained from the crossings (Appendix D). Crossing No. 8 contained more families of invertebrates than Crossing No. 5. Overall most of the species had low (*Odontoceridae*) to medium (*Chironomidae*) tolerance level to organic pollution (Mandaville 2002) (Appendix D).

The collection of benthic samples for the proposed South River crossing was achieved by collecting the samples using a stainless Ponar (grab) sampler from a canoe at seven sampling stations. Samples were transferred to plastic ziplock bags and sent for identification. Eleven invertebrate taxa were obtained from the samples taken at the crossing (refer to Appendix E).

5.3.3 Residual Environmental Effects Evaluation Criteria

The definition for significant environmental effects on fish is population-based and takes into account natural variation and potential for population recovery.

A **significant** adverse environmental effect is one that significantly alters a fish population or a portion of it to cause a decline or change in abundance or distribution of the population over one or more generations. Natural recruitment (reproduction and immigration from unaffected areas) may not re-establish the population to its original level. A significant population effect on fish habitat may alter the valued habitat physically, chemically, and/or biologically in quality or extent, such that there is a decline in the species diversity of the habitat. This effect may be reflected by a decline in abundance and/or change of habitat components (*i.e.*, sediment quality, food resources, water quality, and riparian vegetation).

A **positive** effect is one which may enhance the quality of habitat, increase species diversity, or increase the area of the valued habitat. A positive effect may enhance a population such that an increase in that population is evident.

5.3.4 Potential Issues, Interactions and Concerns

During construction, operation and maintenance, potential interactions with fish and fish habitat may be attributed to the following activities:

- clearing and grubbing of riparian vegetation;
- blasting, ripping, infilling and grading;
- watercourse crossing;
- asphalt repair, repainting or shoulder regrading; and
- salt application, and snow removal.

The potential effects of these activities include erosion and sedimentation, fish mortality, stream morphology alteration and degradation, acid drainage and water quality change. Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

Erosion and Sedimentation

The introduction of sediment to a lotic (moving water) system by way of erosion, sedimentation or instream work, is the main area of concern during the construction phase. The highest risk for erosion and sedimentation will occur during clearing and grubbing, topsoil stripping and grading, and watercourse crossing and backfilling.

Erosion and sedimentation can occur anywhere soil is exposed. Potential characteristics of the proposed stream crossing sites that may increase the risk of erosion and sedimentation include stream morphology, high discharge, and the presence of erodible soils. Soil analysis revealed moderate to highly erodible loam soils at the proposed stream crossing sites.

The area of the proposed highway route shows some evidence of past logging. Both clear-cuts and selective harvest logging operations were evident while conducting the stream assessments. Siltation and erosion were observed where heavy logging had occurred. Stream Crossing No. 10 was devoid of stabilizing riparian vegetation because of recent logging activities and showed signs of erosion in sensitive meander areas. Furthermore the whole channel was blocked off by cuttings from the forestry operation. Despite low discharge many streams showed evidence of siltation; it is assumed that during bankfull stage some streams would have high erosion potential. Residential impact was minimal, with sparse population and development along the proposed route.

Increased sediment loads may have harmful effects on fish and fish habitat. Suspended sediment in the water column may cause direct physical damage to fish by abrading gill membranes and skin, and causing susceptibility to secondary infection. Feeding habits can also be impaired, particularly in salmonids and trout which are visual feeders, invertebrate populations may also be adversely affected. Once deposited, silt clogs gravelled areas that are potential spawning habitat, increasing egg mortality and destroying habitat for small fish and invertebrates.

In the case of small, meandering streams, heavy sedimentation can block flow, preventing fish migration and causing adverse morphological change. Brook trout prefer streams with a relatively high percentage of pools, and sedimentation and erosion can adversely impact these important habitats.

Infilling of wetlands associated with streams (*e.g.*, Brierly Brook) is not expected to have a significant effect on fish and fish habitat since the portions of wetlands to be infilled contribute a minor proportion of water discharge compared to the entire wetland complexes and catchment areas of each watercourse. Therefore the nutrient loading will not significantly change and overwintering fish habitat, if present, would not be altered, assuming adequate fish passage is provided.

Blasting

Sections of the proposed alignment that pass through bedrock areas may require blasting if the rock is not rippable. Blasting in and adjacent to watercourses may cause direct deleterious effects upon fish health from blast percussion, excessive dust deposited in streams, disturbance to the habitat, and introduction of acidic drainage if the bedrock contains sulphide mineralization.

Clearing

The removal of stream-side vegetation during construction of the highway has potential for moderate impacts as shading from the canopy maintains consistent and lower water temperatures more suitable for fish species. Increased algal and macrophyte growth may also choke small streams or lower dissolved oxygen levels through decomposition. Salmonids are highly sensitive when exposed to high summer temperatures generated from exposed water. The potential for death, susceptibility to opportunistic pathogens, and lowered overall reproductive potential is increased. Clearing activities in the vicinity of a watercourse will cause disturbance to the protective vegetative buffer adjacent to the watercourse and could subsequently lead to erosion of the approach slopes and sedimentation into and the obstruction of the watercourse. Riparian diversity supports diverse invertebrate habitat and is a component of many aquatic invertebrates' life cycles. Clearing of riparian vegetation lowers the availability of prey sources for salmonids and other insectivorous fish species.

Culvert Installation

Watercourse beds and banks may be disturbed during the installation of culverts. Fish movement could be impaired or fish may be displaced during culvert installation, and following installation if the culvert is not properly placed or measured (*i.e.* sufficient depth and flow). Instream work also contributes to sedimentation and the potential for damaging stream habitat. If altered, the stream must be remediated to natural conditions. Flow alterations must be kept short and be completely reversible.

Excavation in Acid Generating Bedrock

Although acid generating bedrock is not anticipated within the study area, it is noted that excavation in areas with acid generating potential poses risks to the aquatic environment. Runoff from exposed sources of sulphide mineralization can drastically reduce water quality by acidification. Acidic waters liberate heavy metals which can reach toxic levels for fish and other aquatic life. Aquatic macroinvertebrates, fish eggs, and fry are most susceptible to acidic drainage. Some of the pHs in watercourses assessed (stream crossings 1, 2 and 15) were slightly depressed making them susceptible to acidification from external sources.

Operation and Maintenance Activities

Repetitive clearing of overhead cover along the RoW at watercourse crossings may affect stream temperature control following construction. Road salting could lead to degradation of water quality and fish habitat downstream of the proposed highway by increasing the salt concentration and potentially inducing osmotic stress to fish. Shoulder grading could result in gravel being washed into nearby watercourses.

5.3.5 Analysis, Mitigation and Residual Environmental Effects Prediction

DFO has developed the Policy for the Management of Fish Habitat (1986), which applies to all projects and activities, in or near water, that could alter, disrupt, or destroy fish habitats by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The Policy for the Management of Fish Habitat is regulated by the following sections of the *Fisheries Act*: Section 20, 21, 22, 30, 32, 35, 37, 40 and 43, which are administered by DFO. Under the terms of a Memorandum of Understanding with Environment Canada, the Minister of Fisheries and Oceans is legally responsible for all sections of the *Act*. However, for Sections 36 to 42, Environment Canada administers those aspects dealing with the control of pollutants affecting fish. DFO co-operates with Environment Canada in the establishment of federal priorities for the protection of fish and their habitats from deleterious substances.

With respect to culvert installations and extensions, DFO (*Fisheries Act* Section 20) requires safe fish passage in all watercourses that bear fish. This is administered in close collaboration with NSDEL through the Water Approval process (formerly Watercourse Alteration Permit) under the provincial *Designated Activities Regulation*. This application process applies to new culvert installations and existing culverts which may require extensions and upgrading. DFO encourages all owners or occupiers to inspect existing culverts and upgrade these fishways, if necessary, to ensure adequate fish passage. Upgrades and new culvert installations will be completed as per the criteria presented in Conrad and Jansen (1994), or latest applicable DFO guidelines.

5.3.5.1 Construction

Scheduling

Construction undertaken in or near a watercourse, particularly work involving heavy machinery, may have adverse effects on fish resources. Prudent timing of such instream works can reduce adverse effects. Salmonid species deposit eggs in the substrate of a watercourse in the autumn. The eggs incubate throughout the winter in the substrate, and emerge to feed on external food source in the spring. Spawning, egg incubation and hatching occur very rapidly in the spring and early summer. Table 5.13 provides important biological information on key species.

Table 5.13 Spawning and Emergence Times for Key Fish Species		
Species	**Spawning Dates**	**Emergence Dates**
Brook trout	Late September and November	early to mid-April
Brown trout	October and November	early to mid-May
Atlantic salmon	October and November	mid-May to early June

Where fish are present and construction schedules permit, construction of watercourse crossings will be scheduled for periods when there will be less disturbance to fish populations (*i.e.*, June 1 through September 30). If there is a requirement to conduct construction activities outside the preferred window, compensation and/or additional mitigative measures will be implemented as required. The following periods and areas will be avoided where practical: spawning and incubation periods, critical overwintering areas during winter periods, and migration routes where construction may obstruct fish movements. For spring-spawning species, the period of least sensitivities is generally from mid-July to late September. Fall-spawning species are generally least sensitive between June and mid-September.

Erosion and Sedimentation

Maintaining optimal flow, habitat and fish passage is important for watercourses which naturally have lower flow and discharge potential. The potential of losing smaller watercourses exists if flow is altered or sedimentation increased. These potential passageways for fish species are of prime importance in maintaining healthy and diverse fish populations. Although many of the streams assessed did not contain fish or optimal fish habitat, degraded water quality or siltation in these tributaries could have potential damaging effects to fish and fish habitat downstream of the crossing, and must therefore be protected from Project sedimentation.

Some degree of erosion and sedimentation into watercourses can be expected from equipment activity and earth moving on the RoW, soil erosion on approaches and banks, and substrate disturbance at watercourse crossings. These temporary effects can be minimized by appropriate erosion and sedimentation prevention and control measures which will be specified in an EPP for the Project. All personnel will comply with environmental protection procedures established in the EPP, including a Work Progression Schedule. The Work Progression Schedule is a clause designed to ensure construction in any work area is carried out continuously from initiation to completion to ensure orderly progression of the work and to minimize exposed soil on construction sites. Once a site has been grubbed, it must be graded, seeded and have final slope protection in place within 30 calendar days (NSTPW 1997 and revisions). Erosion and sediment control practices will be outlined in the EPP.

General mitigative measures at watercourse crossings for clearing, grubbing, backfilling, blasting will be detailed in the EPP. No instream work will commence until all erosion and sediment control measures are implemented. There are three categories of erosion and sediment control for construction projects: runoff controls, erosion protection, and sediment interception.

Runoff controls limit or contain soil movement from the construction site. Minimizing raindrop impact on the soil, reducing runoff volume, and decreasing runoff velocity are three of its main objectives. Generic controls considered for this Project include the following.

- To reduce the velocity of runoff, crop residues, plants and rough soil surfaces help spread the flow of water over a greater area and into a thin layer.
- Diversion berms are commonly used on slopes to intercept sheet flow on exposed surfaces and to reroute flow into undisturbed areas. Erosion protection is required at the berm outlets.
- Flow checks are a temporary measure constructed in ditches, swales, or chutes to reduce hydraulic gradient and flow velocity, thus minimizing the potential for erosion of the channel.

Erosion protection measures are used to reduce or eliminate the detachment of soil particles by falling rain or droplets, or to resist sheet or channel flow. These measures are placed on, or applied to, the soil surface and are often used in conjunction with runoff control and sediment interception measures. Revegetation is generally used only for permanent protection and often requires another form of temporary protection measure to be successfully implemented.

Soil loss from slopes may occur even with erosion and runoff control measures. If this soil can enter a waterbody, mitigative measures will be required to intercept it. Methods used to trap sediment include vegetated buffer strips, silt fences, filter berms, and sediment traps.

Thorough maintenance of all temporary and permanent erosion and sediment control measures will ensure the integrity of the aquatic resources they protect. Monitoring of the site following major rainstorms will ensure that runoff control devices are effective and accumulated sediment is removed.

Where reasonable, a 75 m buffer zone will be established to exclude grubbing and grading near watercourses adjacent to watercourse crossings until culverts are installed. Substrate composition will be recorded at crossing areas prior to cut operations to confirm substrate in the precise area of the surveyed RoW. Substrate disturbed or removed during construction will be replaced with the same or a better grade of material to minimize impacts to spawning or rearing habitats, where appropriate.

The risks of sedimentation will be minimized by strict adherence to the EPP, Environmental Construction Plans and by the presence of at least one on-site contractor who has received training in erosion and sediment control. The duration of work at each stream crossing will be short, any instream disturbance will be temporary, and the frequency of disturbance will be low (*i.e.*, one time only).

Blasting

Should blasting be required during construction in or near a watercourse, a permit will be required from DFO for the use of explosives (Section 28 of the *Fisheries Act*). Blasting will be conducted in accordance with "Guidelines for use of Explosives in Canadian Fisheries Waters" (Wright and Hopky 1998). Effects from blasting to fish and fish habitat will be minimized through the following mitigative measures:

- exclusion of fish from the blasting area, where practical, using appropriate methods;
- use of non-propagating explosives;
- use of time delay blasting caps for detonation of multiple charges;
- over-drilling of holes to detonate each charge; and
- use of decked charges.

Construction (including blasting) in or near watercourses will be undertaken between June 1 and September 30, outside of the biologically sensitive period to avoid the sensitive and critical fish life stages. Explosive use, if necessary, will be infrequent and limited to only a few areas, if any, along the RoW.

Clearing

Riparian vegetation will be cleared for the highway alignment. Vegetation will be allowed to grow along the bank of the watercourse to maintain the stability of the banks. Where vegetation must be removed for culvert installation, it will be removed as late as possible and the affected area will be re-vegetated as soon as possible. Vegetation will also provide adequate shade to prevent an excessive rise in water temperature, reduce overgrowth of small streams by invasive gramminoid plant species (*i.e.*, grasses, sedges, bulrush) and prevent prolific algal growth. NSTPW will avoid long skids of timber on steep slopes adjacent to watercourses as well as falling or skidding trees across a watercourse. Where technically possible, NSTPW will not use heavy machinery within 10 m of streambanks. Any trees needed to be cut within 10 m of the watercourses will be cut by hand or by machinery able to 'reach in' within those areas. Residual effects are expected to be temporary and non-significant, as the geographical extent is limited, the duration of construction is short and the removal of vegetation is reversible through natural succession and replanting of appropriate native vegetation.

Culvert Installation and Extension

Instream work will be undertaken between June 1 and September 30 to avoid sensitive and critical fish life stages. All watercourse crossings will be properly sized and designed to ensure watercourse flow and, in fish-bearing streams, to allow fish passage as per the criteria detailed in Conrad and Jansen (1994), or the latest applicable DFO guidelines). All culvert designs requiring fish passage will be reviewed by DFO under Section 20 of the *Fisheries Act*. NSTPW will work with NSDEL and DFO to ensure that new culverts

installed in fish-bearing streams will: not obstruct fish passage; handle peak flows; maintain natural stream conditions (width, habitat); and that culvert extensions will also adhere to these same criteria. Culvert extensions or upgrades may be required where the alignment meets existing routes.

The hydrotechnical evaluation conducted for this Project (Appendix B) recommended that a free-spanning structure be considered at the RoW on West River and that a spanning structure (open bottom culvert, bridge) be installed at Stream Crossing No. 11 (8+150), the unnamed tributary to West River. The South River Impact Study recommended that a four span steel girder bridge be constructed at the proposed South River crossing.

Erosion and sediment control structures, as described above will be used during the installation. Culvert installation plans containing other installation details will be developed prior to construction and will be implemented during construction activities.

Excavation in Acid Generating Bedrock

As discussed in Section 2.4.12, acid producing bedrock is not anticipated to be encountered during Project construction. Geotechnical drilling conducted prior to construction will provide opportunity to test for acid producing potential.

In the unlikely event that acid generating bedrock is encountered during construction and is unavoidable (refer to Section 2.4.12 for avoidance measures during design phase), the following mitigation measures will minimize potential effects:

- Evaluation of depth to bedrock by geotechnical investigation and testing for acid producing and acid consuming potential will be undertaken prior to any excavation in bedrock at, and in the vicinity of, watercourse crossings where there is concern for site runoff into nearby watercourses. Testing will comply with specifications outlined in the *Sulphide Bearing Material Disposal Regulations* under the Nova Scotia *Environment Act*.
- Surface water quality data will be collected for baseline assessment of pH, metals, acidity, alkalinity, sulphate, and conductivity before any construction commences.
- Exposure of acid generating bedrock to rain and air will be reduced by keeping any exposed or stockpiled material covered, and capturing and neutralizing any runoff before discharge. The Project Engineer will ensure erosion control measures are properly installed and maintained.
- If excavated material exceeds acid generating limits, bedrock will be disposed of in accordance with the *Sulphide Bearing Material Disposal Regulations*.
- Exposed bedrock will be backfilled with clay or other low permeability material.

- The duration of construction in areas prone to acid generation will be minimized and surface water pH, acidity, alkalinity, sulphate, and metals will be monitored post-construction upstream and downstream of the crossing site.

If surface water quality monitoring (post construction) shows lowered water pH, the site will be reassessed and mitigation modified to correct the acidic release. NSTPW will develop appropriate mitigative measures in consultation with environmental agencies.

Summary

Primary concerns during construction are the potential degradation of fish habitat and stream morphology due to sedimentation and erosion. More immediate, direct effects on fish populations could result from the excavation of acid generating bedrock or from blasting in proximity to watercourses. Retention of vegetation along the banks of watercourses is important to prevent a rise in water temperature, while consideration of construction schedules promotes minimal disturbance of fish during critical periods.

Because of the small flow potential, narrow stream width and meandering character of many of the streams assessed, it is probable that more than one morphological feature will be compromised within the RoW. Pools, which are important brook trout habitat, will be channelized at some proposed watercourse crossings. Where feasible, location of watercourse crossings in areas of more consistent gradient and naturally straighter stream character, are highly recommended, as this will significantly decrease adverse impacts to fish and fish habitat.

Provided the proposed mitigative measures are applied, no significant adverse environmental effects on fish and fish habitat are anticipated during construction.

5.3.5.2 Operation and Maintenance

Mechanical clearing will primarily be used for vegetation control during highway operation on the RoW (*e.g.*, road shoulders and interchanges). There will be no herbicide applications under any of the following legislated conditions:

- within a 30 m buffer zone of any watercourse;
- within any distance of any watercourse prescribed on a product label; and
- within 60 m of a protected water supply.

Permanent erosion control measures will mitigate long-term effects of erosion and sedimentation. Appropriate erosion control measures for each watercourse bank will be specified in site specific environmental control plans developed as part of the highway design. These will minimize the potential

for stream bank destabilisation and erosion. Residual environmental effects are expected to be non-significant, assuming that minimal to no disturbance of slopes will occur post-construction and that the effects are reversible.

Highway maintenance is typically of short duration and affects short distances or small sections of highway. However, a comparison of the volume of runoff from the proposed highway to the flows in the receiving watercourses indicates potential impact of runoff containing contaminants on the water quality of the local surface water resources (Appendix B - Hydrotechnical Evaluation).

An extensive field monitoring and laboratory analysis program conducted in the United States indicated no significant impact to receiving water ecology resulted from operation of highway facilities with low to medium average daily traffic (ADT <30,000) (Lord 1985). Results from adult toxicity bioassays of undiluted highway runoff concluded that:

- the quality of the receiving water may be temporarily degraded by runoff from a storm event, but will rapidly return to its previous state;
- detrimental substances in the runoff water are flushed out of the receiving waters and do not linger; and
- detrimental effects on the biota of the receiving water would be from direct toxicity, not indirect or delayed effects of assaults on other components of the system.

Experience within Nova Scotia has demonstrated a large degree of dilution of road salt runoff, resulting in occasional degradation of water quality immediately adjacent to the salted alignment, decreasing in concentration with distance downstream from the source (Gibb and Jones 1974).

Environment Canada's Code of Practice for the Environmental Management of Road Salts (Annex A: Environmental Impact Indicators for Road Salts) (Environment Canada 2004) presents thresholds associated with concentrations for chloride in surface water and impacts on aquatic biota. These values are summarized in Table 2 of the Salt Management Strategy (Appendix L). Concentrations of chloride of approximately 140 mg/L should be protective of freshwater organisms for short-term exposure. This value is based on a 4-day LC_{50} for *Ceriodaphnia dubia* (water flea). Environment Canada's Code of Practice also references the United States Environmental Protection Agency who has developed a similar guideline. This guideline indicates that biota, on average, should not be negatively if the one-hour average concentration of chloride does not exceed more than 860 mg/L more than once every three years and/or the four-day average concentration of chloride does not exceed 230 mg/L more than once every three years (Environment Canada 2004).

Concentrations of water samples taken along the existing Highway 104 alignment in the Antigonish area indicate elevated chloride and sodium levels with some chloride levels up to 100 mg/L at some of the smaller stream crossings.

Section 2.5 and Appendix L detail measures undertaken by NSTPW to minimize effects of road salt use on the environment. Given the current operating standards and the unlikelihood of adverse residual environmental effects on fish, no additional mitigative measures are proposed with respect to road salt application.

Highway maintenance is typically of short duration and involves short distances or small sections of highway. Furthermore, due to the small volume of runoff from the proposed highway compared to the flows in the receiving watercourses, the potential impact of runoff containing contaminants on the water quality of the local surface water resources is not likely to be significant.

In summary, provided the noted mitigative measures are implemented, no significant residual adverse environmental effects on fish and fish habitat during highway operations are anticipated.

5.3.6 Follow-Up and Monitoring

All construction activities will require inspection and monitoring to ensure that erosion and control structures are appropriately installed, maintained and removed. Surface water quality monitoring for total suspended solids and acid rock drainage may be required during construction in accordance with federal and provincial regulations. Follow-up inspections will be necessary to evaluate site and habitat restoration, bank protection and stability, and to ensure culvert installation allows fish passage where required. Additional follow-up and monitoring will be determined in consultation with federal and provincial regulators.

5.3.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant residual adverse effects on fish and fish habitat are anticipated during highway construction or operation. Tables 5.14 and 5.15 summarise the residual environmental effects evaluation for fish and fish habitat.

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Table 5.14 Residual Environmental Effects Assessment Matrix
Fish and Fish Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing and grubbing of RoW	•• Erosion and sedimentation (A) •• Alteration of riparian habitat (A)	•• Erosion and sediment control •• Monitoring (suspended solids) •• Adherence to the EPP •• Establish 75 m buffer zone to exclude grubbing and grading until crossing structures are installed	1	4	2 / 1	R	2	N	3
Excavation, infilling, and topsoil stripping and grading	•• Erosion and sedimentation (A) •• Acidic drainage (A)	•• Erosion and sediment control •• Acid drainage risk testing during geotechnical program; application of management program if necessary •• Adherence to the EPP •• Monitoring (suspended solids; acid drainage parameters if necessary)	1	4	2 / 1	R	2	N	3
Blasting	•• Blast percussion (A) •• Erosion and sedimentation (A) •• Habitat disruption (A) •• Acidic drainage (A)	•• Exclusion of fish from area •• Erosion and sediment control •• Acidic drainage management if necessary •• Adherence to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) •• Adherence to the EPP •• Monitoring (suspended solids, pH, etc.) •• Schedule instream work between June 1 and Sept. 30 •• Habitat compensation for HADD	1	3	2 / 1	R	2	N	3

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Table 5.14 Residual Environmental Effects Assessment Matrix
Fish and Fish Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Watercourse crossing and culvert installation	•• Erosion and sedimentation (A) •• Blasting (A) •• Habitat disruption (A) •• Displacement of fish (A)	•• Erosion and sediment control •• Adherence to the EPP •• Monitoring (suspended solids) •• Adherence to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) •• Habitat restoration •• Appropriate crossing method to minimize flow disruption •• Culvert designs requiring fish passage to be reviewed by DFO •• Culvert alignment and sizing to accommodate fish passage as per DFO Guidelines •• Schedule instream activities between June 1 and Sept. 30	1	4	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e,, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation
Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects
Residual Environmental Effect Rating: S = Significant adverse environmental effect; N = Non-significant adverse environmental effect; P = Positive environmental effect
Confidence: 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence

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Table 5.15 Residual Environmental Effects Assessment Matrix Fish and Fish Habitat (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Vegetation control	••Chemical pollution of watercourse (A) ••Erosion and sedimentation (A) ••Alteration of riparian habitat (A)	••No application of herbicides: 1) within 30 m of any watercourse; 2) prescribed on product label; and 3) within 60 m of a protected water supply. ••Installation of permanent erosion and sediment control measures ••Adherence to sediment and erosion control measures and vegetation management plans detailed in the EPP ••Maintenance of a vegetated buffer zone around watercourses	1	1	5 / 1	R	2	N	3
Road De-icing	••Runoff of salt into watercourses; osmotic stress of fish (A)	••Wet salt prior to application to reduce amount required ••Implement Salt Management Strategy	1	1	2 / 2	R	2	N	2

Refer to Table 5.14 for Key.

5.4 Rare Herpetiles

Rare herpetiles (reptile and amphibian species) are considered a VEC due to concerns with protecting species biodiversity. Rare species, by definition, are of interest and often warrant special consideration. This VEC includes all reptile and amphibian species considered to be rare in Canada (COSEWIC 2004) and Nova Scotia (ACCDC 2002a; NSDNR 2002a) that may interact with this project. Also included are herpetile species not considered to be rare which may be sensitive to development due to habitat disturbance from anthropogenic activities.

5.4.1 Boundaries

The spatial boundaries for assessment of rare herpetiles includes habitats with a relatively high likelihood of supporting these species, such as wetlands of all types, forest habitats adjacent to wetlands, and intervale habitats of rivers and streams, contained within the study area (Figure 5.4).

Though capable of undertaking short seasonal movements to and from suitable breeding and hibernating sites, the terrestrial and freshwater herpetiles of Nova Scotia are generally non-migratory. Resident species will remain in the study area year round except in cases where some key habitat component occurs outside the study area. Within the study area, certain species (*e.g.*, spring peeper) may be present in specific habitats (*e.g.*, breeding pools) only at certain times of the year. During the late fall to winter period resident reptiles and amphibians will be in hibernation. Temporal boundaries consider the potential for herpetiles to be affected by Project construction within their active season, and by operation throughout the duration of Project activities.

5.4.2 Description of Existing Conditions

Information regarding herpetiles in the study area was obtained from existing information sources (*e.g.*, ACCDC 2002a, Gilhen 1984; Gilhen and Scott 1981; and Scott 1994) and field surveys. Information collected for the South River Impact Study was gained through discussions with John Gilhen. The findings of the study (Appendix E) concur with the findings of the field program and investigations conducted in the summer of 2002. Herpetile surveys were conducted along the proposed RoW concurrent with the breeding bird survey on June 18-19, 2002 and the rare plant and wetland survey August 20-23, 2002. Almost all of the terrestrial habitat found along the proposed route provides habitat for reptile and amphibian species. These habitats include coniferous, deciduous and mixed wood forests of various ages, clear-cuts, abandoned pasture, and edges of residential and commercial areas. Various wetland habitats suitable to host breeding adult, resident adult, transitory adult, and larval amphibians, as well as certain reptiles, are found within the study area. These include a variety of wetland types, as well as the riparian vegetation zones around rivers, streams, roadside ditches and pools, and wheel rut pools in wetlands and disused woods roads.

Nova Scotia has five species of snakes and four species of freshwater turtles in its reptilian fauna. Three species of snake were recorded during the surveys including: the maritime garter snake (*Thamnophis sirtalis pallidula*), the northern redbelly snake (*Storeria o. occipitomaculata*) and the eastern smooth green snake (*Lilochlorophis vernalis*). These species are considered common to the province. While generally suitable habitat for the northern ringneck snake (*Diadophis punctatus edwardsi*) is present along the proposed route, no specimens were encountered. Records of this otherwise provincially common species are lacking in the area (Gilhen 1984). The study area is far from the disjunct range of the northern ribbon snake (*Thamnophis sauritus septentrionalis*), the sole snake species of provincial concern (ranked as S2S3 (ACCDC2002a)) which, in Nova Scotia, is confined to the warm southwestern interior. No records exist for this species in Antigonish or its neighbouring counties (Gilhen 1984) and none were encountered during the survey.

Of the turtle species common to Nova Scotia, one species, the common snapping turtle (*Chelydra serpentina*) was recorded during the field surveys. A juvenile common snapping turtle was noted in an oxbow pool along the West River just down stream from the RoW. Snapping turtles would be expected to perennially occupy most of the larger bodies of fresh water in the area as well as some of the smaller ones adjacent to rivers and ponds on a seasonal basis.

While aquatic habitat with the capacity to support populations of the eastern painted turtle (*Chrysemys picta picta*) was present in certain beaver flood ponds on streams and ox-bow pools near and within the RoW crossing of the West River, none were encountered along the proposed corridor. Eastern painted turtles are timid and are quick to disappear from basking spots into the water, making detection difficult. Furthermore, there are few records of eastern painted turtles in the more northern regions of the mainland (Gilhen 1984) and as such there may not be populations within the Project area.

Two freshwater chelonian species are of concern in Nova Scotia; namely the provincially endangered Blanding's turtle (*Emydoidea blandingi*) and the vulnerable wood turtle (*Glyptemys insculpta*) (NSDNR 2002b). The Blanding's turtles are excluded from the potential turtle fauna of the Project area, as, like the northern ribbon snake, their disjunct population in Nova Scotia is centred in the warmer south-west interior of the province. No records of any populations of this species are known from Antigonish County or any neighbouring county.

The wood turtle is known from the general area, (ACCDC 2002a) particularly associated with the West and South Rivers, and one of the surveyors had previously encountered the species upstream of the West River crossing. Wood turtles are a species of concern nationally and provincially. They are ranked as S3 by the ACCDC (2002a). The S3 rank indicates that these turtles are uncommon throughout their provincial range, or only found in a restricted range, even if abundant at some locations. Provincially, they are ranked as yellow, or sensitive (NSDNR 2002a), as well as vulnerable under the new *Endangered Species Act* of Nova Scotia (NSDNR 2002b).

No wood turtles were encountered during survey periods, however wood turtles are generally widely dispersed and cryptic and are not easily detected. The June survey period coincided with local nesting activity for this species. No attractive nesting sites were encountered along the route that would contain seasonally concentrated nesting females.

Wood turtle populations are almost invariably associated with streams, creeks, and rivers and the associated rich intervale forest, shrub communities, as well as with the meadows and farmland terrestrial habitat associated with these watercourses. Streams with sand, or sand and gravel bottoms are preferred by these turtles but rocky streams are also acceptable. Wood turtles may wander some distance from water during summer foraging but characteristically remain within linear home ranges. These home ranges are 1 to 6 ha in size and are centred on a suitable river or stream where unvegetated or sparsely vegetated sandy beaches and banks serve as nesting sites. Traditional natural nesting sites consist of sandy river beaches but may also include select anthropogenic sites such as railway grades and roadsides. Wood turtles traverse their ranges all summer long, and are in and out of the water during this period. Some turtles may travel considerable distances up small tributaries that lack suitable nesting sites and hibernacula, but which offer good foraging opportunities. These smaller streams may serve as dispersal corridors between populations on different river systems.

Rich intervale and cobble bottom river habitat suitable for wood turtles was present at the West River crossing site. The summer terrestrial foraging habitat was excellent and a quiet side pool system near the RoW would provide good aquatic foraging and cover habitat for juvenile wood turtles. The river at this location is fast flowing and shallow and does not provide core river hibernacula sites. Similarly, no prime nesting sites were found near the river at this location.

The South River also hosts wood turtles however, the RoW crossing point is downstream of the existing Highway 104 in an estuarine transition area of the river which does not constitute favourable wood turtle habitat. The third site with good potential to provide habitat for wood turtles is Stream Crossing No. 11 (8+150) (Figure 5.4). At this site, a recent beaver dam impounded a section of the watercourse, resulting in a silty bottomed pond. Sections of the stream, both upstream and downstream from this area, were suitable as wood turtle dispersal and foraging corridors. No core habitat features such as breeding sites or hibernaculae occurred at this site.

Nova Scotia has eight species of frogs and toads and five species of salamander. Seven species of frogs and toads were recorded in the study area including northern spring peepers (*Pseudacris c. crucifer*), northern leopard frogs (*Rana pipiens*) pickerel frogs (*Rana palustris*), wood frogs (*Rana sylvatica*), green frogs (*Rana clamitans melanota*), mink frogs (*Rana septentrionalis*), and American toads (*Bufo a. americanus*). Spring peepers and wood frogs were associated with the majority of small wetlands and other habitats offering ephemeral pool habitat in association with woodland along the route. Green frogs were generally distributed wherever significant small pool habitat or other larger bodies of fresh water were present. Mink

frogs, along with green frogs and leopard frogs, were recorded from still water pool habitats near the West River crossing site and from a beaver impounded stream at 8 +150. Pickerel frogs were found only at the beaver impounded stream. American toad tadpoles were noted from a number of pool sites while adults and juveniles were encountered at various points along the proposed bypass routing. The frog and toad species recorded in the area are considered common in Nova Scotia.

There are five salamanders known to inhabit Nova Scotia; the yellow-spotted salamander, the eastern redback salamander, the red-spotted newt, the blue-spotted salamander and the four-toed salamander. Of these, two were encountered during the survey, two would be expected to occur within the study area, and one, the four-toed salamander, is not known from the area (J. Gilhen, pers. comm. 2002). The two common species recorded during the filed survey were the yellow-spotted salamander (*Ambystoma maculatum*) and eastern redback salamander (*Plethodon cinereus*). Evidence of egg masses and larval yellow spotted salamanders, were noted from several woodland pools, ditch pools and wetlands along the route. Leadback and redback phases of the eastern redback salamander were noted from various woodland types during the survey. The rare erythristic phase of the eastern red back salamander was not and is not expected to be found within the study area as the RoW did not pass through the higher altitude, sugar maple (*Acer saccharum*) dominated hardwood forest habitat that typically host this variant (Gilhen 1984).

Two relatively common salamander species, not encountered but which would be expected to occur along the proposed route include the red-spotted newt (*Notopthalmus v. viridescens*) and the blue-spotted salamander (*Ambystoma laterale*). While adult newts can occur in rather dense populations in certain water bodies, they are often much more diffuse in a given habitat and not always readily detectable. The deeper pools, beaver ponds, river oxbow pools and adjacent woodlands present in the study area would provide suitable habitat for this species.

Blue-spotted salamander adults are not reliably detectable outside the spring breeding season. Unlike yellow-spotted salamanders, the eggs of these species are not laid in conspicuous masses and as such are much more difficult to detect, post breeding. The blue-spotted salamander larvae are not always readily separable from the yellow spotted salamander larvae. In the past, blue-spotted salamanders have been seen locally by one of the survey biologists at Brown's Mountain and near the South River. During the survey they were reported by a local farmer at the West River crossing area. Blue-spotted salamanders, though widespread in Nova Scotia, appear to be the most geographically restricted salamander species. They are found in areas of sedimentary rock of a more circumneutral nature than the acidic substrates that overlie much of the province. These salamanders would be expected to breed in suitable ephemeral pool habitat throughout the area.

5.4.3 Residual Environmental Effects Evaluation Criteria

A significant adverse environmental effect occurs when the population of a species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its former level within several generations.

A positive effect occurs when Project activities help to increase populations and/or diversity of species.

5.4.4 Potential Issues, Interactions and Concerns

Road building can adversely affect herpetile populations by: fragmenting habitat; removing or adversely modifying core habitat features such as breeding sites and hibernaculae; acting as barriers or gauntlets to population dispersal and local movements; and through the introduction of additional sources of mortality. Wood turtles are long-lived species and do not mature sexually until the age of 14 - 20 years or more. As such, it is essential to maintain high survivorship of breeding adults and moderate recruitment for population persistence. Highways can adversely affect wood turtles through direct mortality (*i.e.*, vehicle strikes), by removal of turtles from the area and other factors that promote additional mortality.

Positive effects of road building for herpetile species in general include the possible formation of road side ditch pool habitats which may be very productive for certain amphibian species, as well as the creation of sunlit edge habitats along woodlands, providing habitat that favours certain snake and other herpetile species. For many turtle species, any potential positive effects of road building and operation are generally outweighed by adverse effects.

5.4.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.4.5.1 Construction

Should it be determined through a pre-construction survey program that wood turtles are present within the study area, certain preemptive measures will be required to promote protection of this species at specific sites during highway construction. The proposed RoW passes two sites considered to have a high likelihood of supporting populations of wood turtles. A stream and riparian corridor near Stream Crossing No. 11 (8+150) provides potential wood turtle habitat, but the primary site is at the West River crossing. No significant nesting sites were apparent at the West River crossing or the stream near Stream Crossing No. 11, therefore, there would be no need to avoid construction on the shores of these sites during the June nesting season or the June to September incubation season.

Prior to clearing and grubbing of riparian areas within 100 m of these two sites during the period from mid April to early October, a herpetologist and searchers will be dispatched to the area of construction to identify terrestrially foraging wood turtles at risk from construction activities. These turtles will be relocated outside of the RoW but within the stream habitat corridor in which they were found.

Subsequent to the initial search and relocation of the turtles by the herpetologist, construction crews will be briefed in the identification of and relocation procedures for wood turtles. Construction activity during the period from May to October will require work crews to check for wood turtles in the way of such activity. If wood turtles are found in the construction area they will be picked up and moved just off site, along the same habitat corridor in the direction of travel the turtle was originally oriented. A New York State study (Carroll and Ehrenfeld 1978) showed that 84 % of wood turtles displaced less than 2 km overland were able to return to their home range. Moving of wood turtles 100 m or so from the original site where they were found should not unduly disrupt the turtle. These procedures will be included in the Project EPP.

Provided the proposed mitigative measures are implemented, no significant adverse effects on wood turtles or other herpetile species are anticipated during construction.

5.4.5.2 Operation and Maintenance

Operation of the highway can adversely affect wood turtle populations as a result of fragmentation of their habitat. High traffic volumes can lead to isolation of populations leading to inbreeding, which may adversely affect the health of isolated populations. Isolated populations may be so small that they become prone to local extinction events since they are not able to rely on immigration to supplement populations in the event that a large proportion of the population is lost to disease, predation or other perturbation.

The major effect on wood turtle populations from highways that cross the turtle habitat, is an increased potential for mortality within the population, especially the adults and recruiting sub-adults. Turtles cross roads in their travels and may, paradoxically, also be attracted to the roadsides as potential nesting, and foraging sites. This can result in direct vehicle strike-induced mortality, or in turtles picked up by passing motorists and taken away as pets or curiosities. Increased road access to previously remote areas increases the potential number of river and stream-based recreationists who may contribute to incidental removal of turtles.

The effects of habitat fragmentation, and to a limited degree direct turtle mortality, can be mitigated through the establishment of wildlife corridors. All of the sites having good wood turtle habitat along the proposed alignment are associated with rivers and streams. Wildlife corridors can be established at these locations through the use of bridges or open bottom culverts rather than the smaller, traditional culverts. Wildlife species including wood turtles can use these habitat strips as a means of moving from one side of the road

to the other without leaving cover or exposing themselves to traffic. A bridge will be constructed at the West River crossing. Pending a detailed pre-construction wood turtle survey at Stream Crossing No. 11, an open bottom culvert or similar type of structure may be employed at that location to adequately permit the passage of wood turtles if necessary.

The provision of wildlife corridors is particularly important on larger streams normally crossed by culverts. Adult wood turtles on small tributary streams feeding into the upper Canaan River of New Brunswick (n=3, 2 males, one female) were observed moving aquatically along streams crossed by culverts. Rather than swim through the culvert, the wood turtles were observed to leave the water upon approaching the culvert, clamber up the road embankment, cross the woods road and clamber down to the other side to re-enter the water. Observations of adult wood turtles moving along streams suggests that they are reluctant to pass through culverts (M. Macdonald, pers. comm. 2002). This behaviour, though anecdotal, suggests that these three wood turtles were following a traditional route in their territories and that they did not feel comfortable crossing through a dark narrow passage such as a culvert. While crossing a lesser travelled woods road is not very likely to result in turtle mortality, this behaviour on a major roadway very likely would.

At this stage of Project planning, it is not feasible to commit to specific design criteria for crossing structures. NSTPW will consult with NSDNR, prior to structure design, to develop an appropriate mitigative design that accomodates sensitive ecological features at these crossings including, but not limited to, wood turtles.

There is potential for populations to be significantly and adversely affected due to habitat fragmentation, direct mortality and removal during highway operations. The presence/absence of wood turtles and critical habitat along the highway alignment must be further defined through surveys. It is anticipated that the surveys and other aspects of a wood turtle risk management plan will be implemented to reduce the risk to insignificant levels.

5.4.6 Follow-Up and Monitoring

A wood turtle risk management program will be developed by NSTPW in collaboration with NSDNR at the South River, and the West River and its unnamed tributary at 8+150 (Stream Crossing No. 11) including:

- ongoing consultation with wood turtle specialists;
- pre-construction survey to further identify the presence/absence of wood turtles and critical habitat;
- design modifications as required (*e.g.,* open bottom culvert at Stream Crossing No. 11);
- wood turtle avoidance procedures for construction;
- post construction monitoring, if necessary; and
- public education program to reduce turtle removal.

For wood turtle populations potentially present in the Project area, including South River, which although it does not present good habitat at the crossing, is known to host wood turtles, a more detailed analysis of the size and extent of populations within or otherwise utilizing the affected areas would allow greater predictive ability regarding the threat posed by the operation phase of the Project. It is possible that any wood turtle population near or directly within the Project area is a building population, or, alternatively, already in decline or extirpated. A determination of actual wood turtle presence and the extent of any local population will require additional surveys conducted at the proper time of year.

A relatively complete understanding of the size and dynamics of a local population of wood turtles would require individual turtles being sought out, captured, marked, aged and sized, with monitoring conducted during three consecutive years (ACCDC 2002b). For a less certain, and minimal estimate of wood turtle population in the area, a single year survey of the habitat within a kilometre upstream and downstream of the crossing site could be undertaken. The habitat would be searched assiduously for wood turtles. The survey would be accomplished by walking or floating along the relevant stream sections during the early spring wood turtle activity period, mid April to late May, dependant on local onset of spring conditions and weather patterns, on sunny days into the afternoon. In early spring, local wood turtles hold close to the river systems in which they hibernated. Proximity to the river enables turtles to bask on the riverbank and yet still seek shelter in the water when cold weather threatens. In the spring, male wood turtles are also actively cruising the river in search of mating opportunities. There are few records of the species in the study area, and data from the area would in general be of value.

Wood turtles have chromosomal sex determination and generally display a 1:1 sex ratio. Thus an additional method (and one also useful to augment spring surveys) of estimating a wood turtle population is to identify potential nesting sites within the study area and monitor them to count nesting females. In Nova Scotia wood turtles nest from mid-June to early July. Nesting turtle surveys would occur at this time, at suitable nesting sites within a kilometre upstream and downstream of the proposed highway crossing, over a period of several days. This methodology does not show the presence of juveniles in the population.

The focus of the monitoring will be in the vicinity of Stream Crossing No. 11. Because a bridge is planned at the West and South Rivers, comprehensive monitoring is not required but incidental monitoring may be incorporated to increase the general knowledge of the species in the study area. If a large open bottom culvert or similar structure is planned at Stream Crossing No. 11, the concern with impending turtle passage at that location will also be lessened thus also reducing survey requirements.

5.4.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant adverse residual effects on rare herpetiles are anticipated from construction. However, highway operation through wood turtle habitat poses additional risk of mortality to any wood turtle population that may be present. With the implementation of the proposed mitigative measures, no significant adverse residual effects on wood turtles or other herpetile species is likely. Tables 5.16 and 5.17 summarise the residual environmental effects evaluation for rare herpetiles.

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Table 5.16 Residual Environmental Effects Assessment Matrix
Rare Herpetiles (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing and grubbing of RoW near riparian zones, blasting excavation, sub-grade construction	•• Direct mortalities (A) •• Habitat loss (A)	•• Wood turtle presence/absence surveys •• Construction worker training and wood turtle relocation •• Consideration of design modifications to structures (if necessary) at Stream Crossing No. 11 (*e.g.,* open bottom culvert) at West River and at South River to accommodate wildlife corridors	1 - 2	2	2 / 1	R	2	N	2

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e., portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation
Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect
Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.17 Residual Environmental Effects Assessment Matrix Rare Herpetiles (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic/Presence of highway	•• Direct mortality (A) •• Removal of wood turtles (A) •• Habitat fragmentation (A) •• Inhibition of dispersal (A)	•• Consideration (as part of construction) of wildlife corridors at stream crossings (South River, West River and Stream Crossing No. 11) •• Public awareness campaign to decrease turtle strikes on road, and removal of turtles from habitat •• Wood turtle surveys and implementation of a wood turtle risk management plan	2	1 - 2	5 / 6	I	2	N	2

Refer to Table 5.16 for Key.

5.5 Rare Mammals and Critical Habitat

Rare mammals are considered a VEC due to concerns with protecting species biodiversity. Rare species by definition, are of interest and warrant special consideration. Habitat critical for mammals that may not be rare (*e.g.*, white-tailed deer wintering habitat) but are valued by society, is also considered. This VEC includes all mammals considered to be rare in Canada (COSEWIC 2004) and Nova Scotia (ACCDC 2002a; NSDNR 2002a and NSDNR 2002b) that may potentially interact with the Project. It also includes mammals not considered to be rare, but which may be particularly sensitive to development (NSDNR 2002a) due to the fact that they are easily disturbed by human activity or tend to congregate in large concentrations (*i.e.*, hibernating bats) such that a substantial proportion of the population could be adversely affected by a particular development.

5.5.1 Boundaries

The spatial boundaries for assessment of rare mammals includes the study area as defined in Figure 5.4. Most mammals in Nova Scotia are non-migratory and are present in the study area year-round, therefore the temporal boundaries consider that mammals could be affected by road construction and operation continuously throughout the duration of Project activities. Temporal considerations also include sensitive periods such as hibernation and over-wintering behaviour.

5.5.2 Description of Existing Conditions

Information regarding the presence of rare mammals and sensitive mammal habitat within the study area was derived from existing data sources, interviews with staff of the Nova Scotia Department of Natural Resources (M. Pulsifer, pers. comm. 2002) and the Nova Scotia Museum of Natural History (A. Hebda, pers. comm. 2002) as well as a review of the Atlantic Canada Conservation Data Centre data base (ACCDC 2002a), the Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998) and field surveys, which were conducted between June 18 and 19 and August 20 and 23, 2002. Information gathered for the proposed South River crossing involved consultation of the Canadian Land Inventory, The Natural History of Nova Scotia and Dalhousie University's Technical Report for Maintenance of Beaches: Pomquet Antigonish County; A field survey was not conducted for the South River Impact Study (refer to Appendix E).

These information sources provide a good indication of the presence of large mammal species in the study area. Knowledge of the distribution of small mammals in the study area is less well known due to their secretive nature and the need to conduct intensive small mammal trapping programs to determine their presence in the area. Fortunately, many rare small mammals have very specific habitat requirements, which can be used to predict areas where they are likely to be found.

Habitat in the study area is relatively diverse but characterized by disturbed early successional habitats. The area is fairly heavily fragmented by primary and secondary roads, woods roads, agricultural land, electrical transmission lines, several large rivers and recent clear-cuts. Habitats present in the study area include: mixedwood, hardwood and softwood forest ranging in age from immature to mature, recent clear-cuts, tall shrub thickets, low shrub thickets, abandoned pasture, active agricultural land, residential areas, coniferous and mixedwood treed swamps, tall shrub dominated swamps, low shrub dominated swamp, freshwater marsh, brackish marsh, streams, large rivers, and estuary. Most forest along the route has been harvested within the past 20 years with forest stands greater than 20 years of age present along only 21 % of the proposed route.

No critical areas for mammals such as deer wintering areas are known to exist in the study area (M. Pulsifer, pers. comm. 2002; ACCDC 2002a). Table H.1 in Appendix H lists the mammal species (including binomials nomenclature) recorded along the proposed highway route during the field surveys as well as species expected to be found in the area. The species recorded in the study area are characteristic of woodland and riparian habitats. Visual sightings and the presence of abundant spoor suggested that white-tailed deer, red squirrel, varying hare, and raccoon were relatively abundant in the study area. Several large mammal species not recorded during the field surveys may be expected to be found in habitats present in the study area; these include red fox, ermine, river otter, American mink, and bobcat.

Seven small mammal species, including short-tailed shrew, star-nosed mole, American red squirrel, eastern chipmunk, deer mouse, red-backed vole, and meadow vole were recorded during the field surveys. Other small mammal species which may be expected to use habitats in the study area would include smoky shrew, cinerous shrew, little brown bat, northern flying squirrel, meadow jumping mouse, and woodland jumping mouse.

None of the species recorded in the study area are considered to be rare in Nova Scotia (ACCDC 2002a) or Canada (COSEWIC 2004). The Nova Scotia Department of Natural Resources has compiled lists of plant and animal species which are considered to be at risk of extinction or are particularly sensitive to human activities or natural events (NSDNR 2002a). Most of the listed mammals are also considered to be rare (ACCDC 2002a), however, four species are not considered to be rare but are considered to be sensitive including the mainland moose population, fisher, little brown bat, and northern long-eared bat. Given the high level of human activity in the study area, it is unlikely that fishers occur in this area. There was no evidence to indicate that moose use the study area. The relatively high density of white-tailed deer in the area would mean that there is a high potential for moose to contract brain worm (*Parelaphostrongylus tenuis*), an important cause of mortality in moose in Nova Scotia. Moose may occasionally wander through the area but are unlikely to be present on a permanent basis.

Little brown bat and possibly northern long-eared bats are likely to be present in the study area during the period from May to November. At this time they are widely dispersed and local populations are unlikely to be seriously adversely affected by activities associated with construction or operation of the proposed highway. Little brown bats and northern long-eared bats are most sensitive during the winter months when regional populations have congregated into a few locations. Disturbance at these sites can potentially result in the deaths of large numbers of bats. There are no known hibernation sites such as caves or mines in the study area so these species are unlikely to be present during the period from November to May when they are hibernating. Karst topography is present in the vicinity of Antigonish although none was found within the study area. The sink holes associated with karst topography often form over solution caves, which can provide hibernation sites for a number of bat species including little brown bat and northern long-eared bat.

5.5.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the population of a mammal species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its former level within several generations.

A **positive** environmental effect occurs when Project activities help to increase species populations and/or diversity or enhance habitat.

5.5.4 Potential Issues, Interactions and Concerns

Rare or sensitive mammal populations could potentially be affected by habitat loss and disturbance. For small mammals, such as shrews, habitat loss is likely to result in direct mortality of individuals since they stay in close proximity to cover. Larger mammals are less likely to suffer direct mortality since they will tend to flee the area as soon as they detect humans.

Noise, visual stimuli, or scents associated with construction activity or operational activities may potentially disturb rare mammals. However, due to widespread development and human activity in this area, it is likely that many of the mammal species would be relatively tolerant of Project activities.

Operation of the highway will result in an increased incidence of roadkill among mammal species present in the study area. The number of mammals killed by collisions with automobiles can be expected to average approximately 3/km/year based on roadkill data collected for Highway 102 over a two year period (M. Crowell, unpublished data). As such, the total number of mammals killed along the proposed highway each year is estimated to be approximately 45 animals. The species which can be expected to account for approximately 80 % of the roadkills are raccoon, porcupine and striped skunk. The number of deer struck each year is estimated to be two animals per year; this is probably an underestimate since the roadkill

surveys were conducted in 1993 and 1994 during a period when white-tailed deer populations in Nova Scotia were low. The incidence of deer roadkills along the proposed highway may be as high as 10 during a year of peak deer abundance.

The presence of the highway will also cause habitat fragmentation. Some mammal species may be reluctant to cross the road. Species most reluctant to cross the road would be those particularly sensitive to anthropogenic activity and small mammals such as shrews, voles and mice. Given the proximity of the proposed road to existing areas of human occupation, it is unlikely that sensitive species are present. Small mammal populations could be adversely affected by habitat fragmentation. Populations isolated from other populations in small habitat fragments are more prone to local extirpation since these fragments may be too small to support a population. Fragments may be large enough to support a population, but may not be large enough to provide enough animals to rebuild the population should it be heavily impacted by disease or predators. Isolation of the fragment can also impair the immigration of new animals into an area where a local population has been extirpated. Impaired immigration can also adversely affect populations by restricting gene flow between populations leading to inbreeding.

Field surveys and a review of existing data sources suggest that no rare mammals and/or critical habitat are present in the study area.

5.5.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.5.5.1 Construction

No rare, at risk or potential at risk mammal species are known in the study area. Two sensitive species, the little brown bat and northern long-eared bat are likely to be present in the study area during the spring, summer and early fall when they are not particularly sensitive to human activities; they are not present during the late fall and winter when they are particularly sensitive to human activities. Construction of the highway is therefore not expected to adversely affect rare or sensitive mammals. There will be habitat loss and sensory disturbance associated with noise during Project construction as well as the potential mortality of small mammals. However, these effects are not likely to significantly affect mammal populations or critical mammal habitat. Mitigative measures are limited to minimizing vegetation clearing as far as practical during RoW preparation to preserve habitat.

5.5.5.2 Operation and Maintenance

Since no rare mammal species are likely to be present in the study area, and the two sensitive species, the little brown bat and northern long-eared bat, are only expected to be present in the study area when they are not particularly sensitive to human activities, operation and maintenance activities are not expected to adversely affect rare or sensitive mammals. No mitigation will be required for these particular species.

The number of roadkills predicted for the proposed highway is unlikely to have any significant effect on regional populations of mammals; however, where possible, mitigation will be implemented to reduce the number of animals killed in collisions with automobiles. One method to reduce the incidence of roadkill is a longer span than normally required at watercourses and road crossings. This would allow the preservation of a fringe of natural vegetation on either side of the watercourse or road which could be used as a travel route by wildlife.

The study area does not provide habitat for rare small mammal species and the species present or expected to be present are relatively abundant in the area such that isolation of small populations in habitat fragments will not significantly affect regional populations of these species. Nevertheless, it is proposed that mitigative measures be employed to reduce the potential for adverse effects associated with habitat fragmentation. The use of wildlife underpasses would help to connect isolated habitat fragments. The need for and design of wildlife underpasses will be considered after the location of the alignment and interchanges are finalized and after consultation with NSDNR.

5.5.6 Follow-Up and Monitoring

No follow-up studies or monitoring are proposed.

5.5.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are adhered to, there is not likely to be any significant adverse residual environmental effects on rare mammals and critical habitat. Tables 5.18 and 5.19 summarise the residual environmental effects evaluation for rare mammals and critical habitat.

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Table 5.18 Residual Environmental Effects Assessment Matrix Rare Mammals and Critical Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	•• Habitat loss (A)	•• Minimize vegetation clearing as practical for RoW preparation	1	3	2 / 6	I	2	N	3
	•• Direct mortality of small mammals (A)	•• No mitigation recommended	1	3	2 / 6	R	2	N	3
	•• Sensory disturbance (A)	•• No mitigation recommended	1	3	2 / 6	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.,* specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *i.e.,* portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *i.e.,* affecting a whole stock, population or habitat, outside the range of natural variation
Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect
Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.19 Residual Environmental Effects Assessment Matrix
Rare Mammals and Critical Habitat (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	•• Sensory disturbance (A)	•• No mitigation recommended	1	3	5 / 6	R	2	N	3
	•• Direct mortality associated with vehicle collision (A)	•• Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	1	3	5 / 6	R	2	N	2
	•• Habitat fragmentation (A)	•• Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	1	3	5 / 6	R	2	N	2

Refer to Table 5.18 for Key.

5.6 Rare and Sensitive Birds

Rare and sensitive bird species are considered a VEC due to concerns with protection of species biodiversity and protection of other species of interest. Issues of concern are limited in this assessment to rare bird species, and bird species sensitive to human activities, such as raptors. Rare species by definition, are of interest and often warrant special consideration. Raptors (*e.g.*, eagles, hawks, falcons) are generally sensitive to human disturbances, especially during their breeding period.

5.6.1 Boundaries

Spatial boundaries for the assessment of rare and sensitive birds primarily include the study area as indicated by Figure 1.1. Most bird species in Nova Scotia are migratory, though some are considered resident. Temporal boundaries are therefore variable, as some species may be present year-round while others may occupy habitat in the vicinity of the Project only during a particular point in their life (*e.g.*, migration period). The assessment considers both construction and operation phases of the Project, on a year-round basis. Other temporal considerations include sensitive periods during bird life-cycles, in particular the breeding season (predominantly from May to August) when birds are particularly vulnerable to disturbance.

5.6.2 Description of Existing Conditions

Information regarding bird species in the study area were derived from the Atlas of Breeding Birds of the Maritime Provinces data base (breeding bird atlas) (Erskine 1992) and a breeding bird survey. In addition, the ACCDC was consulted to determine if they had any records of rare bird species in the area. Staff of NSDNR (M. Pulsifer, pers. comm. 2002) and the Nova Scotia Museum of Natural History (A. Hebda, pers. comm. 2002) were contacted to determine if any rare or sensitive bird species had been reported in the area. A bird survey was conducted October 1, 2000 for the South River Impact Study. Additional information was gained from the surveyors' personal records, historic Christmas Bird Count data, and the breeding bird atlas (refer to Appendix E).

The breeding bird atlas data is of limited usefulness due to the fact that data is recorded in 10 km x 10 km census squares, making it impossible to establish whether a particular species has been observed in close proximity to the study area. Nevertheless, it does provide an indication as to which species may be expected in the study area. Should any rare or sensitive bird species be recorded in the atlas square, field surveys may be focussed on the preferred habitat of these species to increase the efficiency of the field survey.

The breeding bird survey was conducted along the entire alignment between June 18 and 19, 2002. During the survey the flagged centerline for the proposed RoW was used as a transect line. The transect line was

walked and all birds observed or heard singing along the route were listed and the numbers of each species in each habitat present along the transect were recorded.

The breeding status of each species was determined. Species identified but not exhibiting signs of breeding were classed as non-breeders. Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were classed as probable breeders:

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

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

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

The population status of each species was determined from existing literature. Lists of provincially uncommon or rare birds were derived from ACCDC (2002a) while nationally rare or endangered species were derived from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2004). A list of birds protected under the *Endangered Species Act* in Nova Scotia were derived from NSDNR (2002b). The Lists of birds considered to be sensitive to human activity in Nova Scotia were derived from NSDNR's General Status Ranks of Wild Species in Nova Scotia (2002a).

Table H.2 in Appendix H presents a list of birds recorded for the four atlas squares within which the study area is situated. Table H.3 in Appendix H presents the list of birds recorded along the proposed highway RoW during the breeding bird survey and their breeding status. Table H.4 in Appendix H presents the numbers of each species recorded in the various habitat types present along the proposed route.

A total of 143 species of bird have been recorded in the general area according to the breeding bird atlas. These include 18 species which may be uncommon or rare in the province of Nova Scotia or may be sensitive to human activities. One of the species recorded in the atlas squares, Piping Plover, is considered to be endangered in Canada (COSEWIC 2004). It is also listed as an endangered species in the *Nova Scotia Endangered Species Act*. Piping Plovers breed on sandy beaches. This habitat type is not present along the

proposed highway route so it is highly unlikely that this species would be present. No Piping Plovers were recorded during the breeding bird survey.

Four of the species recorded in the four atlas squares are considered to be rare (S2 - rare throughout its range in the province; 6 to 20 occurrences or few remaining individuals; may be vulnerable to extirpation due to rarity or other factors) in Nova Scotia by ACCDC . These include Whip-poor-will, Wood Thrush, Warbling Vireo, and Philadelphia Vireo. The Nova Scotia populations of these species are considered to be secure (NSDNR 2002a). All of these species are common elsewhere in their ranges and Nova Scotia represents the edge of their distribution. Whip-poor-will, Wood Thrush, and Warbling Vireo are southern species which reach their northern range limit in the Maritime Provinces. Philadelphia Vireo is a boreal species which reaches its eastern range limit in Nova Scotia. Suitable habitat was present along the proposed highway route for Philadelphia Vireo which often inhabit young hardwood and mixedwood stands that are abundant along the proposed route. Wood Thrush are typically found in moist mature deciduous forest which is a rare habitat type along the proposed route. Warbling Vireos also prefer mature deciduous forest but will also nest in riparian forest, thickets and gardens. Thickets are abundant along the route so this species could occur along the route. In Nova Scotia, Whip-poor-wills are typically found in dry open hardwood stands. This type of habitat is not present along the proposed route so it is unlikely that this species would be present along the proposed route. None of these four species were noted on or near the proposed highway route during the breeding bird survey.

Four species listed as rare to uncommon (S2S3 - population status of the species is not well documented) by ACCDC were recorded in the four atlas squares. These species included Red-breasted Merganser, Eastern Phoebe, Vesper Sparrow, and Nelson's Sharp-tailed Sparrow. The Nova Scotia populations of Red-breasted Merganser and Eastern Phoebe are considered to be secure (NSDNR 2002a). Vesper Sparrow and Nelson's Sharp-tailed Sparrow are listed as yellow species by NSDNR (2002a) indicating that the Nova Scotia populations of these species are sensitive to anthropogenic activities or natural events. Vesper Sparrows declined in abundance in Nova Scotia after the 1940s and numbers have remained low. This species typically breeds in agricultural land with a decided preference for blueberry fields which provide the open habitat required by this species (Erskine 1992). No blueberry fields are present along the proposed highway route. Agricultural lands present include pasture, hay fields and grain fields which are not frequently used by breeding Vesper Sparrows. No Vesper Sparrows were observed or heard during the breeding bird survey.

Nelson's Sharp-tailed Sparrow breeds in salt marshes and brackish marshes. The amount of salt marsh habitat in Nova Scotia has been greatly reduced as a result of past dyking of salt marshes to provide agricultural land. Modern activities such as flooding of marshes and disturbance by ATVs also adversely affect this species (NSDNR 2002a). Future global sea level rises could also impact this species by destroying salt marsh habitat. Brackish marsh habitat is present at the proposed South River crossing site. This area was surveyed during both breeding bird surveys (October 2000; June 2002) and a Nelson's Sharp-

tailed Sparrow was heard during the South River study (October 2000) and was observed and heard singing in this habitat during the 2002 survey. Figure 5.4 indicates the area where the Nelson's Sharp-tailed Sparrow was found; most of this area is located to the north of the highway RoW. Approximately 25% of this area is located within the RoW and approximately 5% is located within the footprint of the proposed South River bridge.

In Nova Scotia, Red-breasted Mergansers breed on small coastal islands and sand bars. Nests are situated on the ground near the water. Along the proposed highway route suitable nesting habitat is found near the mouth of the South River on several small islands located north of the proposed bridge. The low peninsula over which the bridge passes may also provide suitable nesting habitat; however, since it is joined to the mainland it may not be preferred nesting habitat since predators such as racoons, striped skunk, red fox, coyote and domestic cat can access this area relatively easily. No Red-breasted Mergansers were observed during the breeding bird survey.

Eastern Phoebe typically nest in open woodlands along water courses or in farmland with scattered trees. They often build their nests inside abandoned buildings or culverts or on bridges. Habitat of this type is present at the West River and South River crossing sites. Eastern Phoebe were not detected at either of these sites during the breeding bird survey.

Five species considered by ACCDC (2002a) to be uncommon in Nova Scotia (S3 - uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations; 21 to 100 occurrences) have been recorded in the four atlas squares within which the proposed highway is located. These include Northern Goshawk, Common Tern, Arctic Tern, Bobolink and Northern Oriole. All of these species, with the exception of the Northern Oriole, are yellow listed by NSDNR indicating that the Nova Scotia populations of these species are sensitive to anthropogenic activities or natural events. The Northern Oriole is considered to be secure in Nova Scotia. Northern Goshawks are threatened by disturbance during the nesting season and loss of suitable forest nesting habitat. Northern Goshawks typically nest in mature hardwood or mixedwood forests remote from human activity. Little suitable forest is available along the proposed highway route and the route runs adjacent to areas heavily populated by humans. It is unlikely that this species nests along the proposed highway route. No Northern Goshawks were detected during the breeding bird survey.

Common and Arctic Tern populations in Nova Scotia are adversely affected by disturbance at nesting colony sites, predation of eggs and young by gulls and loss of prime nesting sites to gulls which typically begin nesting earlier than terns. Common and Arctic Terns generally nest on coastal islands, sand spits, beaches and occasionally salt marshes. Potential nesting sites exist at the mouth of the South River on small islands in the estuary. No evidence of tern nesting activity was observed on these islands during the breeding bird survey.

Bobolinks generally nest in hay fields and pastures. The Bobolink population in Nova Scotia has decreased substantially in recent years. The causes of this decline are not well understood but may relate to changes in agricultural practices such as the use of insecticides, changes in management of hay fields, loss of hay fields to other land uses, and the practices of spring burning and mowing. The proposed highway passes through six areas where agricultural grasslands are present. During the breeding bird survey Bobolink were recorded at two of these areas. A total of three singing males were detected, two at South River and one at North River. In all instances the areas where Bobolinks were recorded were outside of the RoW and the footprint of the highway.

Northern Orioles are uncommon in Nova Scotia; however, the Nova Scotia population is considered to be secure. Nova Scotia is the northern limit of the range of this species. Northern Orioles generally nest in riparian forests or in tall shade trees in towns and cities. Elms are frequently used as nest trees by Northern Orioles since they prefer to attach their hanging nests to pendulous branches. In the past the West River crossing site would have provided ideal habitat for Northern Orioles since it contained a substantial number of large open grown white elms (*Ulmus americana*). However, over the past 20 years Dutch elm disease has killed all of the large elms reducing its suitability as Northern Oriole nesting habitat. No Northern Orioles were detected during the breeding bird survey.

Five species listed as uncommon to common (S3S4 - population status uncertain) by ACCDC were recorded in the four atlas squares or during the field surveys. These species included Merlin, Black-backed Woodpecker, Boreal Chickadee, and Rusty Blackbird. All of these species are considered to be secure in Nova Scotia (NSDNR 2002a).

Merlins usually inhabit open areas or the edges of forests. They generally nest in trees, often in abandoned crow nests. Occasionally they may nest in tree cavities. In areas where trees are not plentiful Merlins may nest on cliffs or on the ground. Merlins are relatively unwary of humans and occasionally nest in close proximity to humans. A successful Merlin nest has been found in Point Pleasant Park in Halifax and another was found on the Edmunds Grounds on the outskirts of Halifax (Tufts 1984). During the breeding bird survey, an agitated Merlin was observed near 4 + 000. The Merlin was initially observed sitting on an electrical transmission line. When the bird noticed the biologists emerging from the forest it became agitated and flew into a small stand of mature spruce and fir at 4 + 075. The bird scolded the biologists for several minutes from this location then disappeared. The agitated behaviour of the Merlin suggested that there was a nearby nest. The forest stand from which the Merlin scolded the biologists was searched but no nest was found. The nest site is likely to have been situated either approximately 300 m south of the area where the bird was first observed in a stand of mature softwoods near Tamara Drive or in mature mixedwood forest located north of 4 + 075. Merlins typically establish a new nest site each year so the nest location can be expected to shift from year to year.

Black-backed Woodpeckers are generally associated with coniferous forests. They usually nest in mature softwood stands but are sometimes found nesting on islands of softwood forest in clear-cuts. Black-backed Woodpeckers are attracted to dead or dying coniferous trees. They typically pry off the bark of these trees while foraging for insects. Their feeding activities leave characteristic piles of bark scraps which can be used to establish their presence in an area. This sign was observed during the breeding bird survey. It was not possible to determine from this evidence if Black-backed Woodpeckers were present near the proposed road during the breeding season or if they only occasionally forage in the area. Black-backed Woodpeckers are noted for their propensity to wander widely outside of the breeding season. Mature softwood forest which might provide suitable nesting sites was present in the general area but was quite rare.

Boreal Chickadees are also associated with coniferous forests. This species is a cavity nester which often nests in cavities in relatively small trees. Suitable habitat for Boreal Chickadees is present at a number of locations along the proposed highway route. This species was not recorded in any of the atlas squares (Erskine 1992) but was recorded at various locations along the route, in immature softwood forest and mature mixedwood forest, during the breeding bird survey. One of the Boreal Chickadees noted during the survey was observed carrying food indicating that there was a nearby nest. This bird was observed near Chainage 8 + 000. Although Boreal Chickadees are fairly common, the results of the breeding bird atlas suggests that their numbers have decreased in recent years probably as a result of heavy harvesting of coniferous forests.

Rusty Blackbirds are typically associated with swamps along sluggish streams or stillwaters. They are most abundant in the interior of the province and are generally found in areas remote from human settlement. Typical Rusty Blackbird breeding habitat was not encountered along the proposed highway route and no Rusty Blackbirds were recorded during the breeding bird survey.

The Black-billed Cuckoo is a southern species which reaches its northern range limit in south central Canada to the Maritime Provinces. It is a species of woods edges, thickets and hedgerows. In the northern parts of its range, the population varies greatly from year to year with outbreaks of tent caterpillars. Black-billed Cuckoo was recorded during the breeding bird survey but was not previously recorded in the atlas squares within which the proposed route is located (Erskine 1992). Two individuals were recorded during the survey, one more than 500 m from the RoW near South River, and another heard at close range at West River. The exact location of the South River bird was not pinpointed, however it was heard at quite a distance from the RoW, and would not likely be affected by the Project. The West River bird was heard within the RoW at 5 + 580 (Figure 5.4). The Black-billed Cuckoo was heard singing from an alder thicket located on a slope overlooking the west bank of the West River. The alder thicket was located immediately adjacent to an occupied house. The bird was heard singing on a number of occasions within the same thicket suggesting that a nest might be located nearby. Suitable nesting habitat was abundant along much of the riparian zone of the West River as well as areas of the riparian zone of the South River upstream of the existing Highway 104 bridge.

Several raptor species other than Merlin were recorded during the breeding bird survey. These included Bald Eagle, Osprey, Red-tailed Hawk, and Barred Owl. The South River Impact Study indicated that two bald eagle nests were located within 2 km of the study site and that adults forage at the study site throughout the nesting season and for as long as the river is not frozen (Neill and Gunter Ltd. 2001). Two Bald Eagles were observed at the proposed South River crossing site during the 2002 survey. Bald Eagles are frequently observed near the West River crossing site as well, particularly during the spring and early summer when they forage for fish in the river. There was no evidence of any Bald Eagle nests near the proposed highway route. Four Bald Eagle nests are located within 2 km of the proposed highway. There are three active nests located north of the RoW at the mouth of the South River. The nearest active nest is 1 km from the edge of the proposed roadway. There is an inactive Bald Eagle nest which is situated 430 m from the edge of the proposed highway located near 2+500. NSDNR recommends the establishment of a 400 m buffer zone around the nest site to prevent disturbance of nesting Bald Eagles. All of these nest sites are more than 400 m from the proposed highway and should not be adversely affected by highway construction.

Two Osprey were observed during the breeding bird survey. Both were observed flying over the proposed route near the South River crossing site, which is frequently used as a foraging area for Osprey and Bald Eagles. Two Osprey nests were noted during the wetland surveys conducted in mid-August. Both nests were situated on power poles located south of the proposed highway RoW. Neither nest was occupied at that time but were in good condition suggesting that they had probably been active in 2002. Osprey typically use the same nest continuously so it is likely that these nests will be used in the future. These nests correspond to two of six Osprey nests documented by NSDNR (M. Pulsifer, pers. comm. 1997). Figure 5.4 presents the locations of these nests. The nearest nest is located approximately 200 m from the edge of the proposed highway at 3 + 300. The second closest nest is 320 m from the edge of the highway at 8 + 650 and the third closest nest is located 370 m from the edge of the highway at 9 + 100. The remaining three nests are more than 500 m from the edge of the proposed highway. Osprey, particularly those nesting in developed areas, are quite tolerant of anthropogenic activities. Osprey nesting away from regular human activity can be sensitive to human activity. A buffer zone of 100 m is generally adequate to protect Osprey nests from disturbance during the nesting season. It is unlikely that construction and operation of the proposed highway will cause abandonment of these nest sites.

One Red-tailed Hawk was observed during the breeding bird survey. This bird was observed capturing a small mammal in a pasture at 7 + 100. The bird left the area when it spotted the biologists. It did not display any agitated behaviour suggesting that its nest was not located nearby. Red-tailed Hawks generally scold intruders that approach their nests too closely.

One Barred Owl was flushed from its roost in a mature softwood stand at 8 + 200. The owl was observed during a wetland survey conducted in mid-August. Barred Owls begin nesting in late March or early April and most chicks have fledged by the end of June. Given the timing of the observation it is unlikely that the Barred Owl was nesting.

Table H.3 in Appendix H presents the results of the breeding bird survey. A total of 79 bird species were recorded during the survey. The most abundant species in decreasing order of abundance were Song Sparrow, Common Grackle, American Robin, Cedar Waxwing, Red-eyed Vireo, Alder Flycatcher, White-throated Sparrow, American Goldfinch, European Starling, Yellow Warbler, Common Yellowthroat, American Crow, and Black-capped Chickadee. Together these 13 species accounted for 58 % of the total of all of the birds recorded during the breeding bird survey. Most of these species are characteristic of disturbed early successional habitats such as clear-cuts, shrub thickets, regenerating forest and residential areas. This reflects the highly disturbed nature of the landscape through which the proposed highway passes. Only 28 % of the route passes through relatively undisturbed forest (stands aged 20 + years) or wetlands. Forty-seven percent of the route passes through regenerating forest (stands 10 to 20 years old), tall shrub thickets or Christmas tree operations. The remaining 24 % of the route passes through young clear-cuts (stands < 10 years old), abandoned pasture, active agricultural land or residential areas.

In descending order, the habitats which had the largest tallies of birds were immature hardwood stands, tall shrub thickets, immature mixedwood stands and tall shrub-dominated swamps. Half of the birds recorded during the survey were recorded in these habitats. This in turn is attributable to the abundance of these habitat types along the route. These habitats also had high species richness compared to other habitat types. Tall shrub swamp had the highest species richness, followed by immature mixedwood forest, immature hardwood forest, mature mixedwood forest, tall shrub thickets, and mature softwood forest. The high species richness associated with the early successional habitats such as immature mixedwood forest, immature hardwood forest and tall shrub thickets is at least partially attributable to the abundance of these habitats along the route. Compared to other early successional habitats they are fairly structurally complex which attracts a wide range of species. This would also contribute to the high species richness of these habitats. Mature mixedwood forest and mature softwood forest habitats have high species richness in spite of the fact that they occupy only about 21% of the route. High species richness in these habitats would largely be attributable to the structural complexity of these mature forests which provides feeding and nesting opportunities for a wide range of bird species.

The results of the bird survey conducted at the proposed South River crossing are included in Table C2 of Appendix C of the South River Impact Study (Appendix E) (Neill and Gunter Ltd. 2001).

5.6.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the Nova Scotia population of a bird species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return the population(s), or any populations or species dependent upon it, to its former level within several generations.

A **positive** effect occurs when Project activities help increase Nova Scotia species populations and/or diversity.

5.6.4 Potential Issues, Interactions and Concerns

The results of the breeding bird survey conducted along the proposed alignment indicates that there was likely a Merlin nest (2002) located in mature forest adjacent the proposed RoW near 4 + 075, and a high probability that a Black-billed Cuckoo was nesting within the RoW adjacent to a house at 5 + 580 near West River in 2002. Merlins are relatively unwary of humans and occasionally nest in close proximity to humans. Merlins typically establish a new nest site each year so the nest location can be expected to shift from year to year. The Black-billed Cuckoo that nested within the RoW in 2002 would be displaced following construction of the highway. There is suitable nesting habitat for Black-billed Cuckoo in neighbouring habitats.

The breeding season is generally the most critical period for bird species, since eggs and nestlings cannot move from the source of disturbance. Potential adverse effects may result from destruction or permanent abandonment of a nest or increased predation of eggs and young during temporary abandonment. Birds in general can also be affected by habitat loss, fragmentation and sensory disturbance as well as the creation of edge habitat, as a result of construction of the proposed highway.

Construction of the proposed highway will result in the creation of habitat edge. Habitat edge has both positive and negative implications for birds. Habitat edges often support a large number and variety of bird species. Edges also tend to attract generalist predators such as raccoons, red fox, coyote, dogs, cats, crows and jays. They may also attract Brown-headed Cowbirds (*Molothrus ater*), a nest parasite of passerine (perching) birds. The presence of high concentrations of predators and Brown-headed Cowbirds along habitat edges can result in these areas becoming reproductive sinks in which large numbers of birds attempt to breed but have poor breeding success. The deleterious effects of habitat edge may extend up to 600 m into the forest interior (Yahner 1988).

Linear developments such as highways also have the potential to fragment habitats. Some species may be reluctant to cross roadways causing populations to be isolated in habitat fragments. These fragments may be too small to support a population of a particular species particularly if it requires forest interior habitats for survival. Physical isolation of a population combined with the deleterious effects of edge may eliminate species in habitat fragments.

During the operational phase of the Project, traffic on the proposed highway could disturb birds nesting or foraging in habitats near the new road. Direct mortality could result as a result of collisions with vehicles. Maintenance activities could disturb birds located adjacent to the highway. Maintenance activities, which will occur in conjunction with the operation of the highway, are unlikely to cause any unique disturbance

to birds, beyond those effects related to operational traffic. Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

5.6.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.6.5.1 Construction

A number of activities (*i.e.*, clearing and grubbing) associated with road construction could interact with sensitive bird species. During construction, potential effects include habitat loss, noise and related disturbance and the creation of habitat edge. Clearing and grubbing will result in the removal of trees, shrubs and other ground cover such as herbaceous plants, brush piles and dead falls that provide nesting habitat for various bird species. This will result in the displacement of birds nesting in these areas. The effects of clearing and grubbing are most severe when these activities are conducted during the period when most bird species are breeding (predominantly from May to August). Clearing and grubbing at this time will result in the direct mortality of eggs and unfledged nestlings. The intentional killing of migratory birds or the destruction of their eggs, or young is an offence under the *Migratory Birds Convention Act*. Clearing and grubbing outside of the breeding season will deny birds suitable habitat; however, birds have the option of establishing nests in adjacent areas. NSTPW will conduct clearing during the winter which should avoid many adverse effects on nesting birds. In addition, the width of RoW cleared will be as narrow as practical to reduce the amount of lost habitat.

Nelson's Sharp-tailed Sparrow was found in marsh habitat on the South River both during the bird surveys conducted for the South River Impact Study (2000) and during the bird survey conducted along the entire proposed alignment (2002). This species is considered to be sensitive to anthropogenic activity in Nova Scotia largely due to the loss of breeding habitat through conversion of salt marsh to agricultural land. Only one Nelson's Sharp-tailed Sparrow was recorded during the breeding bird survey at South River. Approximately 25 % of the area in which the bird was heard and observed falls within the highway RoW and approximately 5 % of this habitat is found within the footprint of the bridge. Construction of the bridge could result in some habitat loss as a result of bridge pier construction. Construction activity could also result in disturbance to Nelson's Sharp-tailed Sparrows using habitat adjacent to the bridge while it is under construction. A Nelson's Sharp-tailed Sparrow monitoring study conducted in a salt marsh adjacent to the Confederation Bridge fabrication yard revealed that Nelson's Sharp-tailed Sparrows shifted their distribution towards the centre of the marsh in response to construction activity (JWEL 1998). Evidence suggested that this shift in distribution was attributable at least partially to displacement of red foxes from the pasture habitat that the fabrication yard was constructed on. These displaced foxes foraged more frequently around the margins of the marsh forcing ground nesting Nelson's Sharp-tailed Sparrows to abandon the marsh margins. Another Sharp-tailed Sparrow monitoring study conducted in Moncton near the Gunningsville Bridge indicated that Nelson's Sharp-tailed Sparrows were not deterred from using habitats immediately adjacent to a very busy highway bridge (JWEL 2001).

Several mitigative measures can be used to minimize the effects of bridge construction on Nelson's Sharp-tailed Sparrow. Bridge construction activities at this site, particularly pier construction, will be conducted outside of the breeding season for this species (early June to late August). Construction of the piers will be planned such that the amount of wetland habitat disturbed by construction activity is minimized. The minimum amount of space required to safely conduct the work will be identified prior to the onset of construction and marked on the construction site to prevent accidental incursions outside of the defined construction area. Vehicle access to the construction area will be from the south away from the preferred habitat of Nelson's Sharp-tailed Sparrow.

Bobolinks are also considered to be sensitive to human activities. Changes in agricultural practices and other land use practices such as the burning of grass are believed to be factors contributing to the decline in Bobolink populations in Nova Scotia. Bobolinks were heard singing at two locations (West River and South River) during the breeding bird survey suggesting that they may nest in the area. The areas where they were heard were outside of the proposed RoW. No loss of Bobolink habitat is expected. This species typically nests in agricultural areas in close proximity to humans. Bobolinks are often observed singing from wires and fences on the sides of roads suggesting that they are not easily disturbed by human activities. Construction activity is unlikely to cause any serious sensory disturbance effects in this species. No significant adverse effects are expected for this species as a result of construction activity and no mitigative measures are proposed.

Black-billed Cuckoo will be directly affected by habitat loss. The likely nesting location found in 2002 is probably within the cleared RoW. Construction of the highway along the presently proposed alignment will likely result in the loss of the nest site. Other suitable habitat is present nearby. Clearing activities will be conducted during the winter, thereby avoiding the destruction of nests, eggs or young of this species. No other mitigation is proposed for this species which is considered secure in Nova Scotia.

Boreal Chickadees were recorded at several locations along the route. Although no nest was found, evidence was collected which indicated that this species breed on or near the RoW. Boreal Chickadees nest in cavities in live trees or snags in coniferous or occasionally mixedwood forest. Suitable nesting habitat is present at various locations along and adjacent to the proposed route. The Nova Scotia Boreal Chickadee population is considered to be secure. Clearing of the RoW will occur during the winter months thereby eliminating the possibility of destroying active Boreal Chickadee nests. No other mitigative measures are proposed.

Merlins will build new nests each year, and may use neighbouring mature coniferous forest habitat. Given that the apparent nesting habitat is reasonably close to human habitation, the Merlin pair is expected to be tolerant of human activities, and therefore there is a low probability of affecting the breeding of Merlins in this area. The effects of highway construction on nesting birds will be reduced by scheduling RoW clearing outside of the breeding season for this species (mid-May to early August).

Three Osprey nests have been recorded within 500 m of the proposed highway. The closest nest is located approximately 200 m from the edge of the road. A buffer zone of 100 m is generally adequate to protect breeding Osprey (NSDNR unpublished Osprey habitat management guidelines). Given the distance from this nest site, adverse effects on Osprey nesting activity at this site are not anticipated. In order to ensure that the nests are not disturbed during construction, no construction related activity will be permitted within 200 m of any of these nest sites.

Habitat fragmentation may adversely affect populations of birds living adjacent to the proposed RoW but will not significantly affect regional populations. The study area has already been subjected to habitat fragmentation as a result of forest harvesting activity, agricultural activity, housing developments and linear developments including roads. Approximately 47 % of the proposed RoW passes through disturbed early successional habitats such as clear-cuts, shrub thickets and regenerating forest. Another 24 % of the RoW runs through areas affected by agricultural or residential land use. The adverse effects of habitat fragmentation can be reduced by routing the RoW through heavily disturbed areas such as recent clear-cuts wherever possible. The proposed highway route has largely accomplished this goal since 71 % of the route passes through recently disturbed habitats.

Due to the apparent habitation and habituation of the bird species of concern to existing human activity, the effects of habitat loss and fragmentation, and sensory disturbance during Project construction is not likely to have a significant adverse environmental effect on rare and sensitive bird populations.

5.6.5.2 Operation and Maintenance

During the operation phase, birds could be affected by disturbance caused by traffic and direct mortality associated with collisions with automobiles. Several studies have shown that disturbance associated with automobile traffic can have an adverse effect on bird abundance and breeding success. A study of terrestrial bird abundance, species composition and breeding success in forested habitats adjacent to a busy highway in New Brunswick (JWEL 1998) revealed a reduction in bird abundance of 18 to 25 % in plots located 100 and 200 m away from the road relative to control plots 500 m from the road. Evidence of breeding activity was reduced by 34 to 39 % relative to control plots. These reductions were not statistically significant. A similar study conducted in the Netherlands revealed a reduction in the number of singing males from 3.3/ha in control plots to 2.1/ha in areas within 200 m of a highway (Reijnen and Foppen 1994). These data indicate that disturbance associated with operation of the road will have a measurable adverse effect on local populations but is not expected to significantly adversely affect regional populations. Reijnen and Foppen (1994) noted that the degree of disturbance to birds by highway traffic was best correlated with noise levels. As such, the best means of mitigating the adverse effects of traffic on birds is to reduce noise levels. There is no practical or effective way in which to do this over a stretch of highway this long. Noise barriers would be prohibitively expensive and a reduction in speed limits within practical limits would have only a minor

effect on noise levels. By way of example, reduction of the speed limit from 80 km/hr to 70 km/hr would only reduce noise levels by an average of 2 dB at a distance of 100 m from the highway.

During the operational phase of the Project there will be bird mortality associated with collisions with automobiles. Roadkill is generally not considered as a significant source of mortality for bird populations (Leedy and Adams 1982). This is supported by a study which demonstrated that the survival rates of male Willow Warblers (*Phylloscopus trochilus*) were equal in areas near and far from highways (Reijnen and Foppen 1994). Roadkill data collected for a 100 Series Highway, secondary highway and city streets in Nova Scotia over a two year period yielded an average rate of roadkill of 0.9 birds/km/yr for the 100 Series Highway, 1.2 birds/km/yr for the secondary highway and 0.7 birds/km/yr for city streets (M. Crowell unpublished data). The new highway will be a 15 km long 100 Series Highway, therefore, the estimated number of birds killed in collisions with automobiles would be 13.5 per year. This is probably an underestimate of the actual number of birds likely to be killed since small birds are easily missed during the surveys and their bodies are quickly destroyed by traffic or removed by scavengers. If it is assumed that only one in ten birds killed by traffic is recorded, the estimated number of birds killed per year would be approximately 135 birds (M. Crowell unpublished data). This number represents only a small proportion of the local bird population.

Maintenance activities such as resurfacing and mowing of the RoW are not expected to have significant effects on local bird populations. Disturbance associated with repairs to the road surface are not expected to be any more intense than that encountered during the construction or operational phases of the project. Mowing of the RoW could destroy the nests of ground nesting birds such as the Bobolink which was found near the RoW at the West River and South River. The cleared RoW will be sown with a suitable seed mix (Table 2.2) and will produce a habitat suitable for this species to nest in particularly in areas where the RoW runs through existing hay fields or pastures. If feasible, the RoW (particularly in areas adjacent to existing agricultural land) will not be mowed until the end of July to avoid nest destruction.

5.6.6 Follow-Up and Monitoring

No follow-up studies or monitoring are proposed.

5.6.7 Summary of Residual Environmental Effects Assessment

Although Project construction and operation activities will potentially adversely affect birds through habitat loss and fragmentation, sensory disturbance, and in some cases, direct mortality, these effects are not likely to be significant with the implementation of the proposed mitigative measures. There is therefore not likely to be any significant adverse residual effects on rare or sensitive bird species. Tables 5.20 and 5.21 summarise the residual environmental effects evaluation for rare and sensitive birds.

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Table 5.20 Residual Environmental Effects Assessment Matrix
Rare and Sensitive Birds (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	••Sensory disturbance (A)	••Minimize the width of the cleared RoW ••Schedule clearing to avoid breeding season of migratory breeding birds ••Establish 200 m radius buffer zones around Osprey nests near route within which no construction activity is permitted	1	3	2 / 1	R	2	N	3
	••Habitat fragmentation and creation of edge habitat (A) ••Loss of breeding habitat and nesting sites (A)	••Minimize the width of the cleared RoW ••Clear RoW outside of breeding season (March to August) ••Identify and mark minimum safe working area around bridge pier construction sites; approach roads to these sites should avoid habitat suitable for Nelson's Sharp-tailed Sparrow	1	3	5 / 6	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.,* specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *i.e.,* portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *i.e.,* affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.21 Residual Environmental Effects Assessment Matrix
Rare and Sensitive Birds (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	••Mortality associated with collisions (A)	••No mitigation recommended	1	3	5 / 6	R	2	N	3
	••Sensory disturbance (A)	••No mitigation recommended	1	3	5 / 6	R	2	N	3
RoW maintenance (*i.e.*, mowing)	••Destruction of nests of ground nesting species (A)	••Where feasible, do not mow cleared RoW between April 1 and August 1 to avoid destruction of the nests bird species such as Bobolinks which nest on the ground in grasslands	1	3	1 / 1	R	2	N	3

Refer to Table 5.20 for Key.

5.7 Rare Plants and Plant Communities

Rare plant species were selected as a VEC because they are rare elements of indigenous biodiversity and are often indicative of rare habitats that harbour unique assemblages of plants and animals. Preserving a rare plant species often ensures that rare habitats and their unique assemblages of species are preserved. Rare plant species are designated in the following ways:

- being listed as a species at risk at the national level by COSEWIC (COSEWIC 2004); and/or
- being listed as a rare species in Nova Scotia (ACCDC 2002a).

The VEC assessed in this section is the Nova Scotia population of any vascular plant species listed as rare in Nova Scotia or Canada.

Also included as part of this VEC are areas of rare or sensitive habitats. Rare or sensitive habitats develop in areas supporting unique combinations of soil, geology, topography, microclimate, and disturbance regimes. These would include habitats such as old growth forest, karst topography, cave systems, cliffs, rich intervales, alpine areas, and dune systems. These habitats often provide living areas for rare species of plants and animals and contribute to the overall habitat diversity of a particular area. The rarity of the habitat type can result in the concentration of plants or animals dependent on them into relatively small areas. By way of example, showy lady's-slipper (Cypripedium reginae) grows only in alkaline swamps and bogs. These habitats are rare in Nova Scotia, consequently, the distribution of showy lady's-slipper is restricted to a very small area of the province. Wetlands are specifically evaluated in Section 5.8 of this report. Plants of significance to Mi'kmaq are addressed in Section 6.3 and Appendix K.

5.7.1 Boundaries

The spatial boundary for the assessment of rare plants is the study area presented on Figure 1.1. Rare plants typically occur at specific places where the local habitat is suitable for their establishment and growth. Similarly, rare or sensitive habitats develop in areas having unique combinations of edaphic, geologic, topographic, and climatic conditions. Habitats with a relatively high likelihood of supporting rare species in the study area are wetlands and riparian habitats. These areas were most intensively investigated during the field surveys; however, all habitats with the exceptions of residential areas and active agricultural land were also surveyed. Field surveys were conducted from August 20 - 23, 2002. Temporal boundaries consider that rare plants or habitats are non-mobile and essentially present at a particular location on a continuous basis, therefore the opportunities for Project interaction are continuous during Project construction and operation.

5.7.2 Description of Existing Conditions

Information regarding plant species present in the study area was derived from a review of the existing literature, correspondence with staff of the Nova Scotia Department of Natural Resources (M. Pulsifer, pers. comm. 2002), the Nova Scotia Museum of Natural History (M. Munroe, pers. comm. 2002), the Atlantic Canada Conservation Data Centre (S. Gerriets, pers. comm. 2002) and through a field survey. The Atlas of Rare Vascular Plants of Nova Scotia (Pronych and Wilson 1993) was also reviewed to determine if any rare plant species had been recorded in the general area of the proposed highway. Eleven of the twenty-three records of rare and uncommon species for the study area are derived from this source. The information in the Atlas is mapped onto 10 x 10 km atlas squares and, as such, it is not possible to obtain precise locations for recorded specimens. A more precise location may be obtained for specimens that are part of the Nova Scotia Museum's holdings, since the closest community or named feature (*i.e.*, river, lake, mountain) to the location where the specimen was collected is provided. Although it is not possible to pinpoint the locations of rare plants using the Atlas, the data provided in it is useful for determining which rare vascular plants are most likely to be found in the study area, and which habitats should be most intensively searched. Information regarding the presence of rare vascular plants in the vicinity of the proposed South River crossing site were derived from botanical surveys conducted as part of the South River Impact Study (Appendix E. Table H.5 in Appendix H lists the 409 species of vascular plants found along the highway RoW during the field surveys.

Fourteen rare or uncommon vascular plants have been previously recorded in the general vicinity of the proposed highway (S. Gerriets, pers. comm. 2002). These include common alexanders (*Zizia aurea*), estuary beggar-ticks (*Bidens hyperborea*), daisy fleabane (*Erigeron hyssopifolius*), white snakeroot (*Eupatorium rugosum*), coffee-tinker's weed (*Triosteum aurantiacum*), button-bush dodder (*Cuscuta cephalanthi*), false mermaid-weed (*Floerkea proserpinacoides*), water pimpernel (*Samolus floribundus*), ebony sedge (*Carex eburnea*), Canada lily (*Lilium canadense*), large purple-fringed orchid (*Platanthera grandiflora*), blunt-leaf pondweed (*Potamogeton obtusifolius*), white-stem pondweed (*Potamogeton praelongus*), and bulblet fern (*Cystopteris bulbifera*). An additional nine uncommon species not previously documented in the Antigonish area were found on or near the proposed highway RoW during the field surveys. These included purple milkweed (*Asclepias incarnata*), black ash (*Fraxinus nigra*), hornwort (*Ceratophyllum demersum*), wood nettle (*Laportea canadensis*), bloodroot (*Sanguinaria canadensis*), water loosestrife (*Lysimachia thyrsiflora*), pennsylvania smartweed (*Polygonum pensylvanicum*), marsh mermaid-weed (*Proserpinaca palustris* var. *creba*) and readhead grass (*Potamogeton richardsonii*). The population status of each of these species is presented in Table 5.22.

Table 5.22 Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish

Species	Population Status			Distribution	
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	Flowering Period/Ease of Identification	Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
Daisy fleabane	S2S3	Yellow	Flowers July and August. Easily identified when not in flower.	Yes	No
Ebony sedge	S3	Yellow	Late May to August. Peregynia required for identification.	Yes	No
Bulblet fern	S3S4	Green	Spores June to September. Can be readily identified by vegetative characteristics.	Yes	No
White-stem pondweed	S3	Undetermined	Flowers June and July. Rarely found fruiting. Can be identified without fruit.	Yes	No
Common alexanders	S1S2	Yellow	Flowers May and June. Fruit present into August. Can be identified using either flowers or fruit.	Yes	No
Estuary beggar-ticks	S1	Yellow	Flowers August and September. Flowers or fruit required for identification.	Yes	No
Water pimpernel	S2	Yellow	Flowers July to September. Can be identified without fruit but most easily identified with flowers present.	Yes	No
Button-bush dodder	S1	Undetermined	Flowers August and September. Flowers required for identification.	Yes	No
Canada Lily	S2S3	Yellow	Flowers in July. Readily identified vegetatively.	Yes	Yes
Coffee-tinker's weed	S2	Red	Flowers in July. Readily identified vegetatively.	Yes	Yes

Table 5.22 Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish

Species	Population Status			Distribution	
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	Flowering Period/Ease of Identification	Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
White snakeroot	S1	Undetermined	Flowers August and September. Can be identified by vegetative characteristics.	Yes	No
False mermaid-weed	S2S3	Yellow	Flowers late May to late June. A distinctive plant that can be identified without flowers.	Yes	No
Large purple-fringed orchid	S3	Green	Flowers in July. Flowers required for identification.	Yes	Yes
Purple milkweed	S3	Green	Flowers early August. Readily identified without flowers or seed pods.	No	Yes
Blunt-leaf pondweed	S2	Undetermined	Flowers July to September. Can be identified without fruit.	Yes	No
Black ash	S3	Yellow	Flowers May and June. Can be identified without samaras.	No	Yes
Hornwort	S3?	Undetermined	Flowers July to September. Can be identified without fruit.	No	Yes
Wood nettle	S3	Yellow	Flowers July to September. Readily identified without flowers or fruit.	No	Yes
Bloodroot	S3S4	Green	Flowers early May. Readily identified without flowers or fruit.	No	Yes
Water loosestrife	S3	Green	Flowers mid June to July. Can be identified without flowers but is considerably more easily identified with flowers or fruit present.	No	Yes
Pennsylvania smartweed	S3	Green	Flowers June to October. Flowers required for identification.	No	Yes

Table 5.22 Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish

Species	Population Status			Distribution	
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	Flowering Period/Ease of Identification	Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
Marsh mermaid-weed	S3S4	Green	Flowers July to September. Can be identified without fruit or flowers.	No	Yes
Redhead grass	S3?	Undetermined	Flowers July to September. Can be identified without fruit.	No	Yes
Atlantic Canada Conservation Data Centre Species Rank Definitions					
S1	Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.				
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.				
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations. (21 to 100 occurrences).				
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the species is of long-term concern (e.g. watch list). (100 + occurrences).				
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2)				
S#?	Inexact or uncertain ranking.				
Nova Scotia Department of Natural Resources General Status Ranks					
Red	Known to be or thought to be at risk.				
Yellow	Sensitive to human activities or natural events.				
Green	Not believed to be sensitive or at risk.				
Undetermined	Insufficient data exists to assess status				

Source: ACCDC 2002a; NSDNR 2002a

While over half of the 23 species listed in Table 5.22 were observed in the area during the survey and over half had been previously recorded in the area, suitable habitat exits for most of these species in the general study area with the exception of daisy fleabane, ebony sedge, white-stem pondweed and bulblet fern. Daisy fleabane, ebony sedge and bulblet fern are typically associated with gypsum outcrops or calcareous (*i.e.*, containing calcium carbonate, calcium or limestone) soils which are not present in the study area. White-stem pondweed is usually found in the deep water of lakes. No lakes are present along the route.

Common alexanders are found in meadows, shores, damp thickets and wet woods. Habitats such as these are present along the proposed highway route. This species has been recorded along the South River above St. Andrews. Common alexanders were not encountered during the botanical surveys for this study or the South River Impact Study (Neill and Gunter Ltd. 2001).

Estuary beggar's-ticks, water pimpernel and button-bush dodder are all associated with seashores. The only area along the proposed highway route which could provide suitable habitat for these species is the proposed South River crossing site, which is located within the upper reaches of the South River Estuary. A botanical survey was conducted in this area as part of the environmental impact study for the proposed South River bridge and bridge approaches. None of these species were encountered during that survey.

White snakeroot is typically found in moist soils along the banks of watercourses as well as clearings, thickets and moist woods. All of these habitats were encountered along the proposed highway route; however, this species was not encountered during the botanical surveys.

False mermaid grows on the slopes of deciduous treed ravines, along watercourses, along the banks of rivers and in intervale forests. Habitat of this type is present at the West River and South River crossing sites. Botanical surveys conducted at these sites as well as elsewhere along the proposed highway route did not reveal the presence of this species.

Blunt-leaf pondweed is typically found in ponds, lakes and slow flowing streams. No lakes or ponds are present in the proposed RoW, however, there are several sluggish streams and streams which have been impounded by beaver activity which could provide suitable habitat. These areas were investigated during the botanical surveys but blunt-leaf pondweed was not found.

Canada lily, coffee-tinker's weed, wood nettle, and bloodroot are frequently associated with rich intervales and intervale forests. Along the proposed highway RoW this type of habitat is found only at the West River crossing site. All three species were found at this location (Figure 5.4). Two small patches of coffee-tinker's weed were found in an intervale thicket on the east bank of the river. The thicket was composed largely of speckled alder (*Alnus incana*), hawthorn (*Crataegus* sp.), apple (*Pyrus malus*), and white ash (*Fraxinus americana*). The ground vegetation understory was dominated largely by a mixture of dames rocket (*Hesperis matronalis*) and enchanter's nightshade (*Circaea lutetiana*). The thicket appears to have developed following abandonment of agricultural land that once extended to the edge of the river. The first patch of coffee-tinker's weed was located 23 m north of the flagged centerline. It consisted of 16 shoots which all appeared to be part of the same plant. This patch appears to be located at the northern edge of the footprint of the proposed bridge. The second patch was located 50 m north of the flagged centerline and contained two shoots which shared a common root system. This patch is located within the RoW of the highway but outside of the footprint of the proposed bridge. Coffee-tinker's weed is listed as rare by ACCDC and the Nova Scotia population is considered to be at risk by NSDNR.

A single patch of Canada lily containing three shoots was found 40 m south of the flagged centerline in the same habitat type as the coffee-tinker's weed. These plants are located at the southern edge of the footprint of the proposed bridge. The ACCDC rates Canada lily as rare to uncommon in Nova Scotia and NSDNR classes this species as sensitive to human activities or natural events.

Wood nettle was found on the banks of the river at the edge of the intervale thicket. Only two plants were found during the survey. Both were located within the footprint of the bridge structure. This species is considered to be uncommon by ACCDC and NSDNR indicates that the Nova Scotia population is sensitive.

Bloodroot was scattered throughout the intervale thicket although it was most frequently encountered along the edge of the thicket nearest the bank of the river. The population status of bloodroot is not well defined and varies from uncommon to fairly common (ACCDC). NSDNR considers the Nova Scotia population to be secure.

Large purple-fringed orchid was found in two wetlands found at 12 + 700 and 13 + 100 (Figure 5.4). Both wetlands were tall shrub dominated basin swamps. The swamp at 12 + 700 was dominated by speckled alder with a ground vegetation understory composed mainly of sensitive fern (*Onoclea sensibilis*) and fowl manna-grass (*Glyceria striata*). The large purple-fringed orchid at this wetland was located outside of the highway RoW. The swamp at 13 + 100 had a shrub layer dominated by a mixture of black alder (*Ilex verticillata*), speckled alder, false holly (*Nemopanthus mucronata*), and meadowsweet (*Spiraea alba*). The ground vegetation layer consisted mainly of sphagnum moss (*Sphagnum* spp.), sedge (*Carex trisperma*) and cinnamon fern (*Osmunda cinnamomea*). At this wetland, large purple-fringed orchid was found at the edge of the highway footprint. This species is listed as uncommon in Nova Scotia by ACCDC and NSDNR considers the Nova Scotia population to be secure.

Purple milkweed has not previously been found in the vicinity of Antigonish. During the botanical survey a large patch of purple milkweed containing approximately 500 shoots was found in a small wetland complex at 2 + 100 (Figure 5.4). The wetland complex consisted of a small basin marsh surrounded by a much larger tall shrub dominated basin swamp. The marsh plant community was composed largely of broad-leaved cat-tail (*Typha latifolia*), sensitive fern and marsh fern (*Thelypteris palustris*). The swamp was characterized by a dense speckled alder dominated shrub layer over a lush ground vegetation layer dominated by spotted touch-me-not (*Impatiens capensis*), cinnamon fern and sensitive fern. The purple milkweed at this site were located outside of the footprint of the highway but within the highway RoW. Purple milkweed is considered to be uncommon (ACCDC) and the population is considered secure (NSDNR).

Black ash was found in a recent clear-cut at 13 + 340 (Figure 5.4). One small black ash less than 20 years of age was found at this location. The tree was found near the edge of a small tall shrub dominated basin swamp and was within the footprint of the highway. Black ash is listed as uncommon in Nova Scotia (ACCDC) and the population is considered to be sensitive (NSDNR).

Hornwort and readhead grass were both found in the West River (Figure 5.4). Hornwort is often found growing in the backwaters of rivers with muck bottoms. It was found growing in a small backwater on the west bank of the river. The plants were outside of the footprint of the bridge but within the RoW. Redhead

grass is typically found growing in lakes or rivers with brackish or alkaline waters. A large bed of readhead grass was found in the main channel of the West River within the RoW, downstream of the proposed bridge. The population status of both of these species are poorly understood. Both are tentatively classed as uncommon (ACCDC) and the sensitivity of the species has not been determined (NSDNR). Aquatic species such as hornwort and readhead grass are often overlooked in the field making it difficult to assess their population status.

Pennsylvania smartweed is found in a wide variety of habitat types including shores, roadsides, ditches, sandy beaches, grain fields, and dyked marshes. In the study area pennsylvania smartweed was found on the shores of the West River. The exact location where this species was found is not known since several species of *Polygonum* were collected at this site and in this habitat. Pennsylvania smartweed is an annual species; consequently, its distribution can vary substantially from year to year. This is especially the case on the shores of rivers where seeds are moved by water during high water events. Pennsylvania smartweed is considered to be uncommon (ACCDC) and the Nova Scotia population is listed as secure (NSDNR).

The habitat of marsh mermaid-weed includes boggy swales, savannas, wet marshes, and the edges of streams. It was found in two wetlands along the proposed highway. At the first site (0 + 650) marsh mermaid-weed was found in a stream marsh where it was one of the dominant species along with broad-leaved cat-tail, bulbous water-hemlock (*Cicuta bulbifera*) and marsh cinquefoil (*Potentilla palustris*). Many thousands of plants were present in the wetland. The distribution of marsh mermaid-weed was focussed largely at the western end of the wetland near the RoW for the proposed highway. About half of the area where this species was found is located within the RoW for the proposed highway; however, only about 10 % of the area is located within the footprint of the highway and would be disturbed by highway construction. The second location (5 + 250) was also in a stream marsh. This marsh was dominated by rush (*Juncus canadensis*), creeping bent-grass (*Agrostis stolonifera*), rice cut-grass (*Leersia oryzoides*), spike rush (*Eleocharis obtusa*), and bulrush (*Scirpus cyperinus*). Marsh mermaid-weed was much less common at this location and all of the plants were found outside of the highway RoW. The population status of marsh mermaid-weed is not well defined and varies from uncommon to fairly common (ACCDC). NSDNR considers the Nova Scotia population to be secure.

Water loosestrife is typically found in swamps, along brooks, or in shallow water and muck, at the edge of alkaline ponds and marshes. In the study area it was found at two locations in a stream marsh at 0 + 700 and 0 + 800. Both of these sites were located outside of the RoW for the proposed highway. Water loosestrife is considered by ACCDC to be uncommon and NSDNR considers the Nova Scotia population to be secure.

Two uncommon habitat types were identified along the proposed highway route during the field survey. These included rich intervale habitat on the floodplain of the West River (5 + 700) and brackish marsh and estuarine habitat located at the mouth of the South River (11 + 300).

Rich intervale habitat is uncommon in Nova Scotia for several reasons. First, the areal extent of fertile soils in Nova Scotia is quite low, limiting the areas where fertile flood plains can develop. Second, when Europeans arrived in Nova Scotia, these areas tended to be selectively developed as agricultural land since they were generally flat, fertile, close to reliable water sources, and often relatively free of stones. Consequently, relatively little undisturbed rich intervale habitat remains today. These areas are particularly valuable as habitats for a number of rare plant species which grow on fertile soils. Some uncommon or rare animals are also associated with intervale habitats. Wood turtles often forage in intervale habitat and the highest densities of wood turtles are typically found on rivers which have rich intervale habitat. Northern Orioles prefer to nest in elm trees and find suitable nesting habitat along rich intervales which are the primary habitat for this tree species. The incidence of Northern Oriole nesting in intervale habitat is probably much reduced now as a result of the loss of most wild mature elms to Dutch elm disease. They now tend to nest most frequently in towns where elms have been protected from this disease.

The rich intervale at the West River crossing site has been substantially degraded by past land use practices. It appears that the intervale was cleared and used as pasture. It was later abandoned and was colonized by tree and shrub species. The intervale thicket is characterized by a relatively dense cover of hawthorn, choke cherry, speckled alder and white ash. The ground vegetation understory is now composed mainly of dame's rocket and enchanter's nightshade. Dame's rocket is an introduced ornamental species which appears to be able to persist under the dense shrub canopy. This species may exclude native plant species from the site. The banks of the river, which in undisturbed intervales provide habitat for a variety of rare native species have, in the case of the West River intervale, been heavily colonized by a variety of introduced weed species including dames's rocket, nipplewort (*Lapsana communis*), common burdock (*Arctium minus*), couch grass (*Elymus repens*), wild cucumber (*Echynocystis lobata*), and live-forever (*Sedum telephinum*).

In spite of the past disturbance of this site it still supports a number of rare and uncommon plant species. These include coffee-tinker's weed, Canada lily, wood nettle, and bloodroot. Several other uncommon species have been recorded in the river or on exposed river bed during low water periods. These include readhead grass, hornwort and pennsylvania smartweed. One uncommon bird species, Black-billed Cuckoo was heard singing in shrub thickets adjacent to the West River. Dead elms along the intervale are used as perching sites by Bald Eagles and Osprey which feed on various fish species which utilize the West River as a migration route.

The second uncommon habitat type found along the route is the coastal freshwater marsh found at the mouth of the South River. Coastal freshwater marshes are highly productive wetlands which develop in areas where freshwater inputs moderate the effects of tidal flooding allowing wetland plant species intolerant of saline conditions to survive (Simmons *et al.* 1984). These wetlands are nutrient rich and highly productive. The vegetation is dominated by a variety of gramminoid including grasses, sedges, and rushes which are tolerant of periodic flooding. Coastal freshwater marshes provide important habitat for a variety of birds and mammals including waterfowl, muskrat, raccoon, and mink. The marsh at the proposed South River

crossing site provides feeding and possibly breeding habitat for American Black Duck and American Wigeon. Other species of waterfowl can be expected to use this habitat. Waders such as Great Blue Heron feed in the wetland and Osprey and Bald Eagle forage along the portion of South River which flows through the wetland. The wetland also provides breeding habitat for Nelson's Sharp-tailed Sparrow an uncommon bird species which is considered to be sensitive to human activities (primarily loss of marsh habitat). This habitat has been described and assessed in the South River Impact Study (Neill and Gunter Ltd. 2001) (refer to Appendix E).

5.7.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the population of a species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return the population to its former level within several growing seasons.

A **positive** effect occurs when project activities help to increase species populations and/or diversity.

5.7.4 Potential Issues, Interactions and Concerns

Twelve uncommon or rare species were found during the field survey, within or in close proximity to the RoW for the proposed highway. These include coffee-tinker's weed, Canada lily, wood nettle, black ash, bloodroot, pennsylvania smartweed, hornwort, readhead grass, purple milkweed, water loosestrife, marsh mermaid-weed, and large purple-fringed orchid. Construction and operation of the highway could adversely affect these species in several ways. During the construction phase of the project, species found within the RoW of the highway could be lost as a result of clearing and grubbing operations. Species found in wetland habitats off the RoW could potentially be adversely affected if the hydrology of the wetland habitats are changed resulting in flooding or drainage of the wetland.

Rare or uncommon vascular plant species could also be adversely affected during the operational phase of the Project. Local populations could be affected by vegetation control programs and application of deicing salt. Rare species located immediately adjacent to bridge structures could be affected by the shade cast by the structure.

Two sensitive habitat types are found along the route, including rich intervale habitat at the West River crossing site and coastal freshwater marsh at the proposed South River crossing site. Construction activities could result in the direct loss of these habitats. At the West River site there are seven rare or uncommon vascular plant species which could be directly affected by habitat loss. Construction activity could also indirectly affect the ability of these habitats to support rare or sensitive species. The South River site provides habitat for a variety of sensitive bird species which may be frightened from the habitat by construction activity.

5.7.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.7.5.1 Construction

Rare or uncommon plant species are most likely to be adversely affected by the Project during the construction phase. A total of twelve rare or uncommon species of vascular plant were found on or near the highway RoW during the field surveys. These species vary in their provincial abundance and in their vulnerability to changes in the environment. In addition, a number of the species encountered during the botanical surveys are located outside of the highway RoW and may not be directly affected by construction and operation of the highway. Table 5.23 lists the uncommon and rare species found on or near the highway route in descending order of sensitivity to the highway Project.

Table 5.23 Uncommon and Rare Vascular Plant Species found in or near the Proposed Highway RoW in Descending Order of Sensitivity to the Project

Common Name	Population Status		Potential for Interaction with Proposed Highway
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	
Coffee-tinker's weed	Rare	At risk	High
Canada lily	Rare to uncommon	Sensitive	High
Wood nettle	Uncommon	Sensitive	High
Black ash	Uncommon	Sensitive	High
Bloodroot	Uncommon	Secure	High
Pennsylvania smartweed	Uncommon	Secure	High
Large purple-fringed orchid	Uncommon	Secure	High
Purple milkweed	Uncommon	Secure	Moderate
Hornwort	Uncommon	Secure	Moderate
Water loosestrife	Uncommon	Secure	Low
Redhead grass	Uncommon	Secure	Low
Marsh mermaid-weed	Uncommon to fairly common	Secure	High

Coffee-tinker's Weed

The species of primary concern is coffee-tinker's weed which is listed as rare and is considered to be at risk. Two patches of coffee-tinker's weed were found, one located at the edge of the proposed West River bridge footprint, the other located in the RoW north of the bridge. Given the close proximity of the first patch to the bridge there is potential for it to be disturbed. The second patch appears to be far enough from the bridge that it could be easily protected from disturbance. Coffee-tinker's weed appears to grow well in areas that have been lightly to moderately disturbed. A large population of coffee-tinker's weed found along the East River of Pictou was growing on a power transmission RoW which had been cleared, grubbed and subjected to regular brush clearing operations. Approximately 90 % of the population was found on the transmission line while 10 % was found in adjacent woodlands.

The preferred approach to minimizing the effect of bridge construction on coffee-tinker's weed would be to shift the location of the bridge crossing approximately 125 m to the north to avoid the two coffee-tinker's weed populations as well as other rare or uncommon species found during the field survey. However, a repositioning of the crossing site is not feasible due to the other constraints (*e.g.*, cemetery, residences and wetland) that would be affected by this shift.

The effect of bridge construction on coffee-tinker's weed will depend largely on the design of the bridge. If the bridge abutments are placed on the banks of the river and the approaches to the bridge are constructed by infilling the intervale habitat on the east side of the river, the population of coffee-tinker's weed closest to the bridge will be lost. The second population might also be lost depending on where the toe of the slope of the infilled portion of the bridge approach road is located. If the bridge abutments are located at the base of the slopes on either side of the river and the intervale habitat is left intact it would be possible to save both populations. Construction activity would have to be closely monitored to ensure that the rich intervale habitat found under and adjacent to the bridge is disturbed as little as possible. Particular care would need to be taken during the placement of the bridge piers.

In addition to altering the bridge design to minimize impacts on coffee-tinker's weed, a habitat enhancement program will be implemented to increase the abundance of coffee-tinker's weed and other rare or uncommon species at this site. The habitat enhancement program would be conducted within the RoW at the West River crossing site. Where possible, NSTPW will consider purchasing intervale land immediately north and south of the RoW which would be restored and protected. The program would consist of planting rare species including coffee-tinker's weed to increase the local population and restoration of the rich intervale plant community. Coffee-tinker's weed seed would be harvested from local areas where coffee-tinker's weed populations are well established such as the population found on the Nova Scotia Power RoW at the East River of Pictou. If seed is plentiful, the harvested seed would be planted in suitable habitat in the RoW and any additional suitable intervale lands purchased by NSTPW. If seed is scarce it may be necessary to germinate the seed and plant the seedlings in order to increase the probability of establishing more coffee-tinker's weed.

Habitat restoration would consist mainly of reducing the abundance of non-native species in the intervale, primarily dame's rocket, which is very abundant in the understory of the intervale thicket. This could be accomplished through mechanical removal of the plants or by painting the leaves of target species with a herbicide. Habitat restoration would also involve the establishment of tree and shrub species characteristic of undisturbed intervales in the area.

Ideally the habitat enhancement program will be underway prior to construction of the bridge. This way, additional coffee-tinker's weed plants established near the edge of the RoW or outside of the RoW would provide a back-up population in case the population at the edge of the bridge was accidentally lost during construction.

Canada Lily

Canada lily is also found at the West River crossing site. A patch of three Canada lily shoots was found at the southern edge of the bridge. Construction activity could result in the disturbance of this species given its close proximity to the bridge. The bridge construction options and habitat enhancement program described for coffee-tinker's weed could also be used to preserve and enhance the population of Canada lily. Canada lily is easily propagated by seed although it may take four to five years to grow a mature plant.

Wood Nettle

Two wood nettle shoots were found under the proposed bridge site on the east bank of the West River. Construction activity is likely to result in the loss of this species if it is necessary to grub or move heavy equipment near the east bank of the river. Establishment of bridge abutments and piers away from the banks of the river would help to preserve this population. The habitat enhancement program would also be directed at increasing the abundance of this species on the intervale.

Black Ash

A single black ash was found in a recent clear-cut near the centerline of the highway. Clearing and grubbing prior to highway construction would result in the loss of this tree. The preferred mitigation for this species would be to shift the RoW 100 m south to avoid the black ash however, this shift could place the large purple-fringed orchid at 12 + 700 at risk and would have a greater impact on an adjacent trailer park. The Nova Scotia population of large purple-fringed orchid is considered secure while the black ash population is sensitive. Since this alignment modification is not feasible, NSTPW proposes to plant black ash seedlings to replace the black ash lost to highway construction. Ideally black ash derived from a local seed source will be planted. The plantings will be made as close to the location of the original black ash as possible and in the same habitat type.

Bloodroot

Bloodroot was found scattered through the intervale thicket at the West River crossing site. Many of the plants were found within the footprint of the bridge. The number of plants lost to construction activity can be reduced by adopting a bridge design which minimizes the degree of disturbance to the habitats within the footprint of the structure. A tall bridge with abutments established at the toe of the slope rather than on the intervale would reduce the number of bloodroot lost to disturbance. Losses of bloodroot caused by construction disturbance could be recouped by propagating bloodroot as part of the habitat enhancement program. Bloodroot is readily cultivated from seed and root cuttings.

Pennsylvania Smartweed

Pennsylvania smartweed was found growing on the gravel shores of the West River at the bridge crossing site. This species could be adversely affected by construction activity if the shore of the river is disturbed by vehicles. Given the value of the West River as fish habitat it is likely that disturbance of the river banks will be avoided in which case loss of pennsylvania smartweed is unlikely. Pennsylvania smartweed is an annual species, consequently, the population may be present in the RoW in some years but not in others.

Large Purple-fringed Orchid

Large purple-fringed orchid is present at two locations along the route. Both sites are in tall shrub-dominated swamps. At the first site large purple-fringed orchid is found outside of the highway RoW and will not be directly affected by construction activity. It could be indirectly affected by construction if the road structure or construction activity alters the hydrology of the wetland. This wetland drains away from the highway so it is unlikely that ponding would occur. Mitigation to protect large purple-fringed orchid at this location would consist of designing the road drainage system to ensure that the hydrology of the wetland is not altered substantially. At the second site large purple-fringed orchid is found within the footprint of the highway and is likely to be lost as a result of construction activity. Given the secure status of this species no mitigation is proposed at this site.

Purple Milkweed

Purple milkweed is also found in a wetland (Figure 5.4). Approximately 500 purple milkweed shoots were found outside of the footprint of a proposed off-ramp but within the highway RoW. Clearing and grubbing of the RoW could result in the loss of this population. The adverse effects of construction activity can be reduced substantially by minimizing disturbance to the wetland habitat in which purple milkweed is found. The portion of the wetland outside of the footprint of the off-ramp will not be cleared or grubbed.

Hornwort

Hornwort is found in a muddy backwater on the west bank of the West River. This backwater is located outside of the footprint of the proposed bridge but inside the RoW. This population could be impacted by construction activities if equipment were run through the backwater or if the morphology of the river channel was changed as a result of bridge construction. If the bridge is designed such that the abutments or piers do not fall within or immediately adjacent to this backwater there should be little effect on this species. In addition, erosion and sedimentation control measures will be implemented to ensure that sediment is not deposited in the backwater. Given the value of the West River as fish habitat, it is likely that disturbance of the river banks will be avoided and erosion and sedimentation controls will be implemented reducing the potential for disturbance of the backwater in which hornwort is located.

Water Loosestrife

Water loosestrife is found at two locations in a wetland situated on Brierly Brook. Both sites are located outside of the highway RoW so no direct adverse effects of construction are anticipated. This species could be indirectly affected by construction activity if the hydrology of the wetland is altered by construction activity. The highway will infill a small portion of the wetland at its outflow so there is potential for ponding or drainage of the wetland if culverts are not positioned properly. In order to prevent any adverse effects on this species care will be taken in culvert placement to prevent any alteration in wetland hydrology.

Redhead Grass

Redhead grass was found in deep water in West River just downstream of the proposed bridge. It is unlikely that bridge construction will occur in the river at this location so direct loss of this population is not expected. Deposition of large quantities of silt could smother the plants, however, this is unlikely since the current at this location is swift and erosion and sedimentation control measures will be used to minimize erosion.

Marsh Mermaid-weed

Marsh mermaid-weed is located in two wetlands along the proposed highway route. The first site is in the Brierly Brook wetland (Wetland 1). Marsh mermaid-weed is very abundant in the marsh habitat at the western end of the wetland. Infilling of the wetland to add an additional lane to the existing highway will result in the loss of a small proportion of this population. This infilling could also adversely affect the population by causing ponding or draining of the wetland if culverts are not positioned properly. The second population is located on another wetland located near the West River. This population was located outside of the highway RoW, however, the wetland is located upstream of the highway so there is some potential for ponding if drainage conditions are altered. Mitigation to minimize adverse effects to these populations would include ensuring that existing hydrological conditions are maintained through proper sizing and placement of culverts. Given the small proportion of the Brierly Brook wetland population lost as a result of infilling and the secure status of this species, the only mitigation proposed to minimize the number of plants lost to disturbance is to infill only enough of the wetland to provide a safe roadbed. No clearing will occur in wetland habitat found within the new highway RoW but outside of the highway footprint.

Uncommon Habitat Types

Construction of the bridge over the West River will result in the loss and/or disturbance of part of the rich intervale thicket found on the floodplain of the river. The main effect of this habitat loss would be the potential loss of several small populations of rare and uncommon vascular plant species as well as a

reduction in the amount of habitat suitable for plant species which are largely restricted to rich intervale habitat. The bridge design options and habitat enhancement program described above to minimize the effect of the Project on rare and uncommon plant species would also be applicable to this uncommon habitat type.

The coastal freshwater marsh located at the mouth of the South River will also be adversely affected by bridge construction. Relatively little habitat is expected to be lost at this location. The main effect would be disturbance of wildlife which use this habitat type for breeding and foraging. Potential mitigative measures to minimize adverse effects on this habitat type discussed in the South River Impact Study (Neill and Gunter Ltd. 2001) included: avoidance of infilling flood plain to maintain flood storage capacity and to minimize displacement of terrestrial habitat; alignment of the structure to minimize the area of terrestrial habitat under the structure; and location of the new structure in proximity to the existing structure to minimize the total area affected by noise and vibration.

No significant adverse residual effects to rare plants and plant communities are anticipated. The primary species of concern during the construction period are the Canada lily, coffee-tinker's weed, wood nettle, and the black ash which can be restored through a habitat enhancement program and replanting. Impacts to other plant communities may also be mitigated through the habitat enhancement program as well as through minimization, where appropriate, of disturbance to vegetation.

5.7.5.2 Operation and Maintenance

Vegetation control operations could pose a hazard to rare plant species found within the RoW of the highway. It is unlikely that coffee-tinker's weed, Canada lily, wood nettle, pennsylvania smartweed or bloodroot would be affected by these operations since they are situated beside the West River bridge. Nevertheless, the locations of these populations on the RoW will be noted and regular mowing or brush clearing will not be conducted in the intervale in which these species are located. Vegetation management programs designed to enhance these populations would be permitted provided they are managed by personnel knowledgeable of the habitat requirements of these species. Hornwort, redhead grass and marsh mermaid-weed would not be affected by vegetation management operations since they are aquatic plants found at locations where herbicide applications are not permitted and where mechanical brush control is not required. The black ash tree found on the RoW will be lost as a result of highway construction and will be replaced by saplings planted outside of the RoW. Similarly, one of the two large purple-fringed orchids found along the highway route will be lost during the construction phase, however, the second orchid is located outside of the RoW and will not be affected. The water loosestrife at Brierly Brook is also located outside of the RoW and will not be affected by vegetation control operations. The purple milkweed population could be adversely affected by vegetation control operations. This population is located within the RoW at an off-ramp. In order to protect this population, no mowing or brush cutting will be permitted within the wetland habitat in which the population is located. The population is located immediately adjacent to a small stream where herbicide applications would not be made.

Road salt applications can damage plants located immediately adjacent to highways and increase the salinity of soils. The effects of road salt are generally observed within 10 m of the edge of the road, although salt related injuries have been detected at distances of up to 80 m from the road. Damage to vegetation includes osmotic (*i.e.*, concentration induced dehydration) injuries as well as direct chloride ion toxicity. Salt deposited on soils can adversely affect plant growth by changing the structure of soil (development of salt crusts) or reducing soil fertility (replacement of calcium and potassium ions by sodium ions). In some areas between 5 and 10 % of trees within 30 m of highways had salt damage (Transportation Research Board 1991).

Road salt applications could potentially affect five of the rare and uncommon species found growing within the RoW of the highway including coffee-tinker's weed, Canada lily, wood nettle, bloodroot and purple milkweed. The first four of these species were found at the West River crossing site while purple milkweed is found at the proposed Addington Forks off-ramp. Bridge design can be used to minimize the effects of road salt on the species found at the West River site. Drainage of salt laden runoff from the immediate approaches and structure will be directed away from areas where rare or uncommon plants are present. Measures will be taken to minimize the amount of brine and brine contaminated slush and snow that are thrown over the side of the bridge by snow plows and other vehicles; for example snow and slush that accumulate on the bridge will be plowed off the bridge rather than over the side. This may require that snow plows reduce speed when plowing the bridge. Techniques which reduce the amount of road salt used will be employed. These include the use of road weather information systems to monitor road surface conditions, pre-wetting of salt and the use of zero velocity spreaders to prevent salt from bouncing off the road and the use of anti-icing systems such as brine solutions to minimize the amount of salt required. These techniques would benefit other VECs in addition to the rare plants found along the proposed highway including groundwater and surface water quality and freshwater aquatic life. This section would be considered as a salt sensitive area to be considered for pre-wetting and anti-icing agents. NSTPW has prepared a Salt Management Strategy for this Project (Appendix L) that will be implemented to minimize adverse environmental effects related to road salt.

The mitigative measures used to protect rare and uncommon plant species at the West River crossing site would also protect the rich intervale habitat at this site. Mitigative measures to protect the coastal freshwater marsh habitat at the South River proposed in the South River Impact Study (Neill and Gunter Ltd. 2001) include a spanning structure to minimize displacement of aquatic habitat and maintenance the hydrologic function (*i.e.,* flood storage) of the area (refer to Appendix E).

The primary impacts of highway operation on rare plants and plant communities result from the use of road salts for deicing during the winter. Provided that the proposed mitigative measures are employed, no significant adverse effects are anticipated from highway operations.

5.7.6 Follow-Up and Monitoring

The most sensitive site for rare plants along the proposed highway route is at the West River crossing site. As part of the mitigation plan to minimize the effects of bridge construction and operation on the species found at this location, an intervale habitat enhancement program is proposed. The populations of rare and uncommon plant species found at this site would be monitored as part of this program. This data would be used to assess the effects of the construction of the bridge and the efficacy of the habitat enhancement program.

5.7.7 Summary of Residual Environmental Effects Assessment

No significant Project-related adverse residual effects on rare plants or habitats are anticipated if mitigative measures are employed. Tables 5.24 and 5.25 summarise the residual environmental effects evaluation for rare plants and plant communities.

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Table 5.24 Residual Environmental Effects Assessment Matrix Rare Plants and Plant Communities (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, Grubbing and Sub-grade construction	•• Mortality of existing plants (A)	Black Ash •• Plant black ash seedlings to replace the ash sapling lost to highway construction; •• Replacement trees will be monitored for at least four years before onset of construction Purple Milkweed •• Avoid clearing portion of Wetland 2 that is located within the RoW but outside of the footprint of the highway Water Loosestrife •• Carefully place and size culverts to ensure that the hydrology of the Brierly Brook Wetland (Wetland 1) is not altered Marsh Mermaid-weed •• At Brierly Brook wetland (1) minimize wetland infilling •• Carefully place and size culverts to ensure that the hydrology of the Brierly Brook Wetland (Wetland 1) is not altered	2	3	1 / 1	R	2	N	2

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Table 5.24 Residual Environmental Effects Assessment Matrix Rare Plants and Plant Communities (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Bridge Construction (West River)	•• Mortality of existing plants (A)	Coffee-tinker's Weed, Canada Lily, Wood Nettle, Bloodroot •• Design the bridge structure to minimize the amount of intervale habitat disturbed by the bridge •• Plan the bridge pier construction sites to minimize the amount of habitat disturbed •• Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species	2	1	2 / 1	R	2	N	2
Bridge Construction (West River)	•• Loss and disturbance of rich intervale habitat (A)	Rich Intervale Habitat at West River •• Design the bridge structure to minimize the amount of intervale habitat disturbed by the bridge •• Plan the bridge pier construction sites to minimize the amount of habitat disturbed •• Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species	2	1	2 / 1	R	2	N	2

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e., portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation
Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect
Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.25 Residual Environmental Effects Assessment Matrix
Rare Plants and Plant Communities (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
RoW Vegetation Maintenance	••Mortality of existing plants (A)	Purple Milkweed ••Avoid mowing or brush cutting wetland habitat at Wetland 2 that is located within the RoW	2	1	1 / 1	R	2	N	2
De-icing	••Mortality of existing plants, degradation of habitat (A)	Coffee-tinker's Weed, Canada Lily, Wood Nettle, and Bloodroot: ••Direct bridge drainage away from areas where rare or uncommon species are present ••Minimize brine and brine contaminated slush and snow thrown over the side of the bridge by snow plows and other vehicles ••Identify the West River section where these species occur as a salt sensitive area to be a candidate for pre-wetting and anti-icing agents to reduce exposure to salt laden runoff	2	1	1 / 2	R	2	N	2

Refer to Table 5.24 for Key.

5.8 Wetlands

Wetlands are considered a VEC because they are an important feature of the landscape, performing many biological, hydrological, social/cultural, and economic production functions which are of value to society. Wetlands provide habitat for plant and animal species, many of which depend on wetland habitats for their survival. Hydrological functions of wetlands include erosion and flood control, contaminant reduction, and groundwater recharge and discharge areas. Wetlands support various forms of recreational activity, as well as subsistence production, such as harvesting of wildlife and plants, and commercial production, such as cranberry bogs, forestry, and peat extraction. Related VECs include: Section 5.4 Rare Herpetiles, 5.5 Rare Mammals and Critical Habitat, Section 5.6 Rare and Sensitive Birds, and 5.7 Rare Plants and Plant Communities

5.8.1 Boundaries

The spatial boundaries for assessment of wetlands is the study area indicated on Figure 1.1. Since wetlands are a semi-permanent landscape feature and may interact with the Project year-round, temporal boundaries consider Project effects on a year-round basis, during construction and operation activities. Other temporal considerations include sensitive times for some species such as bird breeding periods.

5.8.2 Description of Existing Conditions

In Nova Scotia, wetlands are protected by the NSDOE (currently NSDEL) Wetlands Directive (1995a). Any loss of wetland requires a wetland evaluation to establish the value of the wetland in relation to the merits of the development. Wetland evaluations are required if a project will physically disturb a wetland or if the hydrology of the wetland will be altered by construction or operation of the project. Wetlands less than 2 ha in size can be evaluated using a ten-step evaluation process used by NSDEL. Wetlands greater than 2 ha in size are evaluated using the North American Wetlands Conservation Council (Canada) wetland evaluation technique.

Twenty-one wetlands are located within the RoW of the proposed highway, nineteen of which were evaluated during the field survey conducted from August 20 - 23rd, 2002. The remaining two wetlands were not evaluated during this survey because one of the wetlands, Wetland 5, an anthropogenic (man made) pond, had been infilled prior to the evaluations, while the other, Wetland 21 at South River, had been previously evaluated as a component of the South River Impact Study (Neil & Gunter Ltd. 2001). The location of the wetlands are mapped on Figure 5.4, while the findings of the wetland evaluations are summarized in Table 5.26, with complete evaluations presented in Appendix I for the wetlands evaluated in 2002, and in Appendix E for the South River wetland evaluation.

Table 5.26 Wetlands Found Within the Proposed Highway 104 RoW

Wetland No.	Type	Size (ha)	*Area Likely to be Infilled by Highway Development (ha)	Wetland Evaluation Process	Results of Evaluation
1	Wetland complex composed of low shrub stream swamp, tall shrub stream swamp, mixedwood treed stream swamp, and stream marsh	11.23	0.35	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation and habitat for two uncommon plant species. Construction of highway will not significantly alter these functions provided care is taken not to alter wetland hydrology.
2	Wetland complex composed of tall shrub basin swamp and shallow basin marsh	0.42	0.08	NSDEL 10 step	Wetland provides habitat for an uncommon plant species. Area of wetland in which this species is found will not be affected by highway construction.
3	Coniferous treed basin swamp	0.95	0.12	NSDEL 10 step	Not significant
4	Tall shrub basin swamp	0.71	0.27	NSDEL 10 step	Not significant
5	Shallow water wetland (fire pond)	N/A	N/A	No evaluation, wetland infilled	N/A
6	Wetland complex composed of tall shrub basin swamp, deciduous treed basin swamp and shallow basin marsh	4.27	0.81	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation and water quality treatment. Construction of the highway is not expected to significantly alter these functions provided care is taken not to alter the hydrology of the wetland and steps are taken to minimize the amount of wetland habitat affected.
7	Tall shrub basin swamp	0.23	0.21	NSDEL 10 step	Not significant
8	Wetland complex composed of tall shrub basin swamp and shallow basin marsh	0.42	0.21	NSDEL 10 step	Not significant
9	Tall shrub basin swamp	0.31	0.25	NSDEL 10 step	Not significant
10	Wetland complex composed of tall shrub stream swamp, stream marsh and shallow water wetland	0.5	0	NSDEL 10 step	Wetland provides habitat for an uncommon plant species as well as breeding habitat for amphibians. The wetland may also play a small role in surface water regulation. Wetland will not be disturbed and no adverse effects on wetland function will occur provided wetland hydrology is not affected.
11	Wetland complex composed of tall shrub stream swamp, low shrub stream swamp and shallow water wetland	2.93	0.01	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation. This function will not be significantly affected by highway construction.

Table 5.26 Wetlands Found Within the Proposed Highway 104 RoW

Wetland No.	Type	Size (ha)	*Area Likely to be Infilled by Highway Development (ha)	Wetland Evaluation Process	Results of Evaluation
12	Tall shrub stream swamp	7.28	0.75	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation. This function will not be significantly affected by highway construction.
13	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp	0.94	< 0.01	NSDEL 10 step	Not significant
14	Tall shrub basin swamp	0.23	0.14	NSDEL 10 step	Not significant
15	Tall shrub stream swamp	0.57	0.03	NSDEL 10 step	Wetland provides habitat for an uncommon plant species. The area where this species is found will not be affected by highway construction provided care is taken not to alter the hydrology of the wetland.
16	Coniferous treed basin swamp	0.8	0.29	NSDEL 10 step	Not significant
17	Tall shrub basin swamp	0.71	0.05	NSDEL 10 step	The wetland provides habitat for an uncommon species which will be lost as a result of highway construction. The population is small (one plant) and the population is considered secure in Nova Scotia, so this loss is considered acceptable.
18	Mixedwood treed basin swamp	1.13	0.43	NSDEL 10 step	Not significant
19	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp	0.54	0	NSDEL 10 step	Wetland probably provides a water quality treatment function since it receives water from roadside ditches on the existing Highway 104. This function will not be significantly affected by highway construction.
20	Mixedwood treed basin swamp	0.99	0.99	NSDEL 10 step	Not significant
21	Coastal Freshwater Marsh	15.8	0.5 (approximated using Map 1 (Neill and Gunter Ltd. 2001))	North American Wetlands Conservation Council	The wetland contains significant habitat for migratory birds. The area provides good feeding and staging habitat for waterfowl and is an important foraging area for local Osprey and Bald Eagles. Several Bald Eagle nests are located adjacent to the wetland. Nelson's Sharp-tailed Sparrow, listed as sensitive (NSDNR 2002a), probably breeds in the wetland. The South River estuary provides valuable habitat for a variety of fish species. Some flood and tidal impact protection is provided by the wetland. This function will not be significantly affected by highway construction.

* Note: Area to be infilled calculated using a map overlay and the area of the lane width and median.

During the route selection process for this Project, NSTPW identified wetlands as one of several constraints to be considered for avoidance. Wetland Golet scores were used during the screening process to help identify the most significant wetlands for avoidance for preliminary routing.

Specific examples of wetland avoidance during routing include:

- Sta 4+000 alignment kept as far away from wetland to the north. Alignment confined by existing development to the south.
- Sta 8+000 to 9+500 alignment kept as far north from wetlands to the south. Alignment confined by development to the north.
- Sta 13+000 to Sta 14+000 alignment is fixed on both ends due to recommended corossing of South River to the west and the existing Highway 104 to the east. Distance from developments to the south had to be considered, along with curvature design of the roadway.

In recognition of the South River crossing, a specific impact study was conducted, prior to the final route selection and EA Registration to determine the most ideal crossing location, particularly from an environmental perspective. The resulting route is the most desirable route based on environmental, socioeconomic and engineering constraints. As such, the remaining wetlands identified in the EA report cannot be avoided by the RoW. NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project.

Two types of wetland are found within the proposed RoW of the highway: swamp and marsh. All wetlands found in the study area had a swamp element associated with them and in all instances, the swamp element was the largest element of wetland complexes where more than one type of wetland was present. Swamps are mineral wetlands or peatlands with standing water or water flowing slowly through pools or channels. The water table is generally at or near the surface of the swamp. There is internal water movement from the margin of the swamp or from other sources of mineral enriched waters. If peat is present, it consists mainly of well-decomposed wood, underlain at times by sedge peat. The vegetation typically consists of a dense cover of trees or shrubs, herbs and some mosses.

All of the swamps present in the RoW are classed as either basin swamps or stream swamps (National Wetlands Working Group 1987). Basin swamps occur in topographically defined basins where the water is derived locally but may be augmented by drainage from other parts of the watershed. Stream swamps occur on the banks of permanent or semi-permanent streams. The high water table is maintained by the level of water in the stream. The swamp is seasonally flooded, with subsequent sediment deposition. Swamps in the study area can be further subdivided based on the dominant vegetation.

Four types of basin swamp are present including: mixedwood treed basin swamp; coniferous treed basin swamp; deciduous treed basin swamp; and tall shrub basin swamp. Mixedwood treed basin swamps in the study area are characterized by a tree canopy dominated by red maple (*Acer rubrum*), balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). The shrub understory of this wetland type is typically composed largely of speckled alder (*Alnus incana*), winterberry *(Ilex veticata)* and false holly *(Nemopanthus mucronata)*. Coniferous treed basin swamps in the study area typically have a tree layer composed largely of black spruce, tamarack (*Larix laricina*) and red maple. The shrub understory is similar in species composition to mixedwood treed basin swamp. Deciduous treed basin swamps are characterized by a tree canopy composed almost entirely of red maple and a shrub layer dominated by a mixture of speckled alder, red maple saplings, meadowsweet (*Spiraea alba*), and winterberry. Tall shrub basin swamps typically have a diffuse tree canopy composed largely of white spruce (*Picea glauca*), red maple, tamarack, and black spruce under which is a moderately dense shrub layer dominated by speckled alder, winterberry, meadowsweet, and trailing blackberry (*Rubus hispidus*).

Three types of stream swamp are present along the proposed RoW including mixedwood treed stream swamp, tall shrub stream swamp, and low shrub stream swamp. Mixedwood treed stream swamp is characterized by an open tree canopy composed of a mixture of black spruce and red maple. The shrub understory is moderately dense and is composed mainly of speckled alder, meadowsweet and advanced regeneration of red maple. Tall shrub stream swamp is similar in species composition to tall shrub basin swamp. Low shrub stream swamp is typically found in very wet areas and often forms a transition zone between marsh habitats and tall shrub swamp. The shrub layer is typically dominated by meadowsweet and/or sweet gale (*Myrica gale*). Stunted speckled alder are often mixed in with these species.

Marshes are mineral wetlands or peatlands that are periodically inundated by standing or slow flowing water. Surface water levels generally fluctuate seasonally. During drier periods declining water levels may expose areas of matted vegetation or mud flats. The surface waters are typically rich in nutrients. The substrate is usually mineral material although well-decomposed peat may occasionally be present. Marshes typically display zones or surface patterns consisting of pools or channels interspersed with patches of emergent vegetation, bordering wet meadows and peripheral bands of shrubs or trees.

Coastal freshwater marsh, shallow basin marsh and stream marsh are the only marsh types present in the study area. Coastal freshwater marsh is found only at the proposed South River crossing site. This wetland is described in the South River Impact Study (Appendix E). Shallow basin marshes occupy uniformly shallow depressions or swales, having a gradual gradient from the edge to the deepest portion. The marsh edge may be poorly defined due to rapidly receding water levels. Shallow basin marshes in the study area are highly variable in regards to plant species composition. Dominant species associated with these wetlands include broad-leaved cat-tail (*Typha latifolia*), blue-joint (*Calamagrostis canadensis*), dulichium (*Dulichium arundinacea*), and sensitive fern (*Onoclea sensibilis*). Stream marshes occupy the margins of streams. Water level in stream marshes is regulated by fluctuations in stream water level. The plant species

composition in stream marshes in the study area is also highly variable. Dominant species include broad-leaved cat-tail, marsh mermaid-weed (*Proserpinaca palustris*), rush (*Juncus canadensis*), and creeping bent-grass (*Agrostis stolonifera*). Both marsh types support a sparse shrub layer composed largely of either speckled alder or meadowsweet.

The wetland evaluations indicated that five of the wetlands (Wetlands 1, 2, 10, 15, and 17) provide habitat for uncommon plant species including water loosestrife (*Lysimachia thyrsiflora*) (Wetland 1), marsh mermaid-weed (Wetland 1 and 10), purple milkweed (*Asclepias incarnata*) (Wetland 2), and large purple-fringed orchid (*Platanthera grandiflora*) (Wetlands 15 and 17). All of these species are listed as uncommon in Nova Scotia by the ACCDC (2002a). NSDNR (2002a) considers the Nova Scotia populations of these species to be secure. No species considered to be rare or endangered or sensitive to anthropogenic activities were found in any of the wetlands found within the RoW of the proposed highway.

The four largest wetlands (Wetlands 1, 6, 11, and 12) are believed to play a moderate role on surface water flow regulation. These wetlands can be expected to augment stream flow during dry periods resulting in more even stream flow by slowly releasing waters stored in the wetland. These wetlands will also help to reduce flooding by acting as a reservoir for flood waters and by slowing the flow of flood waters.

Five of the wetlands found within the proposed highway (Wetlands 1, 2, 6, 7, and 19) RoW may currently contribute to improved water quality. All of the wetlands with the exception of Wetland 7 are located at the edges of roads. Surface water draining from these roads into the wetlands could be contaminated with sediment, metals, hydrocarbons, and road salt. Wetlands are quite efficient at removing sediment and metals from surface water but are poor at retaining hydrocarbons, sodium and chloride ions. Wetland 7 receives drainage from a hay field and may be exposed to surface water containing sediment, nutrients and pesticides.

5.8.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when there is a net loss of wetland functions in a wetland of significant value as determined through a recognized wetland evaluation system.

A **positive** effect may enhance the quality, increase the species diversity, or increase the area of the wetland.

5.8.4 Potential Issues, Interactions and Concerns

Construction activities could affect wetlands along the alignment in several ways. The movement of heavy machinery across wetlands and infilling associated with wetland crossings could result in physical disturbance of plant communities and substrates. Other activities such as clearing, grubbing and grading of terrestrial habitats at the edges of wetlands could result in sedimentation of wetlands. Runoff from exposed acid generating slates could adversely affect wetlands as a result of elevated acidity, the

mobilization of metals, and smothering of wetland plant communities as a result of deposition of iron floc at groundwater discharge sites in wetlands exposed to acidic drainage. However, this is not considered likely to occur given the geology present in the study area (refer to Section 2.4.12). Infilling of wetlands can alter the hydrologic regime due to interference with or diversion of groundwater or surface water flows in the wetland. Roadbeds constructed adjacent to wetlands can also alter wetland hydrology if improper culvert placement impedes proper drainage resulting in flooding of the wetland. Wetlands not crossed by the RoW could be affected by noise during construction and operations if the wetland supports species that are particularly sensitive to anthropogenic disturbance.

5.8.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.8.5.1 Construction

Twenty-one wetlands are located within the proposed RoW. One of these wetlands, Wetland 5, was infilled prior to the onset of the field survey so a wetland evaluation could not be completed at this location. Another wetland, Wetland 21, was described and evaluated as part of the South River Impact Study. The wetland description and results of the wetland evaluation for this location are provided in Appendix E. Synopses of the results of the South River wetland study are provided in Tables 5.26 and 5.27. The effects of the Project on the remaining 19 wetlands are discussed in the following text. Construction will result in heavy infilling (50 % or more of wetland infilled) of five wetlands (Wetlands 7, 8, 9, 14 and 20), moderate infilling (25 to 50% of wetland infilled) of three wetlands (Wetlands 4, 16 and 18) and light infilling (less than 25% of wetland infilled) of nine wetlands (Wetlands 1, 2, 3, 6, 11, 12, 13, 15, and 17). Wetlands 10 and 19 will not be infilled. Wetlands not crossed by the highway could be adversely affected as a result of alteration of wetland hydrology caused by construction activities or by inputs of sediment.

Wetlands 4, 7, 8, 9, 14, 16, 18, and 20

These wetlands are classed as not significant and will be moderately to heavily disturbed by construction activity. Unfortunately, it is not feasible to avoid these wetlands as a result of other environmental, safety, socio-economic or engineering constraints. NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project. It may be possible to mitigate the loss of wetland habitat through the construction of replacement wetland habitat in the vicinity of the infilled wetland. Replacement wetland, if required, would consist of wetland habitat capable of replacing or exceeding the wetland functions lost or reduced in the original wetland. The most important function of these wetlands is surface water flow regulation, a function that can be replaced using constructed wetlands or by restoring the partially infilled wetlands. These wetlands would be established along the same drainage courses as the original wetlands in order to maintain this wetland function. The use of replacement habitat to mitigate wetland habitat loss is far less desirable than avoidance of habitat loss since it can be very difficult to duplicate the structure and functions of many wetland types.

Regardless of the type of compensation employed, it is important to maintain existing drainage conditions to prevent unintentional alterations of wetland habitat.

The implementation of mitigative measures to minimize sedimentation and accidental discharges of harmful substances would reduce the potential for these wetlands to be adversely affected by construction activity. Mitigative measures to reduce erosion and sedimentation would include:

- keeping ground disturbance in and adjacent to streams and wetlands to a minimum, and restricted to within the RoW;
- stabilization and/or revegetation of disturbed areas immediately after construction;
- the use of drainage control structures designed to prevent erosion;
- isolation of stockpiled soil from adjacent wetlands and streams; and
- direction of surface runoff as overland flow through shallow vegetated channels or into retention/sedimentation basins equipped with debris traps and baffle arrangements.

Wetland 1, 6, 11, and 12

These wetlands were identified as having valuable hydrologic functions. In particular, they are large enough to help augment stream flow during low flow periods. They may also help to alleviate flood conditions by storing flood waters and releasing them slowly. The amount of wetland habitat lost as a result of highway construction in the four largest wetlands (1, 6, 11 and 12), ranges from 0.5 to 19.0% of the wetland area and averages 8.2 %. The loss of this wetland area is not expected to have a significant adverse effect on the hydrological functions of the wetlands (H. Arisz, pers. comm. 2002).

It is not feasible to avoid these wetlands given the presence of other environmental, safety, socio-economic, or engineering constraints along the route. However, the wetland compensation plan may consider replacing the hydrologic functions of the wetland through creation of wetland habitat along the margins of the damaged wetlands. The amount of wetland habitat created would be equal to or greater than the size of the wetland habitat lost. In instances where it is not possible to add replacement habitat to the existing wetland, a new wetland could be established along the same drainage course as the damaged wetland. Where possible, construction of the highway through a particular wetland will be conducted concurrently with the creation of replacement wetland habitat. This would allow the recovery and reuse of the organic matter layer of the wetland. This material would provide a suitable substrate for wetland species to colonize the replacement wetland habitat and would provide a seed bank as well as other propagules that could be used to rapidly establish a cover of native wetland plant species.

These wetlands could also be adversely affected if construction of the highway adversely affects the hydrology of the wetland. To prevent this, care will be taken in the design of the drainage system for the highway to maintain the existing drainage patterns. In addition, mitigative measures to minimize

sedimentation of the wetland and to prevent accidental releases of materials such as fuel and lubricants as described for Wetlands 4, 7, 8, 9, 14, 16, 18, and 20 will be implemented to ensure that biological activity outside of the RoW is not adversely affected.

Wetlands 1, 2, 10, 15, and 17

These wetlands support uncommon plant species and will be partially infilled as a result of highway construction. The amount of infilling ranges from 0 to 19 %. In all but two of the wetlands (Wetlands 1 and 17) the uncommon species will not be directly affected by construction activity. Wetland 1 contains two uncommon species, marsh mermaid weed and water loosestrife. Wetland 17 supports a small population (one plant) of large purple-fringed orchid. About half of the populations of marsh mermaid-weed and water loosestrife in the area are located within the highway RoW. It is unlikely that the portion of the RoW which falls within Wetland 1 (other than the portion required for the roadbed of the eastbound lane) will be cleared and grubbed since vegetation cover is low and the surface of the wetland will not support heavy equipment. It is likely that only the portion of the wetland under the footprint of the eastbound lane will be disturbed. This would result in the loss of about 10 % of the area occupied by marsh mermaid-weed and no loss of any water loosestrife. The large purple-fringed orchid found in Wetland 17 is located within the footprint of the highway and will be lost during construction. The Nova Scotia population of large purple-fringed orchid is considered secure and only one plant was found at this site. Given the difficulty in shifting the RoW, the loss of large purple-fringed orchid at this location is considered acceptable. There is some potential for indirect effects as a result of alteration of wetland hydrology or vegetation maintenance during the operational phase of the project, however, these factors can be controlled by means of mitigative measures.

The areas of these wetlands disturbed by highway construction will be minimized by clearing, grubbing and infilling only the areas required for the roadbed. The portions of these wetlands found in the RoW but outside of the footprint of the highway will be left undisturbed. Other than avoidance and minimization of habitat disturbance, no other mitigation is proposed for the remaining wetlands in regards to the plant habitat function for two reasons. First, the populations of uncommon plant species found in these wetlands will not be directly affected by construction activities. Second, the habitat requirements of these species are poorly understood so that creation of new habitat for these species would have a high probability of failure. More generic mitigation such as the creation of replacement habitat as described for Wetlands 1, 6, 11, and 12 would help to offset the general loss of wetland habitat but would probably not provide suitable habitat for the uncommon species found at these sites.

At Wetland 17 it may not be possible to avoid the large purple-fringed orchid. Given the status of this species as secure in Nova Scotia, the small number of plants affected and its presence at another location nearby, the loss of this population would probably be acceptable. NSDNR and the Nova Scotia Museum would be consulted prior to any activity at this location to ensure that loss of this population is acceptable. Mitigative measures to reduce erosion and sedimentation of streams and wetland habitats will be employed along with measures to avoid alteration of the hydrology of the wetlands will be employed to reduce the potential of any indirect adverse effects on these species.

Wetlands 1, 2, 6, 7 and 19

The field surveys suggested that these wetlands may receive contaminated surface water and may help to improve surface water quality. Wetlands 1, 2 and 19 receive surface water from the existing Highway 104 which may have elevated levels of suspended solids, metals, hydrocarbons, sodium and chloride. Wetland 6 also receives roadside drainage; however, it is also found adjacent to an urban area and may also receive surface water inputs which have elevated concentrations of nutrients such as nitrogen and phosphorus. Wetland 7 receives drainage from a hay field which may contain elevated concentrations of suspended solids, nutrients and pesticides. Wetlands are effective at filtering, absorbing or adsorbing sediment, metals, nutrients, and organic chemicals such as pesticides. They are not very effective at removing sodium and chloride ions or hydrocarbons.

Wetlands 1, 2 and 6 will be partially infilled as a result of highway construction; however, no infilling is expected to occur in Wetland 19. No wetland habitat will be lost in Wetland 19 and relatively little habitat will be lost at Wetlands 1 (3.1%), 2 (19%) and 6 (19%). Road construction at these sites is not expected to result in a significant reduction in the ability of these wetlands to remove contaminants. Wetland 7 will be almost completely infilled (88.9%); consequently, this wetland function will be eliminated at this site. The highway RoW will replace the hay field and Wetland 7 will no longer receive agricultural drainage.

Since avoidance of these wetlands is not feasible due to other constraints, NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Projet. If wetland compensation involves replacing wetland habitat it is recommended that wetland habitat be constructed to maintain the existing water quality function of the last wetland habitat. At Wetlands 1, 2 and 6 replacement wetland habitat could be constructed along the margins of the existing wetlands. At Wetland 7 a new wetland would need to be constructed. The creation of replacement habitats or complete wetlands could be undertaken at the same time that construction is scheduled to occur in the wetlands so that the substrate of the wetland can be salvaged and used in the replacement wetland habitat. This substrate harbours the microbial communities which aid in the breakdown or sequestration of toxic compounds. The organic materials in the substrate are also effective at adsorbing contaminants. Prior to salvaging the substrate at these wetlands, it would be tested to ensure that there is no risk of releasing harmful concentrations of contaminants immobilized therein when the substrate is disturbed. These

wetlands could be adversely affected by sedimentation, hydrological changes or accidental events. The mitigative measures for erosion and sediment control, hydrology and accidental events will be applied to these wetlands.

The concerns with respect to wetlands is the hydrological function they provide as well as the habitat they may offer certain species. The primary mitigative measure for wetlands is avoidance where feasible, or alternatively reconstruction, within the same drainage course, of affected wetlands, to restore habitat and hydrologic function. Implementation of sediment and erosion control measures during construction also aids in minimizing potential alteration of wetland hydrology. Habitat issues are further discussed in antecedent sections (5.4, 5.5, 5.6 and 5.7) where applicable. Specific concerns have been raised by DFO regarding infilling of Wetland 6 and impacts on Brierly Brook. The hydrologic behaviour of wetland 6 controlled by the existing culvert under Highway 104 (*i.e.*, the invert of this culvert and the approach channel controls the upstream water levels, while the discharge capacity of the culvert is believed to control the peak flows from the wetland). Although the infilling of the wetlands will reduce the footprint of the wetlands in this area, the hydraulic control of the existing culvert combined with the gently rolling topography of the watershed upstream of this culvert are expected to ensure that the impacts of the proposed highway construction on the local and regional baseflow hydrology in Brierly Brook will be negligible.

Provided that the proposed mitigative measures are applied, no significant adverse effects to wetlands are anticipated during construction.

5.8.5.2 Operation and Maintenance

Operation of the proposed highway may affect wetlands in the study area in several ways. Traffic on the highway may disturb wildlife which use wetland habitats. None of the wildlife species encountered in the wetlands are considered to be particularly sensitive to human activities. Bird abundance can be expected to be lower in habitats immediately adjacent to the road as a result of disturbance. This effect is localized and is not expected to have significant adverse effects on regional populations (See Section 5.6). Wildlife populations in wetlands may also be affected by collisions with automobiles. Studies have shown that survival rates among bird populations adjacent to roads are generally not significantly lower than in populations located away from roads (Leedy and Adams 1982; Reijnen and Foppen 1994). The incidence of roadkill can be reduced by establishing wildlife corridors which can be used by wildlife to avoid crossing busy highways. Watercourse crossings are good locations to establish wildlife corridors. Wildlife often use riparian habitats as travel routes and the presence of watercourses requires that provisions be made to allow water to cross the RoW. Bridges and culverts used to convey water can be modified or larger structures installed to provide passages for wildlife. One relatively large wetland (Wetland 11) is present on one of the larger streams (Stream Crossing No. 11) crossed by the highway. The northern end of this wetland will be crossed by the highway. The presence of traffic on the highway could impede the movement of wildlife.

An arch-structure (open bottom culvert) is being considered for this location, and this would facilitate wildlife movement.

Four of the wetlands found along the proposed highway route are also located along the edge of the existing Highway 104. There was no noticeable zonation of plant communities in these wetlands associated with proximity to the highway which might indicate that plant species composition had been altered by exposure to road salt. Although no obvious road salt-related environmental effects were noticed, subtle changes in species composition could be present. Given that functional wetland habitats are present at these four locations in spite of exposure to road salt, the potential effect of road salt applications on the remaining wetlands is not expected to be significantly adverse.

The primary concern regarding wetlands with respect to highway operation is the potential effects of road salts on plant communities found within wetlands in the study area. Another concern relates to potential mortality or disturbance of plant species found within the wetlands. No significant adverse effects are anticipated during highway operation from the use of road salts on the highway, particularly with the implementation of NSTPW's Salt Management Strategy (Appendix L). The use of wildlife corridors where feasible will lower impacts to wildlife to insignificant levels.

5.8.6 Follow-Up and Monitoring

NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project. If wetland habitat is constructed to replace wetland habitat lost during construction, a monitoring program will be established. After a suitable growing period (the length of which will be dependent on the type of wetland constructed), a wetland functional analysis will be conducted to determine if the constructed wetland(s) has developed the functional attributes deemed necessary to compensate for the loss of functional attributes in the original wetland.

5.8.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, there is not likely to be any significant residual adverse environmental effects on wetlands as a result of the Project. Tables 5.27 and 5.28 summarise the residual environmental effects evaluation for wetlands.

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Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands in General •• Habitat loss/alteration (A) •• Increased erosion leading to sedimentation (A) •• Alteration of hydrologic regime (A) •• Loss of wetland functional attributes (A)	Wetlands (General) •• Avoid wetland habitat wherever feasible •• Where avoidance is not feasible, construct replacement wetland habitat capable of replacing loss of wetland functions •• Implement erosion control measures •• Design the highway and associated drainage system to avoid altering wetland hydrology	2	2	2 / 6	I	2	N	2
	Wetlands 1, 6, 11 and 12 •• Loss of hydrologic function (surface water retention and flood control) (A)	Wetlands 1, 6, 11 and 12 •• Salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities	2	2	2 / 6	R	2	N	2
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands 1, 2, 6, 7 and 19 •• Loss of water quality function	Wetlands 1, 2, 6, 7 and 19 •• Salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities •• Test salvaged soil to ensure that toxic concentrations of contaminants will not be released when the soil is moved	2	3	2 / 6	R	2	N	2

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Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands 1, 2, 10, 15, and 17 •• Presence of uncommon plant species	Wetlands 1,2,10, 15, and 17 •• Minimize the amount of wetland habitat affected by clearing, grubbing and infilling only the portion of the wetland required for construction of the road bed	2	3	2 / 6	I	2	N	2
	Wetland 21 •• Habitat loss/alteration (A) •• Loss of hydrologic function (Protection from tidal flooding) (A) •• Loss of recreational opportunities (interruption of spring sports fishing and wildlife viewing opportunities) •• Loss of Sharp-tailed Sparrow breeding habitat (sensitive species) (A) •• Disturbance of breeding Sharp-tailed Sparrows (A) •• Sedimentation of wetland and estuarine habitat (A)	Wetland 21 •• Design bridge structure to minimize the amount of habitat affected •• Minimize infilling of flood plain to maintain flood storage function and minimize loss of terrestrial habitat •• Align the bridge structure perpendicular to the river and at the narrowest point •• Locate the bridge as close as possible to the existing structure to minimize the disturbance of wildlife.	2	1	2 / 6	R	2	N	2

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Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low: i.e , specific area of wetland localized, within natural variation; no change to wetland functions; 2 = Medium: i.e., major portions of wetland; changes to wetland functions temporarily outside range of natural variability; 3 = High: i.e., affecting entire wetland, net loss of wetland functions
Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous
Reversibility: R = Reversible; I = Irreversible
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect
Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 5.28 Residual Environmental Effects Assessment Matrix Wetlands (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	••Mortality of wetland wildlife associated with vehicle interactions (A)	••Consider construction of wildlife corridors at watercourse crossing sites (at Wetland 11) to reduce the incidence of roadkill	1	3	5 / 6	R	2	N	2
	••Sensory disturbance to wildlife (A)	••No mitigation recommended	1	3	5 / 6	R	2	N	2
De-icing	••Increased salinity to wetland (A)	••No mitigation recommended	1	3	5 / 6	R	2	N	2

Refer to Table 5.27 for Key.

5.9 Species at Risk

Species at risk are identified within their respective VEC sections (Section 5.4 Rare Herpetiles, Section 5.5 Rare Mammals and Critical Habitat, Section 5.6 Rare and Sensitive Birds, and Section 5.7 Rare Plants and Plant Communities). This section of the report takes a closer look at federal species at risk in context of the SARA.

5.9.1 *Species at Risk Act (SARA)*

One of Canada's strategies to protect biological diversity is to address species at risk. These are native species that are sensitive to human activity due to their rare occurrence, restricted range in Canada, dependence on specialized habitats or declining population or distribution (Canadian Wildlife Service 2004). This has been achieved through, amongst other initiatives, the Species at Risk Act (SARA). SARA serves to protect listed species by prohibiting activities that may harm individuals or critical habitat. Specific prohibitions under SARA came into force on June 1, 2004; those relevant to the proposed Project, include the following:

- Section 32 (1): No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.
- Section 33: No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.
- Section 58: Subject to this section of the Act, no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species - or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada - if (a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada; (b) the listed species is an aquatic species; or (c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act, 1994.

SARA has been linked to the Canadian Environmental Assessment Act (CEAA) through requirements in both Acts. Section 79 of SARA requires that the RA must notify the competent minister (likely DFO or Environment Canada) in writing if a project being assessed is likely to affect a listed wildlife species or its critical habitat. The RA must identify the adverse effects of the project on the species/critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen the effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plan. CEAA specifically includes within its definition of "environmental effect" any change a project may cause to a listed wildlife species (i.e., listed under SARA), its critical habitat (i.e., the habitat that is necessary for the survival or recovery of a listed species and that is identified in the recovery strategy or

action plan for the species) or the residences of individuals of that species (i.e., a dwelling place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating).

5.9.2 Assessment of Species at Risk for the Project

No listed wildlife species were observed within the study area during the field surveys. However, two listed species have been reported to occur in the general area of Antigonish.

The Piping Plover melodus subspecies (Charadrius melodus melodus) is listed as an endangered species (COSEWIC 2004) on Schedule 1 of the SARA. Its presence has been identified within a 10 km x 10 km census square indicated in the Atlas of Breeding Birds of the Maritime Provinces database (breeding bird atlas) (Erskine 1992). However, as indicated in the National Recovery Plan for the Piping Plover (Goossen et al. 2002), nesting and feeding habitat for this species includes sandy beaches, tidal flats, shores of coastal lagoons, ponds and salt marshes, sand and mud flats and algal flats. These habitats are not present within the study area, therefore there is no predicted interaction between the Project and this species.

The other listed species is the wood turtle (Glyptemys insculpta), which is listed as a species of special concern on Schedule 3 of SARA. Although the wood turtle was not observed during field surveys, this species is known to be associated with the West and South Rivers and suitable foraging and cover habitat for this species was found at the West River crossing site. This species was last assessed by COSEWIC in 1996 and therefore must be reassessed against revised criteria before it can be considered for addition to Schedule 1 of SARA. Specific prohibitions such as those listed above do therefore not apply to this species. Furthermore, critical habitat and recovery strategies have not yet been defined for this species. Specific mitigation, including a wood turtle risk management program as described in Section 5.4.6 will be implemented by TPW in consultation with NSDNR to minimize Project-related adverse effects on the local wood turtle population.

6.0 SOCIOECONOMIC EFFECTS ASSESSMENT

6.1 Local Economy

Local economy is considered a VSC due to its importance to the community of Antigonish and quality of life for its residents. In particular, there is a concern among businesses that the customer-base will decline due to reduction in through-traffic to commercial establishments along the existing Highway 104. This could cause a decline in business revenues and business tax income. The local economy could also be affected by increased spending associated with highway construction as well as opportunities for opening new areas for commercial, residential and industrial developments as a result of improved access.

The scope of assessment of this VSC includes potential economic effects on: income and employment; commercial establishments; agriculture; fishery industry; forestry; and recreation and tourism. A related VSC, Land Use, is discussed in Section 6.2.

6.1.1 Boundaries

The spatial boundary of the assessment covers both the Town and County of Antigonish. In 1996, Louis Berger (Canada) Limited, commissioned by the Antigonish Chamber of Commerce, conducted an Economic Impact Study (Louis Berger (Canada) Ltd. 1996) which examined the economic impacts of various highway alignment options on the local economy. Although the alternative alignments that were considered in that report are slightly different from the current proposed alignment, basic information in the study remains relevant. The Berger study divided the study area into six zones for the purpose of their analysis:

Zone 1	From Pictou County Line to the Brierly Brook/Addington Forks Exit
Zone 2	From the end of Zone 1 to James Street intersection
Zone 3	From the end of Zone 2 to Beech Hill Road intersection
Zone 4	From the end of Zone 3 to Taylor Road intersection
Zone 5	From the end of Zone 4 to East Tracadie/Monastery intersection
Zone 6	From the end of Zone 5 to Guysborough County Line

Zone 6 and most of Zone 5 is excluded from the current Project study area. For the purposes of this assessment, the study area is divided into the following zones:

Zone 1	From 0+000 to 1+900 (Addington Forks Road on the existing highway)
Zone 2	From 1+900 to 3+800 (intersection of the existing highway and James Street)
Zone 3	From 3+800 to 6+500 (Beech Hill Road exit)
Zone 4	From 6+500 to 14+827 (eastern point of the proposed RoW)

The spatial assessment boundary includes an area (distance to the north and south from the existing alignment) within which majority of economic impacts occur (Louis Berger (Canada) Ltd. 1996). A rural area with low population (*i.e.*, Zones 1 and 4) would have a confined impact width limited to approximately 100 to 150 m on either side of the roadway, while for more densely populated areas with arterial roads connecting to the existing Highway 104, the impact width extends farther. For the purpose of this study, the boundary in Zone 2 will be 250 m and in Zone 3 will be 500 m on either side of the highway. However the study boundaries will extend to the entire economy of Antigonish (both Town and County) when appropriate. Figure 6.1 presents the boundaries from Zone 1 to end of Zone 4.

Temporal boundaries of Project impacts on local economy include construction and operation phases. Construction is estimated to occur over a four year period, while the operation phase will be continuous. Other temporal issues related to the local economy include seasonal businesses (*e.g.*, tourist-related) and activities (*e.g.*, recreation).

6.1.2 Description of Existing Conditions

6.1.2.1 Commercial Establishments

An inventory of commercial establishments in the Berger study was updated through site inspection. There are no commercial establishments within Zone 1. Zone 2 has several commercial establishments located on both the north and south sides of the existing Highway 104. This section is locally referred to as Post Road. The establishments are summarised in Table 6.1.

Table 6.1 Establishments Along The Existing Highway 104, Zone 2 Antigonish

Establishment	Type
South Side Locations	
Housekeeping Units	Small Business
Lobster Treat	Restaurant
Chrysler Dodge	Auto Dealership
Truck Dealership	Auto Dealership
Zincko's Transfer Co.	Transportation/Light Manufacturing
Super Value Mall	Retail
Ultramar Gas	Gas Station
Equipment Supplies	Small Business
Private Homes (2)	Homes (2)
North Side Locations	
Fashion Frenzies	Retail
Vacuum Village	Small Business
Esso Gas	Gas Station
Metro Gas	Gas Station
Rental Business	Small Business
Century 21	Small Business
NS Transportation Building	Government Building
Irving Gas	Gas Station
Private Homes (4)	Homes (4)

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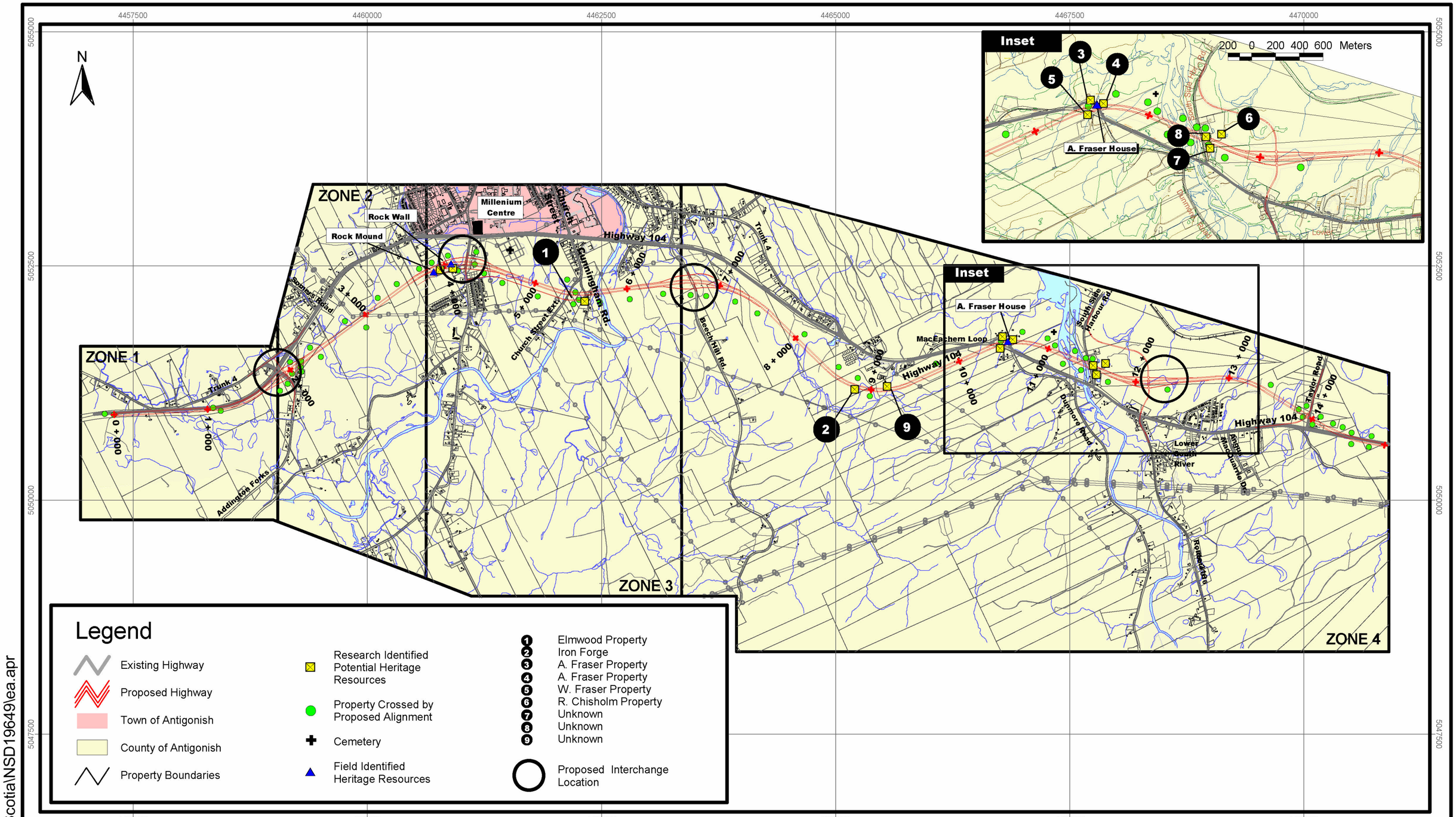

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Jacques Whitford

NOVA SCOTIA Transportation and Public Works

SCALE: 1 : 37 500

Date: 9/01/2004

Drawn By: GM

Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Socio-Economic Features

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.

NSD16949
FIGURE 6.1

Zone 3 covers the commercial stretch on the northern section of the existing Highway 104 and mostly within the boundary of the Town of Antigonish. The Town is bounded by Highway 104 to the south, Greening Drive to the west, and West River to the east. The establishments are summarised in Table 6.2.

Table 6.2 Establishments Along The Existing Highway 104, Zone 3 Antigonish

Establishment	Type
South Side Locations	
Sterlings	Farmers' Market
School Bus Lot	Public Building
Power Substation	Utility
Cemetery and Church Building	Church
Small Millwork Building	Small Business
JR Rahey's Appliance	Small Business
Private Homes (3)	Homes (3)
North Side Locations	
Barn	Agricultural Building
Dairy Queen	Restaurant
Private Homes (2)	Homes (2)
Shopping Plaza	Retail
Claymore Inn	Motel/Hotel
Sobey's	Retail
Canadian Tire	Retail
Millennium Centre	Recreation
Tourist Information	Public Building
Hyundai Dealership	Auto Dealership
Fast Track Computer	Small Business
Chateau Motel	Motel/Hotel

Zone 4 is longer compared to the other zones because of the uniform pattern of economic and transportation profile within this zone. An inventory of various establishments along the existing Highway 104 is summarised in Table 6.3.

Table 6.3 Establishments Along The Existing Highway 104, Zone 4 Antigonish

Establishment	Type
South Side Locations	
Irving Gas	Gas Station
Snow Queen	Restaurant
Pete's Auto Sound	Auto Repair Shop
Central Home Decor	Small Business
Shamrock Homes	Small Business
Mother Webbs	Restaurant
Convenience Store	Convenience Store
Petro Canada	Gas Station
Goshen Restaurant	Restaurant
Cape Breton Info Centre	Public Building
Coffee Shop	Restaurant

Table 6.3 Establishments Along The Existing Highway 104, Zone 4 Antigonish	
Industrial Park	Transportation/Light Manufacturing
Car Wash	Small Business
Esso	Gas Station
School	Public Building
Private Homes (13)	Homes (13)
North Side Locations	
Highland Professional Centre	Offices
Auto Body Shops (2)	Auto Repair Shop (2)
Oasis Motel	Motel/Hotel
Trailer Park (< 20 units)	Trailer Park (<20 units)
Coastal Inn	Motel/Hotel
Esso	Gas Station
Trailer Park (> 50 units)	Trailer Park (<50 units)
Garage/Body Shop	Auto Repair Shop
Trailer Park Sales	Small Business
Church	Church
Private Homes (8)	Homes (8)

Establishments within the Town of Antigonish but not along the existing Highway 104 are not included in the above inventory of establishments. Based on the above, a summary of businesses with direct access to the existing Highway 104 is provided in Table 6.4.

Table 6.4 Summary of Business Type And Number of Establishments Along The Existing Highway 104 Directly Affected by The Proposed Highway	
Business Type	**Number of Establishments**
Transportation/ Trucking and Light Manufacturing	2
Homes	32
Farmers' Market	1
Convenience Store	1
Gas Station	8
Auto Dealership	3
Auto Repair Shop	4
Restaurant	6
Retail	5
Public/Government Building	5
Small Business	12
Motel/Hotel	4
Recreation/Convention Centre	1
Trailer Parks	2
Church	2

The Berger study used the annual average daily traffic (AADT) to quantify the economic impact on business establishments in consideration of: type of business; location and relative access to points on highway; and market range. The Berger study predicted AADT in the study area assuming no new highway as shown in Table 6.5.

Table 6.5 Average Annual Daily Traffic (AADT) Along The Existing Highway 104 without New Highway

Zone	Base AADT	Growth	1996	2001	2003	2011
Zone 1	6,865 (1992)	3.3%	7637	8725	9203	11389
Zone 2	6,470 (1992)	4.3%	8730	10775	11722	16416
Zone 3	9,150 (1992)	4.9%	11110	14151	15571	22831
Zone 4	8,060 (1992)	8.4%	13545	17287	19059	28159

Source: Louis Berger (Canada) Ltd. 1996

Although the base year for the AADT projection was 1992, recent survey results are consistent with the above projections (refer to Section 6.4 – Transportation Infrastructure for comparative data) except for Zone 4 where AADT in 2002 was lower than that predicted in the Berger study (11,000 vs. 15,800).

The existing Highway 104 also provides an important access to an industrial park situated east of the Town. The industrial park is 101 acres (40.9 ha) complete with water distribution system, storm and sanitary sewers, and fire hydrants.

6.1.2.2 Demographic, Income and Employment Characteristics

The Town of Antigonish has a population of 4,754 (2001 data from Statistics Canada), a decline by 2.2% from the 1996 population of 4,860. Population density in the Town is 923.9 persons per square kilometre over a total land area of 5.15 km^2 (Table 6.6). The County of Antigonish has a population of 19,578 in 2001, a slight increase (0.1%) from the 1996 population of 19,554. Its population density of 13.4 is lower than the provincial average in Nova Scotia of 17.2 persons per square kilometre (Table 6.6).

Table 6.6 Summary of Population, Antigonish Town and County, and Nova Scotia

Characteristics	Antigonish Town	Antigonish County	Nova Scotia
Population in 2001	4754	19578	908007
Population in 1996	4860	19554	909282
1996 - 2001 Population change (%)	-2.2	0.1	-0.1
Total Private Dwellings	2354	8377	403819
Population Density (per km^2)	923.9	13.4	17.2
Land Area (km^2)	5.15	1457.9	52, 917.43

Source: Statistics Canada 2001

The age group characteristics of the Town closely resemble that of Nova Scotia. In general, population in the County is younger with 79.5 % of residents aged 15 years and over as compared to that of the Town (83.5 %) and the provincial average (81.8 %) (Statistics Canada 2001).

The combined population of the Town and County is 24,332, a decline of 0.1 % from the 1996 count of 24,414. The average population density per square kilometre is 16.6. Total land area is 1,463.10 km^2 comprising 2.76 % of the entire area of Nova Scotia (Table 6.6).

Based on the profile of Antigonish published by the ARDA (ARDA 2002), the region's main economic advantage is the stability provided by the educational and health services in the Town. The region enjoys employment opportunities for professionals and non-professional with well-paying positions due to the presence of St. Martha's Regional Hospital (300 employees) and Saint Francis Xavier (St. FX) University (500 employees). In general, the largest employers are public organizations, including the school board in addition to the university and the hospital.

The Statistics Canada census divides Antigonish into three census areas: Town; County Subdivision A; and County Subdivision B. County Subdivision A occupies the western section of the area and surrounds the Town. Subdivision B occupies the eastern section and is relatively more rural compared to Subdivision A. The Project area is contained within Subdivision A. Average annual incomes per person (1996 census data) are similar between Subdivision A ($23,054) and the Town ($22,846). This may be attributed to their proximity to the largest employers present in the area as identified above. Subdivision B, on the other hand, has a significantly lower average annual income of $18,942 (Table 6.7). By gender, reported average income of females is approximately only two-thirds of the reported income of males, which is consistent with the provincial average for less urbanized communities.

Labour participation rate is higher in the County at 66.8% in Subdivision A and 62.5% in Subdivision B as compared to the Town average of 57.1%. Unemployment rate in 1996 was 10.9% in County Subdivision A, which is slightly higher than that of the Town at 9.8%. County Subdivision B suffered a higher unemployment rate of 15.8 %, which is higher than the provincial average of 13.3 %.

Considering employment by major industry classification, 74% of workers are employed in service industries, 14% in manufacturing and construction industries, and 12% in agriculture and other resource-based industries. The share of employment in agriculture and resource based industries is significantly higher in Antigonish County compared to Nova Scotia (7%). This may be attributed to the relatively stronger reliance of the regional economy on agriculture and forestry activities as compared to the rest of the province.

Table 6.7 Income and Employment Characteristics of Population Age 15 Years and Over: Town; Subdivision A; and Subdivision B, Antigonish					
Characteristics	**Town**	**Subdivision A**	**Subdivision B**	**Total**	**Nova Scotia**
Labour Force Characteristics of Population Aged 15 years and over					
Average Total Income of Persons Reporting Income ($)	22486	23054	18942	-	21552
1996 Unemployment Rate (%)	9.8	10.9	15.8	-	13.3
1996 Participation Rate (%)	57.1	66.8	62.5	-	61
Industry Characteristics of Population Aged 15 years and over					
Agriculture and Other Resource Based Industries	115	505	485	1105	28675
Manufacturing and Construction Industries	175	540	575	1290	71480
Service Industries	1900	2700	2095	6695	324665
Total	**2190**	**3745**	**3155**	**9090**	**424820**
Source: Statistics Canada 1996					

Based on 1996 data, retail trade employed most of the work force within the service industries (15.1 % of total) followed by educational services (11.8 %) and health (11.6 %). This is consistent with ARDA observation that the economy of Antigonish relies heavily on health (hospital) and educational services (university and school board). Breakdown by sector is given in Table 6.8.

Table 6.8 Breakdown of Employment by Sector, Antigonish, 1996		
Sector	**Antigonish**	**Nova Scotia**
Retail	15.1%	13%
Educational Services	11.8%	7.3%
Health	11.6%	10.6%
Accommodation, Food and Beverage Service	9.2%	6.5%
Construction	7.7%	5.9%
Other Service	6.8%	7.3%
Manufacturing	6.2%	10.4%
Agricultural	4.1%	2.3%
Government Service	3.7%	9.6%
Fishing and Trapping	3.6%	2.2%
Logging and Forestry	3.6%	1.2%
All Others	16.6%	23.7%
Source: ARDA 2002		

6.1.2.3 Fishery, Forestry and Agriculture

In 1999, Antigonish contributed 1.62 % ($10.02 million) to the total landed value of fisheries in Nova Scotia ($616.96 million). Arisaig Fisheries is among the larger processing plants of lobsters and other shellfish in Antigonish and employs 110 persons (ARDA 2002). Lobster is the main fishery commodity in the region

with landed value in 1999 of $8.73 million, followed by blue fin tuna ($870,0000), winter flounder ($158,000), white hake ($113,000), and American plaice ($72,000) (NSDAF 2000). The highway serves an important link for fishery products to various markets in the region.

Pictou Landing First Nation fish salmon in the West and South Rivers and has a fishing plan on file with DFO. Other First Nations members (*e.g.*, Paq'tnkek, formerly Afton) also likely fish in the West and South rivers for food purposes. However, as indicated in the Mi'kmaw Knowledge Study (Appendix K), there is not anticipated to be any significant concerns with respect to First Nations fishing in the study area.

Based on 1997 data, there are 11 sawmills in Antigonish. About 60,000 m^3 of sawn fibre, with over 95 % softwood, were harvested. Roundwood harvest was 5,400 m^3, 76 % of which was hardwood. Sawn fibre production contributed 2 % to the total provincial harvest while only 0.2 % was contributed in provincial roundwood yield. Paper mills Stora (located in Point Tupper, Richmond County) and Kimberly-Clark (Pictou Landing) have employees living in Antigonish. About a kilometre of the new highway alignment will be through managed woodlots impacting at least 15 ha of this land.

The 44 dairy farms in Antigonish contribute about 10 % to Nova Scotia's total production. Scotsburn Cooperative Dairy derives 25 % of its milk from the Antigonish and Guysborough Counties. A total of 20.2 % of the land area of Antigonish is farmland, accounting for 6.9 % of all agricultural farms in the Province. About 33 % of this land is for beef cattle, 22 % for dairy cattle, 21 % for Christmas trees, and 18 % for other crops. There are a total of 247 farms in the County with total value of production of $18.95 million, which account for 4.9 % of Nova Scotia's gross farm income. These data are consistent with the visual inspection conducted, which noted that most of the agricultural lands along the RoW are devoted to pasturage or hay crop production. About 35 ha of this land will be affected by the proposed highway construction.

6.1.2.4 Tourism and Recreation

The Antigonish area is located in northeastern Nova Scotia along the Northumberland Strait and may also be accessed by the scenic highway, the Sunrise Trail.

The Antigonish-Eastern Shore tourism area covers Antigonish County, Guysborough County, and the portion of Halifax County east of a line running from the mouth of the Little Salmon River at Cole Harbour to Gays River. Based on the 2000 Nova Scotia Visitor Traffic Flow Report commissioned by the Nova Scotia Tourism and Culture (2002), Antigonish has the highest traffic levels of communities in the Antigonish-Eastern Shore tourism area, with a total of 428,400 party trips made by 235,200 parties (see Table 6.9 for definitions). It was pointed out that Antigonish is the only community in that area that is located on a 100 series highway, with all other communities located on secondary highways. The area has an estimated capture rate of 21 %, resulting in the highest number of party visits (24,900 party visits), and

the highest number of overnight visits (29,900 party overnight trips including a total of 54,200 party nights) in the Antigonish-Eastern Shore Tourism Area.

Table 6.9 shows the overall community visitor traffic flow in this area.

Table 6.9 Overall Community Visitor Traffic Flow, Antigonish-Eastern Shore Tourism Area, 2000

Community	Party Pass Throughs[1]	Party Stops[2]	Party Visits[3]	Overnight Party Trips[4]	Total Party Trips[5]	Parties[6]	Party Nights[7]	Capture Rate in Percent[8]
Antigonish	338800	34800	24900	29900	428400	235200	54200	21
Canso	9000	600	2900	1700	14200	12900	26500	36
Cape George	3700	800	2200	1000	7600	7600	6100	52
Guysborough	17400	1300	1600	1800	22200	19800	3900	21
Isaac's Harbour	17100	400	1800	2900	22200	19800	67500	23
Liscombe	26400	1400	1100	4100	33100	30600	6200	20
Middle Musquodoboit	1000	0	2300	1600	5000	5000	4200	80
Musquodoboit Harbour	30400	2100	5600	4200	42300	38800	18800	28
Sheet Harbour	25200	3400	3100	3700	35400	32400	9200	29
Sherbrooke	20300	1100	9700	3500	34600	31400	4400	41

[1] Represents the number of non-resident party trips passing through or by a specific community without stopping.

[2] Represents the number of non-resident party trips involving a stop of less than one-half hour in a specific community.

[3] Represents the number of non-resident party trips involving a stop of one-half hour or more, but not overnight, in a specific community.

[4] Represents the number of non-resident party trips involving a stop of one or more nights in a specific community

[5] Represents the sum of party pass throughs, party stops, party visits, and overnight party trips for a specific community.

[6] Represents the total number of unique, non-resident parties passing through, stopping, visiting or staying overnight in a specific community.

[7] Represents the total number of nights stayed by non-resident parties in a specific community.

[8] Percent of total party trips through a community that involved a stop, a visit, or an overnight stay.

Source: Nova Scotia Tourism and Culture 2002

With regard to statistics indicating community traffic flow by trip purpose, Antigonish has a capture rate of 26 % of total party business trips, 20 % of total pleasure trips, and 21 % of trips classified as visiting friends and relatives. By region of origin, it has a capture rate of 27 % of all party trips made by visitors from Atlantic Canada, and 18 % each of visitors from other places of Canada and internationally. Overall capture rate is 21 % (Table 6.10).

In summary, it can be concluded that the relatively high capture rate (percentage of total party trips through a community that involved a stop, a visit, or an overnight stay) in Antigonish is attributable, in part, to the immediate presence of the existing Highway 104.

Table 6.10 Community Traffic Flow by Purpose and Origin, Antigonish-Eastern Shore Tourism Area, 2000

Trip Purpose/ Region of Origin	Party Pass Throughs	Party Stops	Party Visits	Overnight Party Trips	Total Party Trips	Parties	Party Nights	Capture Rate (%)
Trip Purpose								
Business	1700	1600	1400	3100	23000	13200	4400	26
Pleasure	143400	9300	10500	16100	179100	99200	21500	20
Visiting Friends/Relatives	118000	16300	8900	7000	150400	82000	22900	21
Other	59800	7500	4200	3700	75100	40500	5200	20
Region of Origin								
Atlantic Canada	99500	20900	8900	7200	136600	74200	9500	27
Other Canada	141000	7800	9900	13000	171700	94500	29400	18
International	98200	6100	6100	9700	120100	66400	15300	18
Overall	338000	34800	24900	29900	428400	235200	54200	21

Note: Refer to Table 6.9 for definition of terms
Source: Nova Scotia Tourism and Culture 2002

Table 6.11 shows a summary of tourism and recreation areas in the Town and County of Antigonish. These include: supervised beaches (2) in Bayfield and Pomquet; provincial parks (5); shared-use trails (6); other trails (5) such as canoe waterways, coastal water trails, sea kayak routes, snowmobile trails, and the Trans Canada Trail; and nature sites (3) including the Antigonish Harbour Wildlife Management Area, Arisaig Sea Cliffs, and Pomquet Beach Region. All of these designated tourism and recreation resources fall outside the highway study area and are not expected to be affected by highway development.

Table 6.11 Municipality of the County of Antigonish Beaches, Parks, Trails and Nature Sites

Category	Feature	Community
Beaches (Supervised)	Bayfield Beach	Bayfield
	Pomquet Beach	Pomquet
Provincial Parks	Arisaig Provincial Park	Arisaig
	Bayfield Beach Provincial Park	Bayfield
	Beaver Mountain Provincial Park	James River
	Cape George Day Park	Cape George Point
	Pomquet Beach Provincial Park	Pomquet
Shared Use Trails	Antigonish Landing Trail	Antigonish Landing
	Arisaig Provincial Park Trails	Arisaig
	Beaver Mountain Provincial Park Trails	James River
	Cape George Hiking Trails	Cape George
	Fairmont Ridge Hiking Trails	Fairmont
	Mahoney's Beach Trail	Mahoney's Beach
Other Trails	Canoe Waterways	Antigonish County
	Coastal Water Trail	Antigonish County
	Sea Kayak Routes	Antigonish County
	Snowmobile Trails	Antigonish County
	Trans Canada Trail	Antigonish County
Nature Sites	Antigonish Harbour Wildlife Management Area	Antigonish Harbour
	Arisaig Sea Cliffs	Arisaig
	Pomquet Beach Region	Pomquet

Source: Municipality of the County of Antigonish 2002

The principal tourism and recreation area of interest for the highway development is the newly built Keating Millennium Centre located in the Town of Antigonish, owned by St. FX University. It houses an information technology (IT) training centre, two ice surfaces, convention facilities, and various fitness and water-related wellness activities. The Town also hosts the Antigonish Highland Games every July, which features Scottish traditions including language, music, dances and songs, along with feats of strength.

6.1.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on the local economy is one that results in a measurable Project-related reduction in total long term local employment or total local business revenues or profitability as a result of an effect on the number of customers and their spending patterns, or on the costs of doing business.

A **positive** effect is one that increases total long term local employment or total business revenues or profitability.

6.1.4 Potential Issues, Interactions and Concerns

The following sections pertain to potential Project-related effects on the local economy. Potential effects on the related VSC, land use, are discussed in Section 6.2.

Commercial Establishments

Throughout the route selection process for the new highway, many members of the business community in Antigonish have expressed concern that the new highway will bypass existing businesses creating a severe loss of business, particularly for those relying on through-traffic for a significant part of their customer base. A related concern was that this adverse effect would be worsened if businesses and other features in the Town could not be seen from the new highway, further reducing the opportunity to attract customers and other visitors. However, a large segment of the community also believes that the new highway could provide the impetus to expand development in Antigonish. This is due to the lack of available expansion area along the existing highway, especially south of the Town.

Most commercial establishments will be at a distance from highway construction activities and will, therefore, be relatively unaffected. Potential traffic disruption and access issues and mitigative measures are discussed in Section 6.2 (Land Use) and Section 6.4 (Transportation Infrastructure). Measures to mitigate potential adverse economic effects on local businesses, as well as to enhance business opportunities related to highway development, will be undertaken primarily through provision of timely Project information and liaison through a Community Liaison Committee (CLC).

Demographic, Income and Employment Characteristics

The new highway will potentially present a wide array of development opportunities. Land use conversion to residential, commercial and industrial uses as a result of improved access tend to increase in-migration and reduce out-migration due to the availability of local employment opportunities. With commercial development near highway exits situated within the County's jurisdiction, an increase in the number of employment in service industries in the County is expected.

Fishery, Forestry and Agriculture

With an approximate length of 15 km and a width of 150 m for the RoW, the total land area along the highway is calculated at 225 ha. The alignment crosses 2.3 km of agricultural land, which is equivalent to a land area of 34.5 ha, crossing farms near South River, Addington Forks Road, Beech Hill Road, and Willowdale Lane. These agricultural areas are mostly devoted to pasturage or hay crop production. The majority of lands crossed by the RoW is wooded, and it is estimated that approximately 1 km of the alignment is along managed woodlots in Beech Hill Road area.

There are no potential issues or concern with regards to the commercial fishing industry or First Nations fishing activity.

Tourism and Recreation

Due to the anticipated improvement of the transportation system brought about by the proposed highway upgrading, tourism and recreational attractions in Antigonish become more accessible. The positive impact may also extend to tourism areas in other areas of the province due to faster travel time as a result of the highway. There are no apparent negative issues or concerns for tourism and recreation facilities. However, as discussed under Commercial Establishments, there are concerns regarding potential negative impacts on tourism-related businesses (*e.g.*, hotels and restaurants) along the existing Highway 104.

6.1.5 Analysis, Mitigation and Residual Effects Prediction

6.1.5.1 Construction

Commercial Establishments, Employment and Income Characteristics

The economic impacts associated with construction are grouped into: (1) potential local construction job creation, and (2) additional economic stimulus (inside and outside the County).

The Berger study (Louis Berger (Canada) Ltd. 1996) indicated that the positive effects during the construction phase of the Project are the resulting job opportunities for local employment, as well as spin-off effects including accommodations, meals, entertainment, and others. The study pointed out that these effects are short term, which will likely disappear when construction activity is completed, or shortly thereafter.

Total construction expenditures are estimated at $81 million over four years, or approximately $20.25 million per year. Based on the experience of typical transportation construction projects in Nova Scotia (using 1999 Nova Scotia economic input-output data), this means approximately $8.1 million per year in direct labour income within the Province. Direct construction jobs are estimated at 55 to 65 over the four-year construction period. Construction job opportunities include positions for carpenters, general labourers, and equipment operators. The extent to which local individuals are hired will depend on the hiring practices of the selected contractors.

Total number of full-time equivalent direct and indirect jobs within Nova Scotia related to construction are estimated at 75 to 90. Total direct and indirect impact on provincial GDP (value-added) is estimated at $19 million per year over four years.

Fishery, Forestry and Agriculture

Agriculture and forestry areas will be incorporated into the new highway RoW with a combined area of about 50 ha and, thus, permanently removed for production. This will result in reduction in agriculture and wood harvests for Antigonish. However, given the total area devoted to agriculture and forest resources in the County (29,485 ha for agriculture alone), the total reduction is not significant. The primary mitigative measure for lost income related to the lost productivity of the land is fair market compensation to be paid to the land owners. Other potential effects are related to lost or lowered productivity associated with fragmentation of land holdings or impeded access. Section 6.2 provides more discussions about Project impacts and mitigating measures on agricultural and forestry land uses. No impact on the commercial fishing industry or First Nations fishing (refer to Appendix K) is anticipated during construction.

Tourism and Recreation

During the construction period and shortly thereafter, there will be a temporary increase in local incomes in Antigonish coming from the employed construction work force and spending on goods and services to supply the Project. A portion of this income is spent in leisure activities or in tourism and recreation. Based on Statistics Canada household spending statistics (1999), 6 % of the household income is spent in recreation. Assuming an increase in local incomes of approximately $4 million per year over four years, (direct and indirect income, further assuming 30% use of local labour), $240,000 per year will go to tourism

and recreational revenues. Overall, Project construction will be beneficial to the local economy of Antigonish due to employment opportunities and increased revenue for local businesses. Potential adverse impacts on existing resource use will be, on the other hand, minimal.

6.1.5.2 Operation and Maintenance

Commercial Establishments

In 1998, NSTPW retained Environmental Design and Management Limited (EDM) to prepare a "Visibility Analysis of Alternative Alignments for Highway 104 at Antigonish". The Town was concerned that the future alignment might reduce visibility and commercial potential to the existing businesses which front the current highway as well as the visibility of major landmarks in the town, which could also have an impact on visitation. The study found that the route would afford recognition of major landmarks. Travelling east, there would be no primary views of the James Street commercial area, the Visitor Information Centre, or the Church Street commercial area. However, travelling west, there are prolonged or repeated primary views of the mall, the university, the tourist information buildings and the James Street commercial area.

Due to the visibility constraints, business people in Antigonish are concerned that traffic would no longer stop in Antigonish. As a mitigating measure, a visible Visitor Information Centre near the Trunk 7 interchange is proposed (T. Poder, pers. comm. 2002). NSTPW will explore this option with the appropriate government and regional development agencies. Likewise, landscaping and appropriate signage along the new highway will be helpful to mitigate negative visibility effects, particularly for eastbound traffic.

The Berger study pointed out that without a new highway, there would be growth constraints due to the limiting nature of the roadway system. The study concluded that a new highway will result in economic growth in the County and a favourable impact on the tax base. These growth areas are anticipated to be around the interchange locations.

In order to use the results of the economic model in the Berger study in this socioeconomic assessment, the alternative alignments considered in the Berger report were compared to the proposed alignment. Relevant findings of the Berger study corresponding to the highway sections most similar to the selected alignment were used in this analysis. The Berger study used seven alternatives including the 'no build' scenario. The selected alignment closely resembles some of these alignment alternatives at different zones:

Zone 1	similar in all alternatives;
Zone 2	similar with Alternative III;
Zone 3	similar with Alternative III; and
Zone 4	similar with Alternative IV.

The Berger study modelled the change in the number of customers for different types of businesses. The model results showed that with the new highway alignment, customer-base could drop by as much as 22 to 42 % depending on assumptions of traffic diversion rates and pass-by customer mix (Table 6.12). The most vulnerable establishments are hotels/motels, high turnover businesses with 'sit-down' customers, fast food drive-thrus, gasoline and service stations, and supermarkets. The assumptions used for traffic diversion rates in the Berger report ranged from 40 % (low diversion rate, low pass-by custom mix) to 60 % (high diversion, high pass-by customer mix).

Table 6.12 Projected Change in Customer Base by Business Class

Business Class	Low Diversion Rate Low Pass-By Customer Mix %				High Diversion Rate High Pass-By Customer Mix %			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Manufacturing, Transport and Public Utilities	--	0	0	0	--	0	0	0
Hotel/Motel	--	-7	-6	-5	--	-42	-38	-34
Small Business Services	--	-11	-10	-9	--	-17	-16	-14
Health Services and Government Services	--	0	0	0	--	0	0	0
Department Stores	--	0	0	0	--	-10	-9	-8
Building Materials/Garden Supply	--	0	0	0	--	-10	-9	-8
Retail Shopping	--	-11	-10	-9	--	-16	-13	-10
High Turnover (Sit Down)	--	-10	-7	-5	--	-29	-26	-22
Fast Food Drive Through	--	-14	-11	-9	--	-25	-22	-18
Auto Body Repair Shop	--	-2	-2	-2	--	-10	-8	-7
Automobile Dealership	--	-2	-2	-2	--	-6	-5	-5
Gasoline/Service Station	--	-15	-12	-9	--	-39	-35	-31
Gas/Service Station with Convenience Store	--	-18	-16	-13	--	-41	-37	-33
Super Market/Farmers' Market	--	-22	-19	-17	--	-36	-32	-28

Source: Louis Berger (Canada) Ltd. 1996

The reduction in the number of customers of commercial establishments along the existing highway was projected, by the Berger report, to be substantial, in some cases. Business owners on James Street claim they will suffer the most as they believe that a large percentage of their customers is through-traffic, and James Street is a usual stopping point due to its visibility and accessibility from the existing highway (J. Parker, pers. comm. 2002).

A more recent study to determine the origin of vehicles on the existing Highway 104 (Beasy Nicoll Engineering Limited 1999) was conducted through a survey of vehicle license plates. The study found that only 30 to 40 % of traffic entering the Antigonish area from the east or west is through traffic. The remaining 60 to 70 % has origin or destination within the study area (NSTPW 1999). This indicates that most highway users are residents of Antigonish. This survey finding contrasts with the 40 to 60 % diversion rate assumed in the Berger report. The impact on existing commercial establishments may not, therefore, be as great as indicated in the Berger model, except for hotel/motel establishments as these cater basically to non-residents and visibility is a major determinant. A further mitigation factor is the overall economic

mix in Antigonish, which has a strong economic base in the hospital, academic institutions, agriculture, and other industries.

Another related report was prepared by Professor Ian Spencer of St. FX University who estimated that the new highway would cause a reduction of $8.5 million in annual revenue in Antigonish resulting in a total job loss of approximately 125 full time positions (Spencer 2000). The report only considered potential impacts on existing establishments, and no allowance was given for future gains in new businesses resulting from the project. In essence, it was a short-term potential analysis ignoring any benefits due to construction expenditures, adjustments that businesses may make in response to the new highway, or new economic development opportunities.

A separate study on the economic impacts of highway bypass development was conducted as part of this assessment in order to bring a higher level of confidence regarding the predicted impacts on the Town of Antigonish of the proposed Highway 104 improvements. The study is included as Appendix J. Based on the experience of bypassed communities elsewhere, the opening of a highway bypass will have some short-term negative economic effects. The magnitude of the effects depend on many factors, such as the size of the town, the structure of the economy and the characteristics of its economic "flagships", as well as the response from municipal government and economic development agencies. In general, negative economic impacts tend not to persist in the long-term.

The Berger study estimated that without the highway upgrading, the economic growth of the region will become limited with the projected traffic increases on the existing highway, which was estimated to be over-capacity starting 2003. The Berger study stated that with a 'no build' scenario, the highway will be over capacity by approximately 10 % in Zone 2 by 2011. Zone 3 will be at capacity in 2003 with a potential 52 % over capacity in 2011.

Impacts after construction are greatly dependent on growth-oriented strategies for the area. Beneficial growth strategies include planned growth around interchange locations. Businesses, which are subject to a high degree of pass-by traffic such as gas stations, convenience markets, and fast food restaurants, are likely to develop at highly accessible, and highly visible, locations at interchanges. Development of other establishments at these locations is also likely.

Given the above, it is expected that the positive benefits of the proposed highway upgrading to the local economy will outweigh the negative effects. Proposed mitigating measures to reduce adverse impacts are:

- adequate signage, lighting, and landscape design at highway exits particularly in Addington Forks Road Exit which will serve as the main entry point to the Town where commercial establishments are located; and
- construction of a highly visible Visitor Information Centre near the Trunk 7 interchange.

Suggestions had been made by several members of the business community for an additional interchange at the Church Street Extension to increase access to existing establishments at that location. NSTPW has reviewed this request and concluded that it is not feasible due to the relatively close proximity of the proposed interchange at Trunk 7 (approximately 1 km away) and space limitation due to the presence of the West River.

Demographic, Income and Employment Characteristics

The resulting level of improved access and decongestion on the existing highway is an impetus for development expansion. New areas for commercial and industrial developments will likely occur near interchange locations. As well, a large tract of land along Beech Hill Road, south of the highway, becomes accessible and may become suitable for commercial and industrial land uses. With these anticipated changes in land use, demographic characteristics may be altered as new employment opportunities become available locally. In effect, the out-migration and unemployment rate is expected to decline.

Fishery, Forestry and Agriculture

Since about 3 km of the highway will be along agricultural land and managed woodlots, construction and operation of the proposed highway will result in a permanent loss of agriculture and forestry income to Antigonish. The loss will, however, be insignificant when compared to the total agriculture and forestry resources of the County (29,485 ha for agriculture alone). Due to improved potential of the area to host various industrial activities as a result of the highway, resource-based industries will likely develop and would improve value-added opportunities for agriculture, forestry and fishery products. The highway will also improve the regional transportation system and, therefore, will enhance market access for local produce.

Tourism and Recreation

The upgraded highway will likely be beneficial to the newly built Millennium Centre, located in the corner of existing highway and Trunk 7, due to improved accessibility (J. Parker, pers. comm. 2002). The improved access will also benefit other recreation and tourism sites in the region due to general improvement in transportation network. No adverse effects to this sector are anticipated.

6.1.6 Follow-Up and Monitoring

Monitoring will be undertaken during the construction phase by the Project Engineers to ensure that access to businesses and other establishments are adequately maintained and signage is provided as necessary. Any unusual disruptions to local businesses will be reported to the Project Engineer by the CLC or directly by area residents.

Monitoring during Project operations of long term effects on local businesses and the economy as a result of the new highway will be conducted by the CLC. The committee will periodically report their findings to NSTPW and municipal officials who will jointly determine if any remedial action is warranted. Such remedial action may include adjustments to signage, the Visitor Information Centre, or other measures to encourage economic development in Antigonish.

6.1.7 Summary of Residual Environmental Effects Assessment

It is expected that several commercial establishments along the existing Highway 104 will be adversely affected by the traffic diversion, particularly hotels/motels, restaurants, gas stations and other businesses that rely on through traffic. These adverse effects can be reduced through the application of mitigative measures and are not likely to be significant. The existing highway is considered to be a constraint to current and future economic development due to restricted traffic flows. It is predicted that the new highway will permit new development, particularly near interchanges, that will stimulate local economic activity. It is predicted, therefore, that there will be a net long term benefit to the local economy from the construction and operation of the new highway at Antigonish.

Tables 6.13 and 6.14 summarise the residual environmental effects evaluation for the local economy during Project construction and operation and maintenance.

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Table 6.13 Residual Environmental Effects Assessment Matrix
Local Economy (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Land acquisition	•• Loss of resource land from production (A)	•• Open and early communication with landowners •• Adequate planning time •• Purchase of land parcels / land swap •• Fair and reasonable compensation	1	2	5 / 6	R	2	N	3
Construction of highway	•• Disrupted access to recreational lands and commercial areas (A)	•• Liaison/information through Community Liaison Committee and municipal officials to reduce disruption and promote economic planning •• Traffic Management •• Underpass/overpass design to maintain or improve access where practical	1	2	5 / 6	R	2	N	3
	•• Job creation and increased disposable income (P)	•• No proposed mitigation	2	6	3 / 6	R	2	P	3

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Table 6.13 Residual Environmental Effects Assessment Matrix
Local Economy (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low: *i.e.*., not significantly affecting local employment or income (*i.e.*, within normal variation); 2 = Medium: *i.e.*, moderately affecting local employment or income; 3 = High: *i.e.*, severe and lasting effects on employment or income

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 6.14 Residual Environmental Effects Assessment Matrix
Local Economy (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Diversion of traffic from existing highway	••Decrease in through traffic (increased safety and decreased traffic congestion) along existing Highway 104 (P)	••No proposed mitigation	3	4	5 / 6	R	2	P	3
	••Decrease in customer base at commercial operations along existing Highway 104 (A)	••Ongoing liaison and monitoring through the Community Liaison Committee ••Appropriate signage, lighting, landscape design at interchanges ••Explore construction of a visible Visitor Information Centre ••Strategic planning for the new economic growth	1	3	5 / 6	R	2	N	2
Presence of Highway	••Opening new areas for commercial, residential and industrial development due to increased access (P)	••No proposed mitigation	3	3	5 / 6	R	2	P	3
	••Improved regional transportation system and access to tourism and recreational facilities (P)	••No proposed mitigation	2	6	5 / 6	R	2	P	3

Refer to Table 6.13 for Key.

6.2 Land Use

Land Use is considered a VSC because the proposed highway will directly or indirectly affect the use of land in several ways along the length of the alignment. Any Project-related effect on land use has the potential to alter established patterns of activity within communities. The scope of the assessment of this VSC includes residential, commercial, industrial, resource (*i.e.,* agriculture and forestry) and recreational land uses. Changes in land use also have implications for the local economy which are described in Section 6.1. Noise and air emissions can also affect land uses; these are discussed in Section 5.1. Movement of traffic during construction and operation can also affect land uses; this is discussed in Section 6.4. Effects on Mi'kmaq land and resource use are discussed in Section 6.3 and Appendix K.

6.2.1 Boundaries

The spatial boundary of the assessment has been developed in consideration of the specific types of land use (*i.e.*, residential, commercial/industrial, resource lands) and potential effects (*e.g.*, loss of property, noise). The spatial assessment boundary is generally the study area defined on Figure 1.1.

The temporal boundaries for the assessment of land use include land acquisition during the pre-construction phase and throughout Project construction and operation. Other temporal considerations include the seasonal use of some lands (*e.g.*, residential use during the summer) when users may be subject to greater levels of disturbance. An important temporal consideration for this assessment is that Project construction will not likely commence within at least four years. Land use and other elements of the socioeconomic and biophysical environment may change over that time, and may require re-evaluation as the Project nears development.

6.2.2 Description of Existing Conditions

Existing and planned land uses were determined from 1:50,000 NTS mapping, aerial photographs, and consultation with local planners and development officers, local community members, and local interest groups.

The proposed new highway is situated in the Municipal County of Antigonish. The existing Highway 104 serves as the southern boundary of the Town of Antigonish. Most commercial establishments are situated on the north side of the highway along James Street and Church Street. Agricultural activity in the study area is limited, although fields, pastures, and hay farms do occur. The vast majority of property crossed by the RoW is wooded and has forestry resource use potential. The property configuration along the alignment in Zone 4 consists of primarily long, narrow strips of land, running east to west and southwest to northeast, with only a few residences occurring near the highway. The backwoods areas are largely either left intact or harvested as private woodlots. From 8+400 to the west-end of the alignment, property configuration is primarily running southeast to northwest. No well established recreational land uses within the new RoW

area were identified except for the fishing area in South River (Neill and Gunter Ltd. 2001). General land use description by zone is provided below.

Zone 1 From 0+000 to 1+900 or Addington Forks Road

Zone 1 is characteristically rural with an abandoned building on the northern side of the existing highway and storage facilities on both sides. The new RoW will be along the existing highway and veers off south of the Addington Forks exit by about 50 m. An interchange will be constructed at Addington Forks Road including an overpass through the existing Highway 104 connecting to Trunk 4. The RoW will be along four parcels of wooded land adjacent to the existing Highway 104. South of the new RoW are residential buildings located on both the east and west side of the Addington Forks Road.

Zone 2 From 1+900 to 3+800 or James Street

Zone 2 has several commercial establishments located on both the north and south sides of the existing Highway 104. The new RoW will pass through 14 parcels of land, most of which are wooded with a few devoted to pasturage or hay/forage production. Three residential buildings will be affected by the interchange located about 100 m south of the existing highway.

Zone 3 From 3+800 to 6+500 or Beech Hill Road

Zone 3 covers the commercial stretch on the northern section of the existing Highway 104 and St. FX University, mostly within the boundary of the Town of Antigonish. The new highway will cross 15 parcels of land about 80 % of which is woodland. A dairy farm (Riverdale Holstein Ltd.) is located south of the RoW (between 5+900 and 6+100).

There is a proposed interchange at Trunk 7, about 200 m south of the existing Highway 104. The interchange location will cross an abandoned school building and a small business establishment (Crown Tire Services). A service road will be constructed south of the RoW from Trunk 7 eastward to Cunningham Road (Church Street Extension). Cunningham Road connects to Church Street at the northern side of the existing Highway. The road is intended to provide access to farms and residences located south of Kell Road and Cunningham.

Zone 4 From 6+500 to 14+827 or East-end of RoW

The proposed RoW will cross 33 parcels of land. Over 80 % of the area is woodland and the rest is devoted to pasturage or hay/forage crop production. South Side Harbour Road (SSHR) will be relocated to form an exit on the new highway connecting to Route 316. Site inspection on the proposed SSHR relocation and the proposed interchange noted a pre-school about 50 m north of the existing Highway 104 on the east side of SSHR. About 75 m north of the pre-school are four buildings (houses and barns) with a driveway leading

to the buildings situated about 125 m north from the existing Highway 104. About 100 m farther north from these buildings are three occupied houses located 40 m east of SSHR. The proposed RoW will cross the farmland including a portion of the buildings. Current land use is pasturage or hay crop production. South River is immediately west of SSHR.

From 10+400 to 10+600, the new highway will cross a derelict building and will eliminate Dunn's Loop. The RoW will cross the existing Highway 104 as an overpass traversing from north of the existing highway to south and will remain south up to the western point of the highway upgrading.

6.2.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is any Project-related effect that degrades or displaces established or planned land uses, including one that results in an uncompensated permanent loss of renewable rural resources that are used for income generating purposes and/or traditional harvesting activities. Impacts must affect a major portion of land used by a local population and be of long duration or be of such magnitude in the short term that they result in permanent adverse change to land use in the study area.

A **positive** effect is defined as one that enhances the use of lands in the study area including one that enhances the use of rural resources and/or their consequent value.

6.2.4 Potential Issues, Interactions and Concerns

Potential issues of concern related to land use are focussed mainly on the requirement for acquisition of properties within the RoW, and on the effects of highway operation on the remaining adjacent properties. Landowners in either of these situations will be permanently affected by the Project, either through the loss of their properties, or through the continued effects of highway operation. Nearby landowners may be affected by access limitations, air emissions and noise. At least four homes, a commercial establishment (Crown Tire Services) and approximately 60 properties will be directly impacted by the proposed Project.

The diversion of inappropriate through traffic (*i.e.*, trucks) to the new highway from the current route or the existing Highway 104 will likely create positive effects for residential and commercial land use by increasing safety and ease of transit for local residents and business customers. Future land use is potentially affected by the Project as the roadway will preclude any other use of land within the RoW. However the upgraded highway is also likely to promote development in Antigonish and alter land use in the long term (refer to Section 6.1). Without the proposed upgrading, room for expansion is constrained along the existing highway except around Addington Forks Road and Post Road areas. The new highway will provide a good opportunity for development south of Beech Hill Road. It is anticipated that land use in eastern and western sides of the road will change to residential and industrial land uses due to improved access.

The public consultation process undertaken during the highway route selection process has stimulated interest among community groups, business owners, political leaders and individuals to participate in the discussions on local issues and development concerns in Antigonish. In general, those with business interests in the town supported the'red' route (Figure 2.2) (NSTPW 2001a) as opposed to the chosen 'blue' route (subject of this assessment), which also has gained strong support from other sectors of the community. Community discussions have now shifted from the route selection debate to various measures to mitigate the potentially adverse aspects of the highway development.

6.2.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.2.5.1 Construction

One of the greatest concerns with respect to Project construction effects on residential land use is the acquisition of property within the RoW. Based on property configurations, NSTPW has minimized the number of homes directly affected by the proposed highway by establishing the RoW primarily in the woodland properties. Preliminary RoW mapping (Figure 6.1) indicates that approximately 60 properties, including four homes (directly affected), will be intersected by a portion of the RoW. Acquisition of all or a portion of these properties will be required. The actual number of residential properties and area to be incorporated by the RoW will be determined by NSTPW surveys and assessments during final design of the highway. Lands required for the RoW will be obtained through negotiations with landowners. To the extent that NSTPW maintains open and early communication with affected landowners (through the Community Liaison Committee), and fair and reasonable compensation is paid for property acquisition, with adequate time to allow for relocation, no significant adverse effects are predicted with respect to land acquisition.

The uncertain scheduling of the Project, combined with construction impacts on land use (*i.e.*, noise, air, dust emissions) may make it difficult for residential landowners to sell their properties currently on the market. These effects are expected to be temporary and limited to specific areas directly adjacent to the RoW. With respect to property acquisition by NSTPW, landowners are entitled to a fair market value price for their property.

Following property acquisition for the RoW, the main effects on residential land use during Project construction include air, dust and noise emissions from construction equipment. The significance of these impacts will vary according to the precise location of the property with respect to the alignment, the terrain, and vegetation in the immediate area (*i.e.*, hills and trees may serve to mitigate noise, dust and visual impacts), and according to the subjective attitudes of the residents (*i.e.*, some residents are more sensitive to construction disturbance than others).

Effects from Project construction are most likely to affect residential properties along Addington Forks Road and Trunk 7 including the farm houses near South Side Harbour Road and Taylor Road. In order to minimize the effects of construction activities on residences, noise and dust control measures will be adhered to during construction, and an efficient scheduling will lead to the timely completion of the Project (Refer to Section 5.1 for air and noise mitigation). Appropriate traffic management and realignment of access roads where necessary, will be critical for maintaining access for residential, commercial, industrial and resource purposes (Refer to Section 6.4 for traffic mitigation).

A realignment of South Side Harbour Road will likely result in temporary access restrictions. Similarly, access to Trunk 7, Kell and Cunningham Road (Church Street Extension) will result in access limitations during construction. With the implementation of proper mitigation (*e.g.*, alternative access, signage, traffic controls), however, these limitations are not likely to be significant.

NSTPW or its contractors will provide information throughout the construction phase of the Project to all potentially affected landowners and interested stakeholders to keep them informed of construction activities and progress through the CLC. Construction will be scheduled to minimize the amount of time that individual property owners will be subject to construction activity. The proposed alignment minimizes the number of residences disrupted by the Project, as most of the RoW is located on long properties. Since the vast majority of commercial operations in the area are along the existing Highway 104, no significant adverse effects are predicted for commercial/industrial land use during construction.

Woodland property owned or leased within the RoW (about 15 ha) and a few parcels of agricultural land for pasturage and hay crop production (about 35 ha) will be removed permanently as a resource use or agricultural use. Some of the woodlands may be actively or informally managed for forestry resource. Mitigation for loss of wooded or agricultural land may include outright purchase of land parcels or a land swap with the Province for alternate parcels of property of equivalent value which may be used for forestry activities. Every effort will be made to have open and early communication with landowners, and to provide fair and reasonable compensation for woodland and agricultural areas within the RoW. No direct effects on industrial or institutional landowners are expected.

Agriculture and forestry lands not contained within the RoW will also be affected as access to existing roads may be altered during Project construction. To the extent practical, existing access roads will be maintained during the construction period. If an existing access road can no longer be used, NSTPW will negotiate with the landowner to realign an access road, construct a replacement access, or purchase affected properties.

In summary, concerns during construction include land acquisition, dust and noise emissions, temporary access restrictions and loss of resource lands. No significant adverse effects are anticipated provided that appropriate mitigation measures such as early and open communications with landowners, reasonable

compensation, effective scheduling, dust and noise controls and the provision of timely information by the CLC, are implemented.

6.2.5.2 Operation and Maintenance

Some properties near the RoW will not be acquired by NSTPW but will remain in close proximity to the proposed highway during the operation phase. Landowner concerns include: the effect of the Project on property value; access limitations; safety; aesthetic effects; traffic noise; and land and property fragmentation.

The analysis of the potential effect of development of a controlled access highway on the value of adjacent residential properties may only be determined through an exhaustive market analysis. Experiences in both Nova Scotia and New Brunswick have indicated that in general, there is no loss in property value due to proximity to a highway or major road. Site specific analysis would be required to determine the correlation of highway development and property values for a given area. It is considered that other factors more strongly influence property values include: supply and demand; local economic conditions; housing values in other immediate and distant neighbourhoods; presence of schools and other neighbourhood characteristics; and the condition of the house and property.

A controlled-access design is anticipated to reduce the likelihood of vehicle/vehicle and vehicle/pedestrian accidents, as there will be less traffic along the existing Highway 104 than at present. The decreased traffic will contribute to a quieter, safer living environment for residents along this roadway (Refer to Section 6.4). It is anticipated that this improvement of living conditions will entice people to settle along the existing Highway 104, perhaps even attracting settlement from other areas of the Province, Canada and abroad. Noise will have an effect on residential land use near the new RoW. Discussions on noise impacts are presented in Section 5.1.

The Project will have a positive effect on commercial land use along the existing highway by decreasing the frequency of inappropriate traffic, thereby increasing the perceived level of driving and walking safety on this uncontrolled access road. The proposed limited access design, however, may create challenges for developers in determining access points for their concept plans. To mitigate the effect, NSTPW has incorporated new service roads, overpasses, underpasses and interchanges in the highway design. Various underpasses and overpasses are proposed, and full interchanges are planned for Taylor Road, South Side Harbour Road/extension of Route 316 in Lower South River, Dunn's Loop, Beech Hill Road, Trunk 7, and Addington Forks Road or Trunk 4 which will allow access to the new highway. The interchange in Church

Street Extension suggested by some members of the business community is not feasible due to its proximity to the required interchange at Trunk 7, space limitations due to the West River and potential residential impacts along Church Street Extension.

Potential effects on agricultural or resource lands include fragmentation and permanent loss of land (refer to Section 6.2.5.1). Potential for micro-climate modifications along the RoW, in particular, changes to cold air drainage patterns, can affect agricultural crops. Project related effects of cld air drainage patterns are likely to be minor since the relief in agricultural areas is small. Furthermore, agricultural land along the RoW is mostly devoted to hay crop production or pasturage therefore any impacts to agriculture are minor. Acquisition of forested land within the RoW will preclude future forestry resource use, resulting in current and future financial losses if uncompensated. The roadway may also limit access to current woods roads, thereby affecting harvesting of forestry resources on these lands. However, the improved roads will likely have positive effects on forestry operations in the area, reducing travel time.

The new highway will have positive effects on land use in Post Road area as it becomes highly accessible considering the interchanges in Addington Forks Road and Trunk 7. The new highway is also seen as an impetus for residential and industrial development south of the highway near Beech Hill Road including lands near the South Side Harbour Road due to the highway exits located in these locations.

Overall, the Project impact on land use during highway operation will be positive due to improved access and diversion of inappropriate traffic to the new highway. It is expected that land use patterns in Antigonish will change over the long term due as the presence of the highway will result in more efficient use of land.

6.2.6 Follow-Up and Monitoring

NSTPW, through the CLC, will remain in close consultation with property owners along the RoW to discuss scheduling, temporary and permanent alternate access roads, and to monitor other Project elements of concern to local residents and landowners. Consultation will also be conducted with owners of forested lands, as applicable, to determine impacts on logging operations and the suitability of access to existing woodlot areas.

6.2.7 Summary of Residual Environmental Effects Assessment

It is anticipated that most direct and indirect effects from Project construction can be effectively mitigated through early notification to potentially affected residents residing in proximity to the RoW, through fair compensation to landowners displaced by the RoW, and standard mitigation measures to reduce effects from noise, dust and traffic disruption. Ongoing effects on land use include noise and proximity of the new highway. Provided that mitigative measures are adhered to, no significant adverse residual environmental effects are predicted. Project operation is expected to produce benefits for land uses by diverting inappropriate traffic away from the residential areas along the existing highway and to open up new lands for development. Tables 6.15 and 6.16 summarise the residual environmental effects evaluation for land use during Project construction and operation and maintenance.

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Table 6.15 Residual Environmental Effects Assessment Matrix
Land Use (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Land acquisition	•• Loss of residential and resource land (A)	•• Open and early communication with landowners through a CLC and other mechanisms •• Adequate relocation time •• Purchase of land parcels / land swap •• Fair and reasonable compensation •• Maintain access to properties	1	2	5 / 6	R	2	N	3
Construction of highway	•• Air, dust and noise emissions (A)	•• Noise and dust controls (Refer to Section 5.1) •• Restricted working hours	2	2	3 / 1	R	2	N	3

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Table 6.15 Residual Environmental Effects Assessment Matrix
Land Use (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Construction of highway	•• Disrupted access to residential properties, and commercial, industrial, and resource operations (A)	•• Traffic management •• Maintain, to extent possible, existing access roads •• Underpass / overpass design to maintain access •• Negotiate with landowners to realign/construct replacement access roads during construction	1	2	3 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*., not significantly affecting use or enjoyment of property; 2 = Medium: *i.e.*, moderately affecting use or enjoyment of land within a significant portion of the community; 3 = High: *i.e.*, severe and lasting effects on use and enjoyment of land for a significant portion of the community

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 6.16 Residual Environmental Effects Assessment Matrix
Land Use (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Diversion of traffic from existing highway	••Decreased through traffic (increased safety and convenience) along existing Highway 104 (P)	••No proposed mitigation	3	4	5 / 6	R	2	P	3
Traffic	••Increased noise levels at residences (A)	••Refer to Section 5.1 for noise mitigation measures	1	2	5 / 6	R	2	N	2
Presence of Highway	••Potentially restricting access to land uses (A)	••Maintain, to extent possible, existing access roads ••Realign or construct replacement access roads	1	2	5 / 6	R	2	N	3
	••Permits new development of lands through improved access (P)	••No proposed mitigation	3	3	5 / 6	R	2	P	2

Refer to Table 6.15 for Key.

6.3 Archaeological and Heritage Resources

Archaeological and heritage resources are included as a VSC in this assessment in recognition of the interest of Aboriginal people, the general public as a whole, and provincial and federal regulatory agencies in ensuring the effective management of these resources. For the purposes of this assessment, archaeological and heritage resources are defined as physical remains that inform us of the human use of and interaction with the physical environment. These resources may be above and/or below the surface of the ground and cover the earliest prehistoric times to the relatively recent past.

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

6.3.1 Boundaries

Spatial boundaries for the assessment of archaeological and heritage resources include the study area as indicated in Figure 6.1. The assessment of potential Project effects on archaeological and heritage resources is focussed principally on those Project activities that cause ground disturbance.

Temporal boundaries for archaeological and heritage resources consider that these resources are relatively permanent features of the environment. Construction activities carried out at any time of year can therefore affect the integrity of any archaeological or heritage site encountered. Temporal boundaries also consider that archaeological and heritage sites may be affected in the long term by an increase in accessibility.

6.3.2 Description of Existing Conditions

Methodology

The assessment of heritage resource potential within the study area incorporated a number of sources: archaeological site records at the Nova Scotia Museum; historic literature and archival resources; interviews with people knowledgeable of the area; and a visual reconnaissance of the proposed RoW. An additional source of information is the South River Impact Study conducted in October 2000 and the Mi'kmaw Knowledge Study conducted in November 2004. A summary of findings from the impact study (Neill and Gunter Ltd. 2001) is included in this section and a copy of the report is appended in Appendix E. The Mi'kmaw Knowledge Study is included as Appendix K to this report.

Background Research

The study area is located south of the shores of Antigonish Harbour, where a number of pre-Contact archaeological sites have been recorded by the Nova Scotia Museum. The RoW also crosses two major river systems, the West River and the South River. No archaeological sites, prehistoric or historic, have been recorded within the RoW. It is evident that the majority of aboriginal settlement occurred along the shores of Antigonish Harbour where needed resources were much more abundant. The only areas deemed to have high potential for containing pre-Contact archaeological resources were where the RoW crosses the West and the South Rivers. The remainder of the RoW is considered to have low potential as there were no resources available in the past that would have attracted settlement.

Acadian settlement occurred in Antigonish County as early as 1755, in an area east of Antigonish at Pomquet. Black Loyalist settlement of the area was also east of Antigonish, at Tracadie, in 1787. The first historical settlement of the town of Antigonish followed the end of the American Revolution, in 1784. Colonel Timothy Hierlihy led the settlement of 88 people on 21,600 acres of land that became known as the Soldier's Grant. This area lay mainly around the modern town of Antigonish, and north of it, up the harbour around modern day Town Point.

While many of the co-grantees sold off their allotments and left the area after a few years, some remained and became the seed of Antigonish's population. There appear to be only two areas where these early settlers may have impacted the study area. The first is down Kell Road, known locally as the Church Street Extension. The original Kell Road extends south of the study area, which it crosses just beyond the town. Today, it does not follow the full length it did in the nineteenth century, crossing the West River approximately 1 km south of the study area.

Research at Nova Scotia Archives and Records Management and the Antigonish County Museum provided information regarding historical land use in the area. Two maps, in particular Fletcher and Fairbault (1893) and A.F. Church (c. 1869 -1873), indicated that many structures dating to at least the nineteenth century were present near or within the proposed study area. Jocelyn Gillis, of the Antigonish County Museum, was able to identify individuals who could potentially supplement the historical record with local traditional knowledge. Despite consultation with these individuals, no new concerns were brought to light regarding non-Indigenous historical resources within the study area.

While background research indicated a number of potential heritage resources within the RoW, the Nova Scotia Museum had no records of archaeological sites within the study area. Prior to the field survey, a total of nine potential heritage resources were identified through background research.

Mr. Fraser Dunn, a resident of Antigonish, identified an area of concern within the study area alleged to have supported a large Mi'kmaq encampment from approximately 1890-1940. Paq'tnkek Chief Michael

Julien did not deny the possibility of such an encampment, but did not indicate any memory of such. Subsequent research has indicated that the encampment was actually a small hill used seasonally for perhaps as much as fifty years by a couple of families. There were no Mi'kmaq people recorded for Antigonish in the 1891 census. One of the people reported to have lived in Mr. Dunn's 'encampment' was Chief John Prosper, purportedly born there in 1879. John Prosper lived, between 1940 and 1945, in a house (PID # 01263888) located on the South Side Harbour Road, near South River Station (Antigonish County Book 5, Dist. 5, Site # 191-290). The write-up for this house on the Inventory Site Form states: "John Prosper, chief of the Mic Mac [sic] Indians, was conveyed the property in 1940…". It also indicates that John Prosper was a labourer. It seems that Mi'kmaq families lived throughout the area of Antigonish until the mid-twentieth century. There is however no memory within the elder community of Antigonish, of any large encampment in the first half of the century. The Mi'kmaw Knowledge Study (Mi'kmaq Environmental Services 2004) did not identify the presence of such an encampment.

The Mi'kmaw Knowledge Study does however indicate current Mi'kmaq land and resource use (e.g., hunting, harvesting) within the study area, most notably around Antigonish Harbour and the South and West Rivers. In particular, there are six areas containing plants of significance to Mi'kmaq for medicinal (73 species), food/beverage (19 species), and craft/art (21 species). These areas are in the vicinity of Sta. 2+000, Sta. 5+500, Sta. 6+500, Sta. 8+500, Sta. 11+500, and Sta. 13+900 (refer to Figure 3 in Appendix K).

Mr. Dunn was also consulted during the South River Impact Study. He was able to provide photos of structures which led to the identification of a feature which was found during the survey: rip rap footing from a bridge located in the area in 1853. He noted other features in the area that have since been destroyed or moved or have turned out to be outside of the Project footprint.

Field Survey

A pedestrian survey was conducted by two licensed archaeologists over the entire length of the RoW. Special attention was paid to areas that had once been cleared and/or cultivated as well as areas of higher elevation. When evidence of historic occupation was encountered, the area was surveyed thoroughly to determine the extent and nature of the occupation. Areas where the RoW crossed major watercourses were considered to have high potential for containing prehistoric archaeological resources and were therefore subject to more intensive surveying and/or testing.

In general, apart from the West and South Rivers, the proposed RoW is considered to have low potential for prehistoric archaeological resources. The stream crossings at the West and the South Rivers were surveyed thoroughly. Both rivers were found at the time (August) to be wide but very shallow and rocky, making them quite unsuitable for navigation even by the most rudimentary of vessels. This is likely the case throughout the year, with the exception, perhaps, of a major spring flood. Both rivers have broad flood plains and there are high terraces on the west side of the West River and on the east side of the South River.

The terrace on the West River (5+600) had been altered significantly during the construction of the modern home now occupying the lot. Although outside of the study corridor, a large knoll north of the RoW was determined to have sufficient potential to warrant subsurface testing with shovels. Three 40 x 40 cm shovel tests were dug but it was determined that most of the terrace had been disturbed to a significant depth.

The west side of the South River has a steep slope running down to the water. A ploughed field on the west edge of this slope was thoroughly examined for evidence of prehistoric occupation but nothing was found. Although the slope on the east side of the river has been destroyed by the construction of the South Side Harbour Road, a large hill to the east was considered to have sufficiently high potential to warrant shovel testing. A series of nine shovel tests was dug between 11+700 and 11+850. All of the tests were negative.

The nine areas where historic period features were identified during background study (Figure 6.1) were examined closely during the pedestrian survey. It was determined that two of the structures (#3 and 6) were still standing and occupied; however, they would not be impacted by construction of the highway. The third (#4), a typical mid-nineteenth century hall and parlour house, which is not normally considered significant, was still standing but had evidently been abandoned for some time. This structure, the A. Fraser house, would likely be impacted by highway construction. No evidence of the remaining six features was found during the field portion of the survey. This may be due to the fact that the structures had been removed or completely destroyed, or that the accuracy of the maps used was not reliable.

The area of the encampment mentioned by Mr. Dunn could only be examined in a cursory manner as access to the land was restricted. It was noted however, that the site had very little to offer in the way of resources and it seems much more likely that a traditional settlement would have been located close to a significant water source at the very least.

The only evidence of historic settlement found during the pedestrian survey was a large (6 x 5 m) rock mound and a north-south running rock wall. The rock mound, located at 3+900, is interpreted as being a field clearing feature. These features are created by the random throwing of stones uncovered during ploughing, into a pile at the edge of the field. These piles often become garbage middens and this mound was littered with artifacts dating from the first half of the twentieth century. The area surrounding the feature was examined thoroughly but no other evidence of occupation was found. A north-south running rock wall was located at 4+100. This low wall may have been related to a cleared field to the south, but a survey of the area failed to find any other evidence of occupation.

Finally, a small cemetery was observed north of the RoW between 10+900 and 11+000. This turned out to be the Lower South River Cemetery, which was well marked and determined to be well outside of the study area.

During the field investigation conducted October 20 and 21, 2000 for the proposed South River crossing, a rip rap bridge footing believed to date from 1853 was discovered. The feature was, for the most part, destroyed by previous construction and/or tidal action. Considering the (recent) age of the feature and its physical state, it was determined to be of low archaeological significance.

6.3.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is defined as any Project-related disturbance to, or destruction of, archaeological or heritage resources considered by affected First Nations, communities, or provincial heritage regulators to be of major importance due to factors such as rarity, condition, spiritual importance, or research importance, and that cannot be mitigated.

A **positive** environmental effect is one that results in enhanced understanding of local, regional, or cultural heritage through increased knowledge, or provides physical protection for a site that might otherwise have been destroyed through natural or non-Project anthropogenic events, in the absence of the Project.

6.3.4 Potential Issues, Interactions and Concerns

Certain activities associated with Project construction (*i.e.,* grubbing, grading) will cause surficial or subsurface disturbance which could affect archaeological and heritage resource sites. These disturbances, if unmitigated, could result in the loss of the resource and the potential knowledge to be gained from its interpretation. As noted in Section 6.3.2, the proposed RoW has little potential for prehistoric archaeological resources. The four historic resources identified in the two surveys are not considered to be significant.

No other physical evidence of historic resources were uncovered during the October 2000 Neil and Gunter field survey at the proposed South River crossing; however, background information placed a carriage house within the study area, possibly near or under existing buildings or structures, including the existing highway. Although the area has been subjected to significant construction activity, no evidence of the structure has been previously recorded. The report noted that there may be heretofore undiscovered evidence of the structure that has potential to be affected by construction.

The operation phase will not have an adverse effect on significant archaeological resources. If areas beyond the final RoW are not disturbed during maintenance, no other adverse affects on archaeological or heritage resources are anticipated.

In addition to disturbance of archaeological resources, potential impacts to Mi'kmaq land and resource use include temporary and/or permanent loss of access to hunting/kill sites and areas containing plants of significance, as well as loss of individual plants.

6.3.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.3.5.1 Construction

Project construction will cause surficial or subsurface disturbance which could affect archaeological and heritage resources. Three potential heritage resources were identified within the study area during the course of this assessment. The resources, their significance, and predicted degree of impact are shown in Table 6.17.

Table 6.17 Identified Heritage Resources within the RoW for Proposed Highway 104, Antigonish

Resource	Heritage Significance	Approximate Distance to Centreline	Potential Impact	Recommended Mitigation
Field Clearing Pile	Low	10 m	Likely	None.
Stone wall	Low	15 m	Likely	None.
A. Fraser House	Moderate	30 m	Likely	Mitigation plan to be developed as directed by Nova Scotia Museum which may include recommendation to record the house with photographs.
1853 Bridge Footing	Low	Not Noted	Possible	None

The most significant heritage resource associated with the RoW (10+540) is the dilapidated house, identified as A. Fraser on the A.F. Church map, bordering the RoW. This house dates from the middle of the nineteenth century and is considered to have moderate significance. A mitigation plan will be developed, if necessary, at the direction of the Nova Scotia Museum (NSM). While no recommendations related to the house have been proposed to date by the NSM, such a plan may include recording the house with photographs.

A potential resource identified through background research completed for the South River study was a nineteenth century carriage house. Although no evidence of the carriage house was discovered during field investigations, a recommendation was made to have a trained archaeologist monitor the area during construction of the proposed crossing (Neill and Gunter Ltd. 2001).

Three resources, namely the field clearing, the stone wall and the bridge footing are rated as low in heritage significance, thus no mitigation is required for their anticipated removal during highway construction. Contingency planning will be included in the Project EPP to ensure that appropriate steps are taken to protect and report any new discoveries near these features or elsewhere in the RoW.

In the unlikely event that Mi'kmaw archaeological deposits are encountered during construction, work will be halted and immediate contact will be made with the Nova Scotia Museum and the Confederacy of Mainland Mi'kmaq.

As reported in Section 7.2 of the Mi'kmaw Knowledge Study, the hunting/kill sites that may be affected by the RoW also exist throughout the wider surrounding area; therefore the impact of temporary and/or permanent loss of access to identified hunting/kill sites within the proposed RoW is evaluated as not likely significant. Likewise, the loss of some specimens of plant species of significance to Mi'kmaq is evaluated as not likely significant.

No significant adverse residual environmental effects on archaeological and heritage resources during construction are likely. With the amount of potentially valuable information which has already been and that which may be gathered during construction on archaeological and heritage resources in the general area, the residual effect of the Project could be considered positive.

6.3.5.2 Operation and Maintenance

The primary source of potential adverse effects on archaeological and heritage resources during highway operation is anticipated to be vandalism or inadvertent surficial disturbance at sites due to maintenance procedures. However, access is already available to the one known significant heritage resource (A. Fraser house) within the study area, which is likely to be recorded and removed during the construction phase. Contingency planning will address any new discoveries and provisions will be made for periodic monitoring and evaluation, and worker education as required. There are not likely to be any significant adverse residual environmental effects on archaeological and heritage resources as a result of Project operation.

6.3.6 Follow-Up and Monitoring

Follow-up work for the Project will be undertaken at the direction of the Nova Scotia Museum.

6.3.7 Summary of Residual Environmental Effects Assessment

The development of the Project will involve ground disturbance, which could affect any archaeological or heritage sites that may exist within the zone of surficial and subsurface disturbance. The Project could also result in temporary and permanent loss of access to hunting/kill sites and plants of significance to Mi'kmaq.

Assuming that the required mitigative measures are implemented, there are not likely to be any significant adverse residual environmental effects on archaeological and heritage sites and Mi'kmaq land and resource use. With new information being gathered and made available to researchers, communities, regulators, and other stakeholders, the potential overall effect could be viewed as positive. Tables 6.18 and 6.19 summarise the residual environmental effects evaluation for archaeological and heritage resources.

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Table 6.18 Residual Environmental Effects Assessment Matrix
Archaeological and Heritage Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, excavation, blasting, watercourse crossings	••Disturbance of any archaeological, heritage or traditional land use resource (A)	••Mitigation at the A. Fraser house as directed by the Nova Scotia Museum; may include recording the house with photographs ••Monitoring of the area of the nineteenth century carriage house during construction of the proposed South River crossing	1	4	2 / 1	I	2	N	3
	••Improved understanding of cultural history (P)	••No mitigation recommended	1	4	5 / 6	N/A	2	P	3

KEY

Magnitude: 1 =Low: *i.e.*, all or part of a site of minor importance, common resource with virtual duplicates; 2 = Medium: *i.e.,* all or part of a site not fully assessed, part of a rapidly depleting group of sites; 3 =High: *i.e.,* all or part of a site considered to be of major importance due to individual attributes or rarity.
Geographic Extent: 1= <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 =101-1000 km²; 6 = >1000 km².
Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months.
Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200 events/year; 6 = continuous.
Reversibility: R = Reversible; I = Irreversible.
Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.
Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect.
Confidence: 1 = Low; 2 = Medium; 3 = High.

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Table 6.19 Residual Environmental Effects Assessment Matrix
Archaeological and Heritage Resources (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Road Traffic, Surveillance, Maintenance	••Access to adjacent archaeological and heritage resources and vandalism (A) ••Inadvertent disturbance of site surfaces (A)	••No mitigation recommended	1	4	5 / 6	I	2	N	3

Refer to Table 6.18 for Key.

6.4 Transportation Infrastructure

Transportation Infrastructure includes the existing and proposed roads and highways in the study area. Transportation Infrastructure is a VEC because the safe, convenient, economic and efficient movement of persons and goods is essential to travel in and through the study area.

6.4.1 Boundaries

The spatial boundaries (Figure 6.1) for the study include part of Antigonish County, Nova Scotia, near the Town of Antigonish and include the following:

- West - just west of the existing Highway 104 / Trunk 4 / Addington Forks Road intersection;
- North - areas adjacent to the existing Highway 104 from west of the Trunk 4 / Addington Forks Road intersection to east of the Taylor Road intersection;
- East - the areas adjacent to the Taylor Road intersection, east of Lower South River; and
- South - areas adjacent to the proposed Highway 104 from west of the Trunk 4 / Addington Forks Road intersection to east of the Taylor Road intersection.

The temporal boundaries during which the Project will affect transportation include both construction and operation phases. Although construction scheduling is uncertain at this time, it is expected to be spread over a two to four year period. The operation phase for the new Highway 104 will be ongoing.

6.4.2 Description of Existing Conditions

Volumes

During the summer of 2002, machine traffic counts were obtained at various locations throughout the study area to provide count data needed to estimate 2002 AADT volumes. Estimated 2002 AADT volumes, calculated from these counts and supplemented with data recorded in the Highway 104 Antigonish Safety Review (Beasy Nicoll Engineering Ltd. 1999) as well as available 1999 to 2001 machine counts supplied by NSTPW, are included in Table 6.20.

Volumes on Highway 104 are high for a predominantly two lane highway without access control. The 2002 AADT volumes vary from 8,400 vehicles per day (vpd) west of the study area, to 10,000 to 15,000 vpd throughout various sections of the study area. NSTPW historical count data indicated that growth rates are about 3 % per year west of the study area, about 2.5% per year west of James Street, and 2% per year for segments east of James Street. AADT volumes for 2002 have been factored, using the 2% to 3 % simple annual percentage growth rates, to project estimates of 2022 AADT volumes, which are also included in Table 6.20.

Table 6.20 AADT Volumes for Existing and Proposed Highway 104 Segments

Route Segment	AADT Volumes on Existing Segments (Without New Highway 104)		AADT Volumes on Existing and Proposed Segments (With New Highway 104)	
	2002 [1]	2022 [2]	2002 [3]	2022 [2]
Existing Highway 104 Segments				
West of Addington Forks Rd.	8,400	13,400	8,400	13,400
Addington Forks to SuperValu	10,600	15,900	4,800	7,200
SuperValu to James Street [4]	12,400	18,600	6,000	9,000
James St. to Trunk 7	10,200	14,300	4,300	6,000
Trunk 7 to Church St.	12,300	17,200	3,600	5,000
Church St. to Beech Hill Rd.	14,200	19,900	5,500	7,700
Beech Hill Rd. to Trunk 4 (East)	13,700	19,200	1,400	2,000
Trunk 4 (East) to Central Supply Area	15,800	22,100	3,500	4,900
Central Supply Area to Route 316	14,400	20,200	2,600	3,600
Route 316 to Industrial and Mobile Home Parks	13,000	18,200	3,900	5,500
Industrial and Mobile Home Parks to Taylor Rd.	11,000	15,400	1,200	1,700
East of Taylor Rd.	10,100	14,100	-	-
Proposed New Highway 104 Segments				
Addington Forks Rd. to Trunk 7	-	-	6,400	10,200
Trunk 7 to Beech Hill Rd.	-	-	8,700	12,200
Beech Hill Rd. to Route 316	-	-	12,700	17,800
Route 316 to East of Taylor Rd.	-	-	10,100	14,100

NOTES:
1. The 2002 AADT volumes were obtained or factored from volume data recorded in the *Highway 104 Antigonish Safety Review* (Beasy Nicoll Engineering Ltd. 1999) and updated using available 1999 to 2002 machine counts supplied by NSTPW.
2. The 2022 AADT volumes were projected from 2002 volumes using 3 % simple annual growth rate for sections west of Addington Forks Rd., 2.5% for Addington Forks Rd. to James Street and 2% simple annual growth rate for sections east of James Street.
3. Volumes for existing and proposed Highway 104 segments have be estimated by updating the volume information from *Highway 104 Antigonish Safety Review* (Beasy Nicoll Engineering Ltd. 1999).
4. The Antigonish Education Centre access road, opening in Spring 2003, will remove about 2000 AADT from the SuperValu to James Street segment. This has reduced the volume from 14400 to 12400 AADT. (Source: Atlantic Road and Traffic Management 2002).

Daily volumes fluctuate from one time of year to another, with volumes typically higher in the summer and lower in the winter. NSTPW maintains a permanent count (NSTPW 2001c) and vehicle classification station at Marshy Hope, approximately 15 km west of the study area. Volume data from the permanent counter were used to calculate the seasonal volume variations for the study area for the three times of year indicated in Table 6.21.

Table 6.21 Seasonal Variation in Average Daily Volumes	
Season	**Average Daily Volume as a Percent of AADT**
Winter (December, January, February, March)	76 %
Spring / Fall (April, May, October, November)	100 %
Summer (June, July, August, September)	137 %
Source: NSTPW 2001c	

The traffic stream on Highway 104 is composed of a mix of passenger cars, vans, light trucks, heavy single unit trucks and tractor trailer units. The vehicle classification mix for Highway 104 is shown in Table 6.22.

Table 6.22 Vehicle Classification for Study Area of Highway 104		
Vehicle Type	**Description**	**Percent**
Passenger	Cars and vans	83
Trucks	Single Unit, 2 axle	6
	Single Unit, 3 axle	2
	Semi Trailer, 5 and 6 axles	9
Source: NSTPW 2001c		

Road Types and Widths

Road types and widths are shown in Table 6.23. Highway 104 generally has a good paved surface, including climbing lanes and auxiliary turning lanes at appropriate locations. Generally, the highway provides two through lanes throughout the study area, with the exception of a 2 km segment of narrow, curbed median, four lane roadway from just west of James Street to just east of Church Street. The alignment throughout is suitable for the posted speed limits.

Table 6.23 includes existing cross section characteristics of roads that will be affected by Project construction. Access management and interchange construction will cause major changes to most of the roads crossed by the proposed alignment.

Table 6.23 Existing Road Types and Widths in Study Area				
Location	**Surface Type**	**Travel Width (m)**	**Shoulder Width (m)**	**Construction Impact**
Addington Forks Rd.	Paved	6.5	2.0 both sides; gravel	Interchange Location
Trunk 7	Paved	6.2	1.6 west - paved with curb 2.2 east - gravel	Interchange Location
Kell Rd.	Dirt	6.4	n/a	Cut-off; access via service road to Trunk 7
Cunningham Rd. (off Church Street Ext.)	Dirt	6.3	n/a	Cut-off; access via service road to Trunk 7
Beech Hill Rd.	Gravel	5.1	n/a	Interchange Location
South Side Harbour Rd.	Paved	7	0.0 west 1.1 east - gravel	Cut-off and diverted to Route 316 Interchange
Taylor Rd.	Paved	6	1.1 both sides - gravel	Diverted to overpass New Highway 104
Source: Field observations and measurements for road characteristics, and NSTPW alignment plans for construction impacts				

Speed Limits

There are nine speed zones involving four speed limits on existing Highway 104 in the study area (Table 6.24). The combined effect of the multiple speed zones is an average speed of approximately 80 km/hr throughout the study area. Actual travel speed is also affected by traffic conditions and traffic signal timing at the signalized SuperValu, Trunk 7 and Church Street intersections.

Table 6.24 Number and Lengths of Speed Zones in Study Area

Posted Speed Limit (km/hr)	Number of Speed Zones	Total Length Each Posted Limit (km)
60	1	0.75
70	1	3.95
80	4	3.45
90	3	4.75
Totals	9	12.9 [1]

Note: 1. The total length is longer than the distance between Addington Forks Rd. and Taylor Rd. since the reduced speed zones extend east and west of the actual study area.

Source: Field measurements using a vehicle odometer.

Collision Rates

During the ten year period from 1992 to 2001, the 12.1 km section of Highway 104 between Addington Forks Road and Taylor Road experienced 304 property damage only (PDO), 128 injury and one fatal collisions. The break down of annual collisions by severity for four sections of the study area is shown in Table 6.25. Collision rates expressed as number of collisions per hundred million vehicle kilometres (HMVK) are also included in the table.

Table 6.25 Number of Collisions and Collision Rates-1992 to 2001

			Number of Collisions				Collision Rates			
Year	AADT	HMVK	PDO	Injury	Fatal	Total	PDO	Injury	Fatal	Total
Highway 104 Section 275 (Addington Forks Rd. to James Street; 2.19 km)										
1992	7,510	0.0602	9.0	2.0	0.0	11.0	149.5	33.2	0.0	182.7
1993	7,740	0.0619	7.0	5.0	0.0	12.0	113.1	80.8	0.0	194.0
1994	7,970	0.0637	12.0	1.0	0.0	13.0	188.4	15.7	0.0	204.1
1995	8,370	0.0669	5.0	2.0	0.0	7.0	74.7	29.9	0.0	104.6
1996	8,620	0.0691	5.0	3.0	0.0	8.0	72.4	43.4	0.0	115.8
1997	8,880	0.0710	3.0	5.0	0.0	8.0	42.3	70.4	0.0	112.7
1998	8,900	0.0711	2.0	1.0	0.0	3.0	28.1	14.1	0.0	42.2
1999	9,490	0.0759	3.0	2.0	0.0	5.0	39.5	26.4	0.0	65.9
2000	11,000	0.0882	2.0	2.0	0.0	4.0	22.7	22.7	0.0	45.4
2001	11,000	0.0879	2.0	5.0	0.0	7.0	22.7	56.9	0.0	79.6
Totals / Averages		0.71585	50	28	0	78	69.8	39.1	0.0	109.0

Table 6.25 Number of Collisions and Collision Rates-1992 to 2001

Year	AADT	HMVK	Number of Collisions				Collision Rates			
			PDO	Injury	Fatal	Total	PDO	Injury	Fatal	Total
Highway 104 Section 280 (James Street to Trunk 7; 0.50 km)										
1992	6,620	0.0121	1	1	0	2	82.5	82.5	0.0	165.1
1993	6,800	0.0124	6	2	0	8	483.5	161.2	0.0	644.6
1994	7,300	0.0133	4	3	0	7	300.2	225.2	0.0	525.4
1995	7,510	0.0137	3	0	0	3	218.9	0.0	0.0	218.9
1996	7,700	0.0141	2	2	0	4	141.9	141.9	0.0	283.9
1997	7,930	0.0145	2	0	0	2	138.2	0.0	0.0	138.2
1998	8,050	0.0147	6	0	0	6	408.4	0.0	0.0	408.4
1999	10,270	0.0187	9	2	0	11	480.2	106.7	0.0	586.9
2000	10,420	0.0191	6	1	0	7	314.7	52.4	0.0	367.1
2001	10,200	0.0186	4	3	0	7	214.9	161.2	0.0	376.0
Totals / Averages		0.1512	43	14	0	57	284.3	92.6	0.0	376.9
Highway 104 Section 285 (Trunk 7 to Church Street; 1.08 km)										
1992	9,200	0.0364	5	2	0	7	137.5	55.0	0.0	192.5
1993	9,400	0.0371	4	2	0	6	107.9	54.0	0.0	161.9
1994	9,500	0.0374	5	2	0	7	133.5	53.4	0.0	186.9
1995	10,190	0.0402	10	0	0	10	248.9	0.0	0.0	248.9
1996	10,400	0.0411	4	1	0	5	97.3	24.3	0.0	121.6
1997	10,800	0.0426	3	1	0	4	70.5	23.5	0.0	94.0
1998	10,960	0.0432	6	1	0	7	138.9	23.1	0.0	162.0
1999	11,860	0.0468	6	5	0	11	128.3	106.9	0.0	235.3
2000	12,220	0.0483	4	2	0	6	82.8	41.4	0.0	124.2
2001	12300	0.0485	4	1	0	5	82.5	20.6	0.0	103.1
Totals / Averages		0.42147	51	17	0	68	121.0	40.3	0.0	161.3
Highway 104 Section 290 plus 1.75 km of Section 300 (Church Street to Taylor Rd.; 8.37 km)										
1992	11,100	0.3400	24	3	1	28	70.6	8.8	2.9	82.3
1993	11,300	0.3452	13	2	0	15	37.7	5.8	0.0	43.5
1994	11,600	0.3544	17	8	0	25	48.0	22.6	0.0	70.5
1995	12,400	0.3788	20	11	0	31	52.8	29.0	0.0	81.8
1996	12,700	0.3891	24	13	0	37	61.7	33.4	0.0	95.1
1997	13,100	0.4002	10	7	0	17	25.0	17.5	0.0	42.5
1998	13,300	0.4063	18	5	0	23	44.3	12.3	0.0	56.6
1999	13,400	0.4094	12	7	0	19	29.3	17.1	0.0	46.4
2000	13,600	0.4166	10	9	0	19	24.0	21.6	0.0	45.6
2001	13,800	0.4216	12	4	0	16	28.5	9.5	0.0	38.0
Totals / Averages		3.8617	160	69	1	230	41.4	17.9	0.3	59.6

Note: AADT-Average annual daily traffic
HMVK-Hundred million vehicle kilometres
PDO-Property damage only

Source: NSTPW collision data base and published collision data.

Collision rates are the number of collisions per unit exposure. The collision rates noted for Section 290 compared with the other Sections detailed in Table 6.25 are significantly lower. There is a difference in the number of driveways and intersections in the various sections. There are two intersections and thirty three driveways from Addington Forks to Church Street, while there are seven intersections and forty three driveways between Church Street and Taylor Road. It is further noted that the other sections in the study area are shorter and have a smaller HMVK column. Section 290 has a higher volume but is significantly longer, exceeding by 6 km the length of the second longest section, (275) which is 2.19 km in length, than the sections described in the table. The volume and the number of driveways and intersections along Section 290 are 'smoothed out' by the length of the section.

The relative safety of a section of highway is evaluated by comparing study area collision rates to the average collisions rates for all similar highways in the Province. NSTPW periodically publishes collision statistics that include five year average collision rates by severity and by highway class. *Motor Vehicle Collision Rates for Numbered Highways and Sections 1996 to 2000* (NSTPW 2002a) is the most recent publication. The study area is considered a 100 Series No Access Control road. Collision rates for this area of Highway 104 are included in Table 6.26 for the five years from 1996 to 2000, and the ten years from 1992 to 2001 (NSTPW 2002b). The Provincial five year (1996 to 2000) average collision rates for all sections of two-lane '100 Series No Access Control' and 100 Series Full Access Control, as well for Four-Lane Wide Median 100 Series Highways are included for comparison.

The Five Year 1996 to 2000 blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. The study area rate is also about twice the rate for four lane divided wide median highways for the five year period. While injury rates in the study area are comparable to the provincial average for all provincial 100 series highways without access control, they are also about twice as high as the rate for four lane divided wide median highways for the five year period. There were no fatal collisions within the study area of Highway 104 between 1996 and 2000, and only one fatal collision between 1992 and 2001.

Table 6.26 Collision Rate Data for Highway 104 Compared with Provincial Averages			
	Collision Rates by Severity		
Road Class	**PDO**	**Injury**	**Fatal**
Five Year (1996 to 2000) Provincial Average Collision Rates [1]			
2 lane Arterial (100 Series No Access Control)	36.6	23.2	1.2
2 lane Arterial (100 Series Full Access Control)	31.5	16.6	1.5
4 lane Freeway (100 Series Wide Median)	24.1	11.2	0.6
Five Year (1996 to 2000) Collision Rates for Highway 104 Study Area [1]			
Addington Forks Rd. to James Street	40	34.7	0
James Street to Trunk 7	308.6	61.7	0
Trunk 7 to Church Street	103.7	45.1	0
Church Street to Taylor Rd.	36.6	20.3	0
Blended Sections - Study Area (1996 to 2000)	**50.8**	**25.6**	**0**
Ten Year (1992 to 2001) Collision Rates for Highway 104 Study Area [2]			
Addington Forks Rd. to James Street	69.8	39.1	0
James Street to Trunk 7	284.4	92.6	0
Trunk 7 to Church Street	121	40.3	0
Church Street to Taylor Rd.	41.4	17.8	0.3
Blended Sections - Study Area (1992 to 2001)	**59**	**24.9**	**0.2**

Sources: 1. *NSTPW 2002a.*
2. *NSTPW 1997b.*
– Section collision tallies for 2001 from NSTPW.

Number of Accesses

There are approximately 25 street or road intersections in the study area, eight of which carry significant volumes, including the three which have traffic signals (Super Valu, Trunk 7 and Church Street). There are also about 76 entrances to residential, commercial, agricultural and institutional locations. The locations of the road intersections and the distribution of driveway entrances from Addington Forks Road to Taylor Road are shown in Table 6.27.

Table 6.27 Locations of Road Intersections and Driveways

kms Eastbound from Aorks Rd.		Intersecting Roads (N - North side; S - South side)	Number of Driveways		
From	To		North Side	South Side	Total
0	1	Trunk 4 (N) and Addington Forks Rd. (S) Somers Rd. (N)	10	4	14
1	2	**New School Access Rd.** (N) and **SuperValu** (S); NSTPW Office (N); MacIsaac Rd. (N)	12	4	16
2	3	James Street (N); **Trunk 7** (N and S)	0	2	2
3	4	Cemetery Entrance (S); **Church Street** (N and S)	1	0	1
4	5	Willowdale Lane (N and S); Beech Hill Rd. (N and S)	0	0	0
5	6		0	2	2
6	7		0	0	0
7	8	Trunk 4 (N); Silver Birch Drive (S)	4	5	9
8	9	MacEachern Loop (N - 2 intersections); Dunn Loop (N)	0	2	2
9	10	Dunn Loop (S); South River Loop (S); Dunmore Rd. (S)	0	0	0
10	11	South Side Harbour Rd. (N); Route 316 (S);	8	10	18
11	12	Mobile Home Park (N); Residential Street (S); Industrial Park Roadway (S)	2	9	11
12	End	Taylor Rd. (N)	1	0	1
	Totals		38	38	76

Note: Intersection names in **bold text** have traffic signals. Other intersections have STOP sign control on the side road.
Source: Site visit observations and NSTPW location plans

6.4.3 Residual Environmental Effects Evaluation Criteria

Transportation infrastructure is evaluated as being 'safe, convenient, economic and efficient' by consideration of level of service or performance, and safety as indicated by collision rates.

A **significant** adverse environmental effect is one in which:

- the traffic flow is altered at many areas that currently have satisfactory levels of traffic performance so that the levels of performance are reduced to levels unacceptable or undesirable by engineering standards or professional judgment; or

- the collision rate at one or more locations throughout the study area increases above existing rates for the location(s), or Provincial average rates for the road class, so as to increase the number of collisions in the study area.

A **positive** environmental effect is one that:

- provides improved levels of service or performance, by increasing capacity or diverting or reducing traffic volumes; or
- improves safety by reducing the number of collisions throughout the study area.

6.4.4 Potential Issues, Interactions and Concerns

There will be some interaction between the Project and transportation infrastructure during the construction phase as construction vehicles use some sections of area roadways to access the construction site. Construction impacts will also occur at areas where the proposed highway crosses existing roads and at the western and eastern extremities of the alignment where the proposed and existing Highway 104 alignments meet. Construction phase impacts may include traffic delays, detours and additional construction vehicles operating in the area.

The Project will become part of the transportation infrastructure since it involves construction of a new Highway 104 alignment in the Antigonish area. Therefore, the greater interactions between the Project and transportation infrastructure will occur when a large percentage of traffic on the various sections of the existing highway between Addington Forks Road and Taylor Road is diverted to the new fully operational Highway 104. This improvement will have a number of benefits for members of the public travelling through the area including improved traffic flow and safety. In fact, these improvements are the reason for the Project.

It is a good policy for new 100 series highways to provide access to provincial trunk highways, and Trunk 7 is a major entrance to Antigonish, Saint Francis Xavier University and the Millennium Centre. Trunk 7 is a major access to Guysborough County and a direct connection is seen as a very important interchange from Highway 104 to Trunk 7 for an expeditious link to the town and the other above noted key locations. The interchange provides access to the town with minimal impact to other roads.

Issues and concerns associated with potential interaction between the Project and transportation infrastructure include the following.

- The proposed Highway 104 alignment will sever the Church Street Extension.
- The proposed alignment will sever many properties; property accesses must be maintained.

•• Appropriate access points must be provided to connect existing transportation infrastructure to the proposed Highway 104 alignment.

6.4.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.4.5.1 Construction

The road construction process comprises several phases which generally include survey and design, grading, construction of overpasses/underpasses and interchanges, and paving. Each step has potential effects on transportation infrastructure.

Survey and design

During the survey and design phase, the existing topographical features of the proposed alignment are recorded by a field survey. Field survey data, together with available mapping of the study area and the highway design criteria, are used by design engineers to establish the vertical and horizontal design details of the proposed highway alignment. The design of treatments for intersected roadways, such as severing or provision of a service road or construction of an overpass, underpass or an interchange, is also included in the design phase.

The field survey has the potential to affect the existing transportation infrastructure at areas where survey crews must work on or near existing roadways at both ends of the alignment and at intervening roadway crossing points. When working on a roadway driving surface or shoulders, survey crews will be required to use signs, traffic control persons and warning devices as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual.

Since design does not have immediate impacts on roadways, and field survey involves only minimal work on or near the roadway, significant effects on transportation infrastructure are not anticipated during the survey and design phase.

Grading

Grading involves re-contouring existing ground levels throughout the alignment to provide a roadbed that is suitable for the horizontal (curves) and vertical (hills) alignments that comprise the design for the proposed highway. Roads and properties that will be severed by the highway will typically be severed during this phase.

Since the proposed alignment parallels and does not use the existing Highway 104 RoW, much of the grading phase will be completed without affecting traffic using existing transportation infrastructure. At the west and east ends of the Project, where the new and existing Highway 104 will connect, grading will be carried out with minimal effect to existing traffic. Grading activities and crossing construction traffic will occur at minor road locations, and at one crossing of the existing Highway 104 in Lower South River, along the new alignment where overpasses/underpasses will be constructed. Local roads will be used to access the various construction sites along the new alignment; these will be restored as necessary after construction is complete. Signing for all construction activities will be as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual.

NSTPW considers existing property boundaries during highway route location and design in an attempt to minimize the number of properties that will be affected and to reduce the impacts on properties that must be crossed by the proposed roadway. When properties are severed, NSTPW will either purchase minor severed portions, or provide access across the new highway by a series of access roads and access road crossings under the highway.

Both Kell and Cunningham Roads, two dirt roads south of Church Street Extension, will be severed from Church Street Extension by the Project alignment. A service road is proposed to provide alternate access to Trunk 7, about 1 km west of where the roads will be severed. Since traffic volumes are very low on these roads, and since the service road will provide direct access to Trunk 7 in close proximity to a new Highway 104 interchange, impacts are not considered to be significant.

South Side Harbour Road will also be severed by the Project, however safer and improved access to existing traffic on this road will be provided by the proposed alignment to meet the extension of Route 316 at a new Highway 104 interchange.

The grading phase will not have a significant effect on transportation infrastructure.

Overpasses, Underpasses, and Interchanges

Since the Project will involve construction of a fully controlled access highway, overpasses or underpasses will be required to grade separate roadways that are crossed by the proposed Highway 104; interchanges will be required to allow access to/from the Highway.

Construction of overpasses, underpasses, and interchanges will occur at various times throughout the two to four year construction period. Impacts to existing transportation infrastructure will generally be confined to areas immediately adjacent to each construction site. Traffic volumes at most intersecting roads are low to moderate, so effects which may occur will not cause significant problems on minor roads. Signing for all construction activities, including short detours that may be required, will be as prescribed in the most

recent edition of Nova Scotia Temporary Workplace Traffic Control Manual. Construction of overpasses, underpasses and interchanges will not have a significant effect on transportation infrastructure.

Pavement

The final phase to complete the highway and prepare it to receive traffic involves installation of pavement, pavement markings, guide rail, and signs. Also, during this phase the final grading and paving is done to complete the transition sections at west and east ends of the Project. This will complete Highway 104 as a four lane divided controlled access highway from west of the Addington Forks Road to east of Taylor Road. Connections to the existing Highway 104 at both ends will provide continuity of travel so that traffic on Highway 104 travelling through Antigonish County will move seamlessly from the existing Highway 104 to the new Highway 104.

Although some trucking of paving materials will be required on area roads, it is anticipated that asphalt or concrete batch plants will be located close to the Project to minimize trucking costs. Signing for all construction activities, including short detours that may be required, will be as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual. Paving and installation of pavement markings, guide rail, and signs will not have any significant adverse effects on transportation infrastructure.

6.4.5.2 Operation and Maintenance

The purpose for the Project is to construct a four lane divided Highway 104 to replace the existing uncontrolled access section from west of the Addington Forks Road intersection to east of Taylor Road. The existing Highway 104, has numerous driveways and intersections, three sets of traffic signals, is speed zoned between 60 and 90 km/hr throughout its length, and carries a mixture of local traffic and through traffic. The opening of the new Highway 104 and the removal of through traffic, as well as a considerable amount of local traffic, from the existing highway will have a positive effect on transportation infrastructure in the area.

Calculation of average speed in this report considers the average of posted speed limits. In the study area, there are three sets of traffic signals which would further reduce speed however, each is fully traffic actuated to minimize impacts or delays to Highway 104 traffic. While there are traffic signals present along the area, this is not factored into the calculations. To calculate the overall average, inclusive of traffic signals, it would be necessary to develop a weighted average of the existing speed limits, factor in stop time, the length of each speed zone and the overall length of the study area.

There are nine speed zones involving four speed limits on existing Highway 104 in the study area. The combined effect of these speed zones reduces the average travel speed through the area to under 80 km/hr, compared to the usual 100 km/hr on two lane controlled access highways, and 110 km/hr on four lane

divided wide median highways in Nova Scotia. Delays from traffic signals (red lights) would further reduce this. The proposed Highway 104 will be posted at 110 km/hr. The diversion of long through-trips to the new highway will greatly increase the percentage of short local trips on the existing road, which may provide a small reduction in travel speeds.

The most noticeable change from the construction of the Project will be the diversion traffic from the existing road to the new highway. The proximity of the proposed alignment to the existing alignment and provision of four strategically located interchanges will divert both through traffic and a considerable amount of local traffic to the new highway. Volume information from Highway 104 Antigonish Safety Review (1999) has been reviewed and updated to provide 2002 and 2022 AADT estimates of diverted and residual volumes on the proposed and existing Highway 104 alignments. AADT volumes for 2002 and projected 2022 AADT volumes for both existing and proposed highway sections are included in Table 6.20.

Between 50 and 80 % of the traffic on the existing Highway 104 will likely divert to the new highway. While traffic collisions are inevitable, the new Highway 104 is expected to have a significantly improved collision rate compared with the existing Highway 104. Since this will be a new controlled access four lane divided highway with a wide median, collision rates are expected to be considerably lower than those on the existing two lane highway without access control. Large reductions in traffic volumes on the existing road will improve the ease and safety of access for the many road and driveway entrances throughout the study area. Also, since most of the heavy trucks will divert to the new highway, public concerns for safety and noise along the existing Highway 104 will be reduced.

With the completion of the Project, the study area will be served by four interchanges:

- Addington Forks Road and Trunk 4 (west end);
- Trunk 7;
- Beech Hill Road; and
- Route 316 (east end).

Appropriate auxiliary turning lanes on the existing or reconstructed intersected roadways will be included in the design interchange ramp terminals for each of the interchange locations where deemed necessary.

In summary, operation of the new section of Highway 104 will create a number of long term benefits for motorists in the study area including improved traffic flow and safety. These benefits will be more pronounced over time as traffic volumes in the study area are predicted to increase significantly.

6.4.6 Follow-Up and Monitoring

There will not be any need for any special follow-up or monitoring of impacts on transportation infrastructure. Traffic counts will continue to be obtained every three years on the existing roadway, and two additional traffic count locations will be required on the new highway.

6.4.7 Summary of Residual Environmental Effects Assessment

The purpose of the Project is to construct a four lane divided controlled access Highway 104 from west of the Addington Forks Road intersection to east of Taylor Road to replace the uncontrolled access section of two lane highway. The removal of through traffic, as well as a considerable amount of local traffic, will improve ease and safety of access to residential and commercial driveways on the existing road. The new Highway 104 will improve the safety, convenience, economy and efficiency of travel for both the traffic diverted to the new highway and the residual traffic on the existing road. Due to the relative location of the existing Highway 104 and adherence to the current edition of the Nova Scotia Temporary Workplace Traffic Control Manual, no significant adverse residual effects on transportation infrastructure from Project construction are likely. Operation of the proposed highway will fulfill the purpose of the Project and will therefore have a positive effect on transportation infrastructure. Tables 6.28 and 6.29 summarise the residual environmental effects assessment for transportation infrastructure.

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Table 6.28 Residual Environmental Effects Assessment Matrix
Transportation Infrastructure (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Survey and Design	• Survey crews working on or near existing roads may affect traffic flow at areas where the proposed alignment crosses or joins existing roads (A)	• Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual*	1	4	2 / 1	R	2	N	3
Grading	• Properties will be severed (A) • Kell and Cunningham Roads will be severed (A) • Construction traffic will use some area roads (A) • Construction activities will affect traffic flow at areas where the proposed alignment crosses or joins existing roads (A)	• Alignment location and access roads will minimize impacts to severed properties • Kell and Cunningham Roads traffic volumes are low and a convenient service road to Trunk 7 will be provided • Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual*	1	4	3 / 1	R	2	N	3
Construction of Overpasses / Underpasses / Interchanges	• Construction activities will affect traffic flow at areas adjacent to each site (A) • Temporary short detours will be required (A)	• Adherence to the *Nova Scotia Temporary Workplace Traffic Control Manual*	2	2	2 / 1	R	2	N	3

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Table 6.28 Residual Environmental Effects Assessment Matrix
Transportation Infrastructure (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Paving	•Some construction traffic will occur on area roads (A) ••Traffic flow at west and east ends of the new highway will be affected as connections to the existing highway are completed (A)	•Locating paving batch plants adjacent to the new alignment ••Adherence to Nova Scotia *Temporary Workplace Traffic Control Manual*	1	3	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low *i.e.,* temporary reduction in level of performance; 2 = Medium *i.e.,* temporary alteration of travel patterns; 3 = High *i.e.,* permanent change in travel patterns

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Existing transportation infrastructure provides for safe and efficient travel; 2 = Existing transportation infrastructure is ineffective, below standards; 3 = Existing transportation infrastructure shows evidence of unsafe transportation conditions.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

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Table 6.29 Residual Environmental Effects Assessment Matrix
Transportation Infrastructure (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic Activity	••Diversion of through traffic from existing Highway 104 (P) ••Diversion of some local traffic from existing Highway 104 (P) ••Potential reduced traffic speeds on existing Highway 104 (P) ••Improved ease and safety of access to properties on existing Highway 104 (P)	••No mitigation proposed	3	4	5 / 6	R	2	P	3

Refer to Table 6.28 for Key.

7.0 MALFUNCTIONS AND ACCIDENTAL EVENTS

All necessary precautions will be taken to prevent the occurrence of malfunctions and accidental events that may occur during the life of the Project and minimize any environmental effects should they occur. Accidental events with the greatest potential for environmental effects include: spills of hydrocarbons or other hazardous materials; failure of erosion and sediment control measure; fires; and vehicular collisions. It is difficult to predict the precise nature and severity of these events. However, the probability of serious accidental events or those causing significant adverse environmental effects is low, particularly when construction and operation procedures incorporate contingency and emergency response planning. Construction and operation procedures will be conducted in accordance with relevant regulations, guidelines and accepted industry procedure. Accidental events related to effects of the environment on the Project are discussed in Section 9.

Spills

Spills of petroleum, oils, or lubricants (POLs) may occur during construction during refuelling of machinery or through breaks in hydraulic lines. These spills are usually highly localized and easily cleaned up by onsite crews using standard equipment. In the unlikely event of a large spill, soil, groundwater, and surface water contamination may occur, thereby potentially adversely affecting the quality of groundwater, fish and fish habitat, and wetland habitat, and resulting in the ingestion/uptake of contaminants by wildlife. Depending on the nature of the spill, it could also potentially affect residential, commercial, agricultural, and other land uses.

The EPP will contain best management procedures to minimize the likelihood of a spill and will contain instructions for crew training and orientation in spill prevention and management. POLs and other hazardous materials will be handled in accordance with applicable regulations and procedures as noted in the EPP. Construction equipment will be frequently inspected to detect possible fuel and hydraulic system leaks. Any leaks will be repaired immediately. Refuelling and equipment maintenance will be conducted at designated sites, away from residential and known cultural or heritage properties, and not within 30 m of a wetland or watercourse. The Project EPP will also contain a Spill Contingency Plan for the Project.

In the unlikely event of larger contaminant spills (*i.e.*, tanker accidents during highway operation), local and provincial emergency response procedures will be invoked to minimize impacts. It is noted that a site specific contingency plan will be in place to address such potential spills in the area of the Lower South River Wellfield protection zone (C) which encompasses a portion of the proposed alignment near the Taylor Road. Emergency response and contingency planning are accepted and effective means to limit the severity of accidental effects. These plans and procedures will be implemented through NSTPW's EPP and supported through training programs.

Significant adverse effects on any VECs or VSCs due to accidental spills are not considered likely.

Erosion and Sediment Control Failure

A potential exists for failure of erosion and sediment control structures due to precipitation events. Such a failure could result in the release of a large quantity of silt-laden runoff to receiving watercourses with adverse effects on fish and fish habitat. Erosion and sediment control measures will be implemented according to provincial guidelines (NSDOE 1988; NSTPW 1997 and revisions) and the Project EPP. Measures will be monitored by an environmental inspector, particularly after a heavy precipitation event or snow melt. Remedial action will be rapidly taken as necessary. In the event of a failure, Project construction will be shut down until controls are restored. An erosion and sediment control failure leading to a significant adverse effect on any VECs or VSCs is considered unlikely.

Fires

Fires may result in habitat loss, sensory disturbance, direct mortality to wildlife, loss or damage of property, and loss or damage to archaeological and heritage resources. Material management and operational procedures will reduce the frequency and extent of accidental fires related to the Project. Burning on the RoW will not be permitted. In the unlikely event of a fire, local emergency response and fire fighting capability will be able to reduce the severity and extent of damage. A fire prevention procedure will be included in the EPP to reduce the potential for fires along with training and orientation information for work crews. Significant adverse effects on any VECs or VSCs due to fires is considered unlikely.

Vehicular Collisions

Between 50 and 80 % of the traffic on the existing Highway 104 will likely divert to the new highway. While traffic collisions are inevitable, the new Highway 104 is expected to have a significantly improved collision rate compared with the existing Highway 104. Since this will be a new controlled access four lane divided highway with a wide median, collision rates are expected to be considerably lower than those on the existing two lane highway without access control. Diversion of through traffic, as well as part of the local traffic, to the new Highway 104, will improve the ease and safety of access for the remaining local traffic using the numerous road and driveway entrances throughout the study area. Public concerns for safety will be further reduced since most of the heavy trucks will divert to the new highway.

Any construction project that affects public highways has the potential for transportation related malfunctions and collisions. However, the following features of the Project will minimize the number, severity and effects of malfunctions and accidents in the study area:

- the opposing roadways of the new highway will be separated by a wide median;
- all entrances, exits and crossing of the new highway will be by interchanges, overpasses or underpasses;
- the horizontal and vertical alignments will be designed and constructed in accordance with current freeway design guidelines;
- the cross section of the new alignment will provide flat slopes and will minimize the number of roadside obstructions;
- traffic volumes on the existing roadway will be reduced considerably;
- the close proximity of a continuous parallel road (the existing Highway 104) and strategically located interchanges will reduce response times by emergency vehicles.

Malfunctions and collisions are not expected to have a significant impact on Transportation Infrastructure.

Summary

In summary, with adherence to best management practices, including adherence to the Project EPP and, if necessary, implementation of NSTPW's emergency response and contingency procedures, opportunities for malfunctions or accidental events as a result of this Project are minimized; in the event of occurrence, they are not likely to have significant adverse environmental effects.

8.0 CUMULATIVE EFFECTS ASSESSMENT

8.1 Methodology and Approach

Subsection 16(1)(a) of the *CEAA* requires that every assessment of a project conducted pursuant to *CEAA* include an assessment of the "cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out". Specific guidance related the assessment of cumulative environmental effects is provided by the Canadian Environmental Assessment Agency (CEA Agency) (1994, 1999a, 1999b). The methodology for the cumulative effects assessment is very similar to that adopted for the environmental effects assessment as described in Section 4 and is integrated with that assessment.

The approach to the environmental assessment for the Project integrated cumulative effects assessment in several ways. In particular, the effects of past and present activities with the potential to interact cumulatively with VECs and VSCs have been considered in the review of existing (*i.e.*, baseline) conditions. Where possible and pratical, existing environmental effects are attributed in the existing environment sections to particular projects and activities (*e.g.,* other linear developments, forestry activities) to identify causes of these past and present effects. However, consideration also needs to be given to the cumulative environmental effects resulting from interactions among the environmental effects of the proposed project with those of likely *future* projects and activities (refer to Section 8.1.2). Potential cumulative effects from past, present and likely future projects and activities are considered and integrated into the overall residual effects summary and conclusions (Section 12).

Mitigation and monitoring requirements related to other projects and activities are often outside of the proponent's control and responsibility. However, there often exists an opportunity for the proponent to participate in regional planning and monitoring efforts where cumulative effects are identified in order to help manage these regional effects to the extent that there is shared responsibility. General compliance with all pertinent regulations and guidelines by all proponents (*i.e., Wildlife Habitat and Watercourses Protection Regulations*) will also assist with regional environmental management and education of cumulative effects.

8.2 Scoping of Other Projects and Activities and Potential Interactions

A critical step in the cumulative environmental assessment is determining what other projects or activities are to be considered. Relevant guidance related to this determination is provided by the CEA Agency (1994, 1999a, 1999b). Also, it is helpful to consider the clarification provided by the Joint Review Panel for the Express Pipeline Project in Alberta (NEB and the CEA Agency 1996). Following an analysis of subsection 16(1)(a) of *CEAA*, the Joint Review Panel

determined that certain requirements must be met for the Panel to consider cumulative environmental effects:

- there must be an environmental effect of the project being proposed;
- that environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or will be, carried out and are not hypothetical.

Furthermore, the Joint Review Panel indicated that it is an additional requirement that the cumulative environmental effect is *likely* to occur; that is, there must be some *probability*, rather than a mere possibility, that the cumulative environmental effect will occur. These criteria were used to guide the assessment of cumulative environmental effects of this Project.

In the early stages of the assessment, a scoping exercise was conducted to identify other past, present, and future projects and activities, the effects of which may interact cumulatively with those of the Project (Table 8.1). This assessment adopts the CEA Agency's current position of including 'certain' and 'reasonably foreseeable' projects in the consideration of cumulative environmental effects (CEA Agency 1999b). 'Certain' future projects and activities (*i.e.*, those that will be carried out) are assumed to include any that have already been approved by regulatory authorities or that are currently in a regulatory approvals process. 'Reasonably foreseeable' future projects and activities are assumed to include any that have been publicly announced by their proponents.

This scoping for cumulative environmental effects was included as part of the overall environmental assessment issues scoping exercise and therefore involved: consultations with local and regulatory authorities; review of previous Project-related documents and other relevant literature; field observations; and professional judgement.

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Table 8.1 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VECs

Project Activities	Air Quality	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Forest harvesting	•		•	•	•	•	•	•	Destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; habitat alteration and fragmentation; sensory disturbance to wildlife
Off-road traffic (ATVs)	•		•	•	•	•	•	•	Destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; sensory disturbance to wildlife.
Agriculture		•	•	•	•	•	•	•	Habitat alteration and fragmentation; sensory disturbance to wildlife; erosion; sedimentation of watercourses; eutrophication of watercourses; contamination of soils and watercourses by pesticides.
Proposed Residential Subdivision Development near the RoW	•	•	•	•	•	•	•	•	Habitat alteration and fragmentation; sensory disturbance of wildlife; erosion; sedimentation of watercourses; eutrophication of watercourses; alteration of hydrology

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Table 8.1 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VECs

Project Activities	Air Quality	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Highway 104 New Glasgow to Sutherlands River			•	•	•	•	•	•	Potential cumulative effects from habitat alteration and fragmentation; sensory disturbance to wildlife; erosion and sedimentation; and dust generation. The effects from each Project are limited in space and time such that cumulative effects on these VECs are likely minimal.

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Table 8.2 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VSCs

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
Forest harvesting		•		•	Noise disturbance to residential land use; woods roads provide increased access to remote areas
Off-road traffic (ATVs)		•		•	Noise disturbance; provides increased access to remote areas, possible trespassing onto private lands; increased access and potential vandalism to archaeological and heritage resources
Agriculture	• •				Provides increased access to remote agricultural areas; improved access to market
Proposed Residential Subdivision Development near or along the RoW	•	•	•	•	Noise disturbance to residential land use; improved accessibility to residential lands will also have an affect on land values during the land acquisition negotiation stage for subdivision plans along the RoW
Proposed amalgamation of the Town and County of Antigonish	• •				Positive and negative impacts on commercial establishments; distribution of potential benefits may be more equitable between Town and Country
Highway 104 New Glasgow to Sutherlands River	•		•	•	Effects on local economy related to tourism travel; improvements to transportation infrastructure in the area; temporary and permanent loss of access to lands used for traditional purposes by Mi'kmaq people.

8.3 Cumulative Effects Analysis

Tables 8.1 and 8.2 provide an overview of the potential effects that other projects and activities may have on the VECs/VSCs selected for this assessment. In some cases, evidence of these effects has already been observed during the collection of baseline information for these VECs/VSCs (*e.g.*, effects of past forestry operations on fish and fish habitat).

Forestry and agricultural activities are currently occurring in study area, have occurred in the past, and are likely to continue in the future after the Project is constructed and is in operation. Potential cumulative effects on VECs associated with forestry activities and the Project include: destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; habitat alteration and fragmentation; and sensory disturbance to wildlife. As indicated in Section 5.3, many of the smaller watercourses in the area showed signs of heavy siltation potentially attributable to forestry activities in the study area.

The new *Wildlife Habitat and Watercourses Protection Regulations*, which came into force January 14, 2002, provide for the protection of water quality, biodiversity and wildlife habitat. These regulations were derived from the NSDNR Forest/Wildlife Guidelines and Standards of 1989 and now make guidelines for forestry operations mandatory on all lands. As NSDNR works with industry and landowners to help promote understanding of and compliance with these regulations, adverse effects on wildlife, habitat and water quality are expected to diminish. Assuming effective implementation of Project erosion and sediment control measures, no significant cumulative effects on fish habitat are considered likely. Standard erosion and sediment controls and proper culvert design on other highway projects (*e.g.,* Highway 104, New Glasgow to Sutherlands River) will reduce the potential for cumulative effects on regional fish and fish habitat. In general, cumulative effects on watercourses and wetlands with respect to other linear developments is limited by spatial separation (*i.e.,* separate watersheds).

With respect to habitat loss and fragmentation, the study area has already been subjected to habitat fragmentation as a result of forest harvesting activity, agricultural activity, housing developments and linear developments including roads (*i.e.,* twinning of Highway 104, New Glasgow to Sutherlands River) and electrical transmission lines. Approximately 47 % of the proposed RoW passes through disturbed early successional habitats such as clear-cuts, shrub thickets and regenerating forest. Another 24 % of the RoW runs through areas affected by agricultural or residential land use. In instances where relatively undisturbed habitat must be used for highway RoW development, the RoW may run along side the edge of existing disturbed or settled areas, to the extent practical, in order to minimize the number of habitat fragments and habitat edge created by construction. The use of wildlife corridors, where possible, will also help to mitigate effects of habitat fragmentation and prevent isolation of wildlife populations. Regulatory protection of wetlands, including required mitigative measures and habitat compensation, will reduce the potential for cumulative effects on wetland and habitat, including habitat for birds. There is not likely to be any

significant adverse cumulative effects on rare herpetiles, rare and sensitive birds, or rare mammals as a result of habitat fragmentation.

Several housing developments are planned for the area and it is expected that the new highway will make previously inaccessible areas available for development. These projects can potentially result in a number of adverse environmental effects including loss of natural habitat, sensory disturbance of wildlife, increased predation pressure on wildlife species due to the presence of cats and dogs in the area, erosion, sedimentation, alteration of the local hydrologic regime, and introduction of contaminants such as pesticides and fertilizers. These types of developments (*e.g.*, subdivisions) generally not subject to environmental approval other than sewer and water services. While habitat will be lost through clearing, standard mitigative measures (*e.g.*, erosion and sediment control) and regulatory requirements regarding working in proximity to watercourses will reduce the potential for cumulative effects with the Project to insignificant levels.

Some evidence of adverse effects associated with off-road traffic (*i.e.*, ATVs) has been observed along the proposed RoW. ATV riders use some of the woods roads along the route as travel corridors as well as a short section of the existing highway RoW near 0 + 700. The extent of ATV use along the route is relatively low compared to other areas in the province probably as a result of the limited number of access points for ATVs and the general lack of woods roads in the area. The Project may increase the amount of ATV traffic in the area. The cleared RoW could be used to access other woods roads and trails where they are intercepted by the new highway. The potential adverse effects of increased ATV access is not expected to be significant.

Mitigative measures proposed in this document will help to minimize potential adverse cumulative effects on VECs that may be currently affected by habitat fragmentation and sensory disturbance associated with forestry and off-road traffic activities, agriculture, and new subdivisions (*e.g.*, wetlands, rare herpetiles, rare and sensitive birds, rare mammals and critical habitat, and rare plants and plant communities). Watercourse crossings for the Project will be constructed in accordance with the applicable standards to minimize erosion and sedimentation, and disturbance to fish species as well as other mitigative measures specified in this document. The installation of new culverts and/or upgrading existing culverts may improve the current watercourse crossing conditions.

No significant cumulative effects on air quality are anticipated as a result of the Project since the air quality in the area is expected to be good and air emissions (exhaust) from construction and operational vehicles are not predicted to be substantial. In general, the Project will not cause additional traffic to travel through the study area. Dust emissions from Project construction activity will be localized and short-term, and are not expected to interact cumulative with dust generated by forestry activities, ATV traffic and other regional construction projects. There are therefore not likely to be any significant adverse cumulative environmental effects on air quality.

The Project activities are not anticipated to cumulatively interact with other projects to significantly affect groundwater resources.

With respect to cumulative effects on VSCs, the main issue is related to improved access to relatively inaccessible areas. Although there currently exist several woods roads and trails providing limited access throughout relatively undisturbed areas east of the proposed RoW, the highway will likely enhance access opportunities. This may result in increased trespassing on private lands and potential disturbance to land uses. However, access to these areas is only 'enhanced' by the Project as various trails currently extend to throughout these areas. Since trespassing and vandalism have not been identified as significant issues in the study area, it is not likely that the enhanced access provided by the Project will result in significant adverse cumulative effects.

Antigonish has a strong agricultural economy, primarily dairy production. Some studies indicate that nearby highways have effects on the growth and productive capacities of animals, the extent of which has not been fully ascertained. Existing and future animal production near the highway and development of other required highways, may therefore interact cumulatively with the planned highway development. This negative effect is, however, insignificant. Positive cumulative effects include improved access to farms and enhanced access to markets.

The Municipality of the County of Antigonish has received several residential development plans from owners of private properties along or adjacent to the proposed RoW. This interest in development will be facilitated, in general, by development of the new highway, creating cumulative effects on land use (*i.e.*, increased residential development and land value) in the study area. These effects will generally be positive for the VSCs Land Use and Local Economy.

There is an on-going discussion between political leaders and interest groups of amalgamating the Town and County of Antigonish. The amalgamation will result in just one local government for Antigonish. The new highway RoW is expected to cause commercial developments to move to areas within the jurisdiction of the County while there may be relatively greater adverse effects on commercial establishments situated within the Town. These effects may be translated to more fiscal revenue from commercial establishments for the County and less for the Town. The amalgamation therefore, if carried out could, in effect, distribute the potential economic benefits from highway development more equitably within the expanded municipal district.

Concerns have been raised to TPW that without adequate signage at Sutherlands River, the coastal route to Antigonish (referred to by some as a "mini-Cabot Trail") may be overlooked by travellers. In this case, the potential adverse effect of the Project on the local economy may be compounded by the New Glasgow to Sutherlands River highway upgrade as travellers will be offered a higher travel speed alternative over a

larger geographical area, bypassing the local Town. It is believed, however, that adequate signage at Sutherlands River would mitigate this effect to non-significant levels.

Mi'kmaq land and resource use, may experience adverse cumulative effects as a result of multiple projects along Highway 104 . As indicated in the Mi'kmaw Knowledge Study (Appendix K), there are several areas along both alignments that support current Mi'kmaq land and resource uses and, in particular, several areas containing plants of significance to Mi'kmaq. However, as the Study indicates, these cumulative effects are not likely to be significant since these resource areas are not limited to lands within the RoWs.

8.4 Summary

With the implementation of the mitigative measures specified in this document, and adherence to applicable legislation and guidelines (refer to Section 3.3 for an overview), there are not likely to be any significant adverse cumulative effects associated with this Project. There is, in fact, predicted to be a positive cumulative effect on transportation infrastructure, land use, and the local economy.

9.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The definition of environmental effects under Section 2(1) of the *CEAA* includes "any change to the project that may be caused by the environment". Climate and weather conditions including precipitation and wind statistics for the area are provided below to help provide context for the analysis of environmental effects on the Project which follows.

9.1 Climate and Weather Conditions

Climate normals for the study area are based on data collected by Meteorological Service of Canada (MSC) weather stations located at Collegeville, Nova Scotia (Lat. 45° 28•N Lon. 62° 1•W) and Eddy Point (Lat. 45° 31•N Lon. 61° 15••W). These data were taken from the Canadian Climate Normals (1971-2000) for Collegeville and Canadian Climate Normals (1951-1980) for Eddy Point. The station at Eddy Point (no longer in service) monitored wind conditions, an aspect not measured at Collegeville.

9.1.1 General Climate and Weather Patterns

The Project area, and Nova Scotia in general, has good air quality due to the relatively small population and small industrial base (NSDOE 1994). Climatic conditions provide good dispersion of air contaminants. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transport contaminants into the area, causing poorer air quality.

On a global scale, the Atlantic Region lies within the zone of prevailing westerly winds. This zone is characterized by the passage of a series of high and low pressure systems. Paths taken by these systems are further influenced by ocean currents and continental topography. Cyclonic passages (low pressure systems moving through an area) may track across the continent or up the eastern seaboard. Typical cyclonic passages are marked by the onset of wind from an easterly direction, thickening cloud, and a gradual fall in pressure. Strong north-easterly winds and heavy precipitation are familiar accompaniments to these storms. Should the storm centre pass to the south, the wind direction will change in a counterclockwise manner and precipitation may persist for several days. If the low pressure centre tracks to the north of the observing station, the wind direction usually veers (changes in a clockwise manner). The cyclonic passages typically last from a few days to a week.

During the summer, persistent high pressure systems off Bermuda result in prolonged periods of stagnant weather with warm temperatures and light winds from the south. These events promote the movement of air pollutants from the eastern seaboard to the Project area. There may also be a subsidence inversion (persistent meteorological conditions limiting atmospheric dispersion) accompanying the high pressure system that further enhances the potential for air quality to deteriorate.

This is the situation that generally accompanies the days with perceptible pollutant haze and hot stagnant periods in the summer.

During periods of low wind speed, particularly in the summer months, the occurrence of sea-breezes and land-breezes are evident along the coastline and several kilometres inland. In the daytime, strong solar insolation causes a warming of the land and the rising air is replaced by air moving in from the offshore. During the night, the reverse may occur, but the cold water temperatures tend to reduce the possibility of the land-breezes.

Hurricanes can develop in the tropics and typically move up the eastern seaboard. These storms are significantly downgraded as they encounter the colder waters off the northeast United States and Canada. Usually, by the time a hurricane reaches the Project area, it will have weakened into a tropical storm or an intense low pressure system with strong winds and heavy rains. Hurricanes may also cause heavy swells and high waves along the coast. Although the hurricane season starts June 1st, the peak time for these storms is between September and October.

9.1.2 Temperature Normals and Extremes

Temperature Normals for Collegeville are shown in Table 9.1. The annual temperature range for Collegeville is normally between +18°C and • 7°C. However, extreme temperatures of +38°C in summer and • 37°C in winter have been recorded.

Table 9.1 Temperature Normals and Extremes for Collegeville, Nova Scotia

Month	Daily Maximum (°C)	Daily Minimum (°C)	Daily Mean (°C)	Extreme Maximum (°C)	Extreme Minimum (°C)
Jan	-1.5	-11.6	-6.6	17.0	-34.4
Feb	-1.6	-11.6	-6.5	15.5	-37.2
Mar	2.6	-6.8	-2.1	23.0	-30.6
Apr	7.9	-1.4	3.3	27.8	-23.3
May	15.0	3.4	9.2	33.9	-8.0
Jun	20.5	8.2	14.4	35.0	-4.4
Jul	24.0	12.4	18.2	36.1	-1.1
Aug	23.5	12.3	17.9	38.3	-0.6
Sep	18.9	8.0	13.5	34.4	-6.7
Oct	12.7	3.1	8.0	28.3	-10.0
Nov	6.8	-1.0	2.9	25.6	-18.9
Dec	1.2	-7.5	-3.1	20.6	-30.5
Year	**10.8**	**0.6**	**5.8**	--	--

Source: Canadian Climate Normals 1971-2000 (Environment Canada 2002)

9.1.3 Precipitation Normals and Extremes

Precipitation measured at Collegeville is presented in Table 9.2. Although rain may occur in any month of the year, the rainfall in the area is highest during fall. Snow and freezing precipitation can occur between October and May, with the largest amounts falling between December and March.

Table 9.2 Precipitation Normals and Extremes for Collegeville, Nova Scotia

Month	Mean Rainfall (mm)	Mean Snowfall (mm)	Total Precipitation (mm)	Extreme Daily Rainfall (mm)	Extreme Daily Snowfall (mm)	Extreme Daily Precipitation (mm)
Jan	78.3	47.2	125.5	87.6	38.1	87.6
Feb	51.0	45.3	96.3	56.4	40.6	61.0
Mar	80.1	36.2	116.3	78.7	45.7	78.7
Apr	81.2	17.7	99	53.3	38.1	53.3
May	106.5	2.5	109.1	54.6	25.4	54.6
Jun	99.7	0.0	99.7	198.1	0.0	198.1
Jul	89.8	0.0	89.8	104.1	0.0	104.1
Aug	102.1	0.0	102.1	203.2	0.0	203.2
Sep	112.2	0.0	112.2	104.1	0.0	104.1
Oct	145.0	1.3	146.3	115.1	17.8	115.1
Nov	133.3	12.2	145.5	98.6	34.3	98.6
Dec	96.6	46.2	142.8	100.2	40.6	100.2
Year	**1175.7**	**208.5**	**1384.3**	--	--	--

Source: Canadian Climate Normals 1971-2000 (Environment Canada 2002)

Total precipitation is rainfall plus the water equivalent of the snowfall and all other forms of frozen precipitation. Normally, the monthly precipitation amounts for Collegeville ranges from 90 mm (July) to 146 mm (October).

9.1.4 Wind Normals and Extremes

Wind statistics are not available at the Collegeville station. Statistics (Canadian Climate Normals 1951-1980) from a past monitoring station at Eddy Point (Lat. 45° 31•N Lon. 61° 15••W) are provided. The prevailing winds in the area are westerly to northwesterly in the colder months and south to southwesterly in the warmer months.

The average and extreme wind speed and direction values are shown in Table 9.3.

Table 9.3 Wind Statistics from Eddy Point

Month	Average speed (km/h)	Most Frequent Direction	Extreme Hourly Speed (km/h)	Direction	Extreme Gust Speed (km/h)	Direction
Jan	19.5	W	70	SSE	97	ENE
Feb	19.4	NW	64	NNW	106	WNW
Mar	19.1	NW	77	W	130	SW
Apr	16.6	NW	71	E	93	E
May	15.6	NW	55	NE	85	S
Jun	14.1	S	64	SVL	89	NNE
Jul	13.2	Calm	60	S	87	S
Aug	12.7	Calm	44	SSW	65	NW
Sep	14.7	S	50	WNW	89	W
Oct	16.6	W	64	S	137	S
Nov	17.9	W	61	W	91	NW
Dec	19.2	W	69	SSE	93	S
Year	**16.6**	**NW**	**77**	**W**	**137**	**S**

Notes: Wind direction refers to point of wind origin. SVL=several directions
Source: Atmospheric Environment Branch, Canadian Climate Normals: 1951- 1980

In winter, many low-pressure systems pass through south of the region, while in summer they tend to pass north of the region. Average wind speeds vary from 12 to 15 kilometres per hour (km/h) in summer to near 20 km/h in winter.

9.2 Effects of the Environment on the Project

There is a number of planning, design and construction strategies intended at minimizing the potential environmental effects of the environment on the Project so that the risk of serious damage to the Project or interruption of service can be reduced to acceptable levels. Mitigation measures include, among other things, designing structures to relevant codes, and scheduling of activities to allow for weather interruptions. All of the construction activities will be taking place out-of-doors and thus weather has been factored into the design of the Project.

9.2.1 Climate Change

On a national basis, Canada shows a warming and cooling pattern with a higher overall warming trend of approximately 1.1 °C since 1895. The Atlantic Region, however, shows a warming trend from 1895 which peaked in the mid 1950s followed by a cooling trend in the 1990s. The overall warming trend of 0.4°C in Atlantic Canada since 1895 is not statistically significant. With respect to precipitation, the Atlantic Region shows an overall increasing trend in precipitation since 1948, with an increasing trend

in the number of daily precipitation events above 20 mm and a very slightly increasing trend in the number of daily snowfall events above 15 cm (Lewis 1997). Appendix B contains additional information on climate changes, particularly as it may affect precipitation and hydrology.

Effects of climate change on the Project are not considered to be particularly relevant due to the time frame associated with climate change relative to the proposed time frame for Project construction. Extreme events, including increased precipitation are considered in Project design and mitigation during operations (see below).

9.2.2 Sea Level Rise

Relative sea level has been changing systematically throughout southeastern Canada for thousands of years, due to the interplay between crustal loading (by ice or water) and the level of the global ocean (Forbes *et al.* 1997). Tide-gauge data from Halifax indicate a rising trend of 0.36 m/century since 1920 (Shaw and Forbes 1999). It is estimated that as much as a third of this may be due to global rise in sea level (Grant 1975). Low lying coastal lands are subject to inundation under high tides and storm surges. The frequency of such flooding and the landward limits of flooding will increase with a rise in mean relative sea level. It is not likely that sea level rise will have an effect on the Project.

9.2.3 Extreme Precipitation

Extreme rain can result in work stoppages during construction and create difficult working conditions. Rain is an expected work hazard and the schedule allows for rain. In the event of extreme rain, the EPP will be designed to ensure that environmental loads (*e.g.,* sediment-laden water) are addressed appropriately and minimize sedimentation events. The EPP will also ensure that the integrity of the highway is not compromised. If unusual wet periods or excessive rain do occur, this can result in Project delays and an associated delay in completion and can result in additional capital cost. During the operational phase of the highway, extreme rain may limit visibility and can lead to hydroplaning conditions.

Excess water is addressed by the proper sloping off the highway to allow for run-off. Proper roadbed design prevents settlement and rutting which result in water pooling on the roadbed, potentially leading to hydroplaning. Water control off the highway is mitigated through ditching along and between the lanes.

Extreme snowfall can also affect winter construction or contribute to unusual flooding during snowmelt. Exceptional early snowfall could delay construction and result in additional work for snow clearing and removal. This could increase construction costs. Early snow cover can minimize or prevent ground freezing and this may affect winter construction intended at improving work progress and accessibility.

Ice and snow interferes with the operation of vehicles on the highway as it can cause slippery driving conditions and limit visibility. Ice and snow are controlled through snowplowing, and sand and salting of the roadways. Snow and ice can result in visibility issues. Under extreme conditions operation of the highway can be temporarily suspended at the discretion of RCMP and NSTPW officials.

Major cuts and fills in roadway construction can affect the deposition of snowfall, depending on micro-climate conditions. At present, there are eight areas along the alignment with significant cuts (>5 m) proposed. The approximate locations are: 4+240 (north end of Trunk 7); 5+900 (South of Willowdale Lane); 7+230; 7+770; 8+430; 9+620; 10+270 (South of MacEachern Loop) and; 11+670 (East of Dunns Loop).

NSTPW will undertake further study of the entire alignment with regard to snow deposition once detailed design of the highway is in progress. The final profile will be designed to reduce the possibility of obstructions to visibility or snow drifting. Once cross sections for the design are finalized, a section of roadway of similar profile and orientation to prevailing winds will be studied in combination with detailed storm data for the Antigonish area. The severity of effects from blowing/drifting snow will be estimated and mitigation determined. Mitigation measures, if necessary, may include cut/slope design, and aerodynamic barriers to decelerate the wind and cause the snow to accumulate away from the affected section of roadway.

9.2.4 Flooding

As discussed in Appendix B, ice or debris jam may endanger the stability of the roadway embankment. Unnamed watercourses at chainages 0+275, 2+240, 8+150 and 10+250, were identified as having potential for ice and debris jam, especially with additional flows from the highway. Watercourse crossing structures will be designed to allow the passage of ice and debris.

9.2.5 Fog

Reduced visibility due to dense fog is more prevalent in late spring and early summer, when warm moist air from the south flows over relatively cold coastal waters. The period from mid-spring to early summer is generally the foggiest time. By early fall, a combination of cooler, drier air and warmer ocean temperatures both contribute to a decrease in fog.

Bands of thick, cool fog lie off the coast, produced where the chilled air above the Labrador Current mixes with warm, moisture-laden air moving onshore from the Gulf Stream. With onshore winds these banks of fog move far inland. Sea fog often affects the headlands by day, moving inland and up the bays and inlets at night. At other times of the year fog is much more transient and local in nature (Environment Canada 2003).

Fog can occur at any location along the route under the right meteorological conditions. Under extreme conditions operation of the highway may be suspended, but this is highly unlikely for this portion of the route. Sheltered areas (e.g., cuts) are susceptible to early morning radiation fog under clear sky conditions where there is little air circulation. In general, the highway will discourage these conditions as the four-lane road construction will open areas and promote air mixing.

9.3 Summary

The Project will be designed to account for potential effects of the environment. No significant adverse effects on the Project are therefore predicted.

10.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

10.1 Environmental Management

NSTPW is committed to the effective management of all Project activities potentially affecting the biophysical and socioeconomic environments. This commitment has been demonstrated during the Project planning phase through the completion of an environmental screening conducted by NSTPW, resulting in a route selection process geared toward minimization of adverse effects. NSTPW is also committed to effective implementation of all of the environmental design and mitigation measures specified previously in this document including other measures described in this section.

Environmental protection plans (EPP) and emergency response plans for the Project will be completed after environmental assessment approval, prior to construction. These plans will be submitted to NSEL for approval, which will involve circulation to Environment Canada, DFO and other regulatory agencies as required.

An EPP will contain general and specific mitigation measures for Project construction and operation, including measures specified in this document and applicable approval conditions. The EPP will combine generic protection measures applicable to all highway construction activities in the province with environmental protection measures specific to this Project (*e.g.*, site specific erosion control plans for the West River and South River crossing). In particular, areas of special environmental consideration (*e.g.*, South River and locations of rare and sensitive species) will be identified with specific protection measures included as appropriate. The EPP will also contain requirements for the contractor to complete a work progression schedule for approval by the NSTPW Project Engineer. Monitoring requirements, including, but not limited to, the rare plant monitoring at West River, and other follow-up plans (*e.g.*, wood turtle risk management plan) will also be included.

10.2 Emergency Response and Contingency Planning

Accidental events resulting in potential adverse environmental effects may occur during Project construction and operation (refer to Section 7.0). These events may include: spills of fuels and other hydrocarbons; fires; and vehicular accidents. It is difficult to accurately predict the precise nature, probability and severity of these events on the environment. Material management and operational procedures will reduce the frequency and extent of accidental events. Emergency response and contingency planning are accepted and effective means to limit the severity of effects.

NSTPW will have contingency plans in place to address these events as well as to address unlikely encounters with heritage resources, contaminated sites and acid producing bedrock.

10.3 Monitoring Programs

Different types of environmental monitoring occur at different phases of a Project and for different purposes. Once the specific alignment is fixed within the study area, pre-construction monitoring and survey activities will be implemented to establish baseline conditions for certain VECs/VSCs, as specified in this document or subsequently required under conditions of regulatory approval. Two other types of environmental monitoring, which are normally carried out during and after construction, are environmental compliance monitoring (ECM) and environmental effects monitoring (EEM). ECM involves monitoring of activities by regulatory authorities and NSTPW, to ensure compliance with all regulatory requirements and self-imposed environmental commitments. EEM is environmental monitoring which may be undertaken to assess the accuracy of impact predictions, and to evaluate the effectiveness and identify the need to alter or improve mitigative and compensatory measures.

10.3.1 Pre-Construction Monitoring

Pre-construction monitoring activities will, at a minimum, include a well water survey and a pre-blast survey. Other pre-construction monitoring, as specified in this document include pre-construction surveys for wood turtles on the West River (Section 5.4.6) and for rare plants, as a component of an intervale habitat enhancement program (Section 5.7.6).

Well Water Survey

Based on final project design, a well water survey will be developed to assess the quality and quantity of wells near proposed blasting operations if blasting is required and near areas of significant excavations. The number of wells to be sampled and sampling parameters will be determined by the blasting contractor. A well water survey protocol is included in Appendix G.

Pre-Blast Survey and Monitoring

Detailed design surveys will indicate where, if at all, blasting will be required. If blasting is conducted, a pre-blast survey of all properties that would potentially be affected by construction blasting will be performed. A pre-blast survey and monitoring program will be developed when design details, field conditions and the amount of bedrock that requires blasting is fully defined.

The area that would be affected by blasting operations depends largely upon the magnitude of blasts required to achieve the desired volume of cut in bedrock. The number of properties to be surveyed will be determined by the contractor.

For each residence and outbuilding to be inspected, external and internal conditions will be recorded. Landowners who will not permit examination of their properties will be asked to sign a waiver to this effect.

Monitoring of ground vibration with one or more seismographs and monitoring of air blast with a decibel meter will be carried out for each blast; refinements may have to be made to the charge weight when actual site specific vibration data becomes available.

In the event of blast danger claims, the construction contracts will stipulate that such claims be dealt with promptly. A telephone number to which claims and inquiries about the operations could be directed, will be made public by the contractor.

10.3.2 Environmental Compliance Monitoring

NSTPW will establish an ECM program to ensure that all regulatory requirements and commitments are being met. ECM can be divided into two elements: regulatory environmental surveillance; and self-regulatory environmental compliance monitoring. Regulatory environmental surveillance is carried out by regulatory authorities. Self-regulatory environmental compliance monitoring is that which NSTPW undertakes to monitor its own activities against internal and external environmental standards. Self-regulatory ECM overlaps with regulatory environmental surveillance where the external standards which are being monitored are regulatory in nature. However, self-regulatory ECM is a much broader concept and is an important tool for the implementation of mitigation, particularly where government regulations are vague or non-existent. Self-regulatory ECM can involve:

- monitoring of all environmentally-sensitive activities to ensure compliance with internal and external non-regulatory environmental standards;
- coordination of communication with regulatory authorities; and
- provision of on-site environmental advice to Project personnel.

The principle mechanism for ECM will be the EPP, which provides the practical framework for the implementation of the environmental requirements of the Project. The EPP will also provide a common reference document against which compliance can be judged by both regulatory authorities and NSTPW.

10.3.3 Environmental Effects Monitoring

EEM involves taking repetitive measurements of environmental variables over time to detect changes caused by external influences directly or indirectly attributable to a specific human activity or development. EEM is generally undertaken to:

- improve environmental understanding of cause and effect relationships;
- provide an early warning of undesirable change in the environment; and
- verify earlier predictions of impacts and effectiveness of mitigative measures.

The EEM program will be incorporated into the EPP developed by NSTPW and will be updated as required, as information regarding the predicted impacts and effectiveness of mitigative measures is collected.

Routine monitoring of dust is not anticipated. If required however, air sampling will be conducted in accordance with NSDEL and Environment Canada methodologies for High-Volume air sampling of TSP matter. Erosion and sediment control structures will be routinely inspected and maintained appropriately. Surface water quality, site and habitat restoration, and bank stability and protection will be monitored regularly during construction and thereafter until soils have been permanently stabilized. Where habitat restoration is undertaken, monitoring programs will be implemented. Archaeological monitoring at the South River crossing will be undertaken as necessary.

10.4 Compensation Programs

10.4.1 Compensation for Land Acquisition

NSTPW's land acquisition and compensation policy will generally follow the guidelines developed under the Nova Scotia *Expropriation Act*. Property expropriation under the *Act*, however, only occurs when negotiations between individual property owners and/or their legal representatives fail in reaching a fair and equitable settlement.

Once the final design and location of the proposed undertaking has been determined, the process of land acquisition begins. Normal practice is to determine the local market value in accordance with recognized real estate appraisal practices for properties directly impacted and those which may be injuriously affected as appropriate. Acquisition and Disposal Officers will contact property owners to negotiate a mutually acceptable settlement. If negotiations fail, the property is formally expropriated and the claim is scheduled to be heard by the provincial Expropriation Board.

There are a few additional actions which could assist in reducing some of the potential adverse impacts of relocation from these properties. These include landowner notification at the earliest possible time in the planning and design stages of the proposed alignment. Early property purchases are considered in cases where: the property may already be on the market; the majority of the property will be impacted by the alignment; and when NSTPW is fairly confident the alignment will be approved, requiring certain properties to be acquired. There are, however, risks associated with early property purchases. If properties are acquired too early, before Project approval, there is a risk that the environmental assessment, survey and detailed design may reveal issues previously unknown which may warrant changes to the Project, possibly changing the location of impacts and properties to be acquired.

10.4.2 Compensation for Lost Habitat

DFO has developed the *Policy for the Management of Fish Habitat* (1986) under the federal *Fisheries Act*, which applies to all Projects and activities in or near water that could alter, disrupt or destroy fish habitat by chemical, physical, or biological means (refer to Section 5.3). The guiding principle of this policy is to ensure no net loss of the productive capacity of fish habitat. All activities which have the potential to affect watercourses inhabited by fish must be approved in advance by NSDEL and DFO. NSTPW may be required to develop compensatory fish habitat if mitigative measures are not effective, resulting in a loss of the productive capacity of the habitat.

NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to compensate for wetland lost in the area during Project construction. Wetland replacement, if required, would consist of creating wetland habitat capable of exceeding the wetland functions lost or reduced in the original wetland (refer to Section 5.8 and Appendix I).

11.0 PUBLIC INFORMATION PROGRAM

NSTPW began working with the Atlantic Expressway Committee (AEC), a broad based local interest group, in 1996 to identify an alignment and access locations that would meet the requirements of NSTPW the local community. NSTPW and AEC decided to bring alignment options before the community for discussion prior to the making any selections. A total of three open house public meetings were hosted by NSTPW. The initial meeting was held in May 1997 during the early planning stages of the Project to present local stakeholders and the general public with Project information and obtain feedback. At the second meeting in May 1998, three potential alignments were presented to the community to receive feedback from the public to be used in the alignment selection process. The third meeting, held in May 2001, presented the recommended alignment for the EA Registration document (NSTPW 2001a).

The initial open house, held at the Saint Francis Xavier University in May 1997, served to present the results of NSTPW's preliminary environmental screening and to solicit opinions related to the broad corridor and potential access locations being considered. This corridor incorporated ten exclusion zones identified through the completion of the screening. The corridor, between approximately 1 km and 3 km wide, extended west to east from approximately 1 km west of Addington Forks Road to just east of Taylor Road.

The public meeting was well attended with 339 recorded visitors and 102 questionnaires completed. Respondents who thought that the Project would impact their business or property identified the following concerns: potential impacts on business; increased traffic, noise and pollution; reduced safety for children; reduced access to the existing highway; impact to water supply; impacts, including devaluation, to residential, farming or woodlot properties; and loss of aesthetic value. Constraints identified at the open house included eagle and osprey nests along South and West Rivers and a cemetery near South River that was outside the corridor boundaries. The issues identified as important by the questionnaire were safety, economic, environmental and residential impacts, noise, traffic flow, social impacts, property values, pollution, aesthetics, farmland and cost. Benefits identified at the meeting included increased safety, improved traffic flow/access, less traffic and noise, and potential positive economic impacts/commercial development.

A second open house meeting was hosted by NSTPW and AEC in May 1998 at the St. Andrew Junior High School in Antigonish. There were three formal presentations by NSTPW and AEC made at different times throughout the day. The objective of this consultation was to provide information and afford members of the community the opportunity to provide input on the selection of the alignment and access options. Prior to the meeting, efforts were made to contact all landowners directly affected by any of the alignment options by either telephone or by mail to inform them of the potential impacts to their property and to give them the opportunity to provide input. Information flyers were sent to most homes

and businesses in Antigonish County and advertisements were placed in the local paper. At the meeting, fact sheets describing the Project, including a small plan of the alignment options, were distributed and attendees were encouraged to complete questionnaires. Some 700 residents of the area registered their names in the guest book and 612 completed questionnaires. The questionnaire asked respondents to identify a preferred alignment, provide reasoning for their choice, to rank acceptability and identify the pros and cons of each of the alignment options, and to identify four preferred interchange locations. Subsequent analysis of the questionnaires identified the preferred alignment as the Red alignment and preferred access locations as Trunk 7 and Addington Forks overall with varied support for Church Street, Route 316 and Taylor Road, dependent on the route preference.

A debriefing of staff following the meeting and subsequent correspondence received by the NSTPW and the local newspaper indicated strong support for the Blue and Brown routes, conflicting with the survey analysis which identified the Red alignment as the preferred route. Further investigations including a safety review in 1999, a peer review in 2000 and an impact study on the proposed South River crossing in 2001 were completed and the Blue Route was selected based on a global evaluation of constraints.

A third public consultation session was held in May of 2001 to present the recommended alignment for the EA Registration. The final alignment proposed for EA registration of the Project was presented at a third open house meeting held in May 2001. Approximately 200 people attended this session with 27 completed comment sheets handed in. Analysis of the comment sheets revealed 52% of respondents supported the Project while 15% did not support the Project. Another 22% of respondents did not oppose the Project but had concerns over certain aspects of the proposed work.

In addition to alignment alternatives, other alternative means of carrying out the proposed Project may include buffer zones, alternative wetland and watercourse crossing methods/structures such as bridges, underpasses, and wildlife corridors (refer to Section 2.4.3). Specific alternatives and preferred options are discussed further in relevant sections in this report.

In November 2001, NSTPW registered the Project with NSDEL under the *Environment Act*. A newspaper notice was placed notifying the public of the registration document, along with proposed terms of reference for the environmental assessment; these were made available for public review. NSDEL considered comments received from the public on both the EA Registration and draft EA terms of reference during preparation of the final terms of reference.

Since the Project is considered a Class II Undertaking under the *Environmental Assessment Regulations*, the public will also have an opportunity to review this environmental assessment report and submit comments to NSDEL.

NSTPW is committed to an ongoing public involvement and information program to identify stakeholder issues and concerns. A CLC will be developed to act as a liaison between NSTPW and various stakeholders in the Project. Issues to be discussed may include Project information, conflict resolution, and input to monitoring and mitigation programs.

A dispute resolution policy will be established for addressing Project- related complaints and concerns that may be received from nearby landowners or stakeholders. The intent of the dispute resolution policy is to ensure that a structured system is established to enable NSTPW to fulfil the goal of effective and responsible communication with landowners and stakeholders.

12.0 SUMMARY AND CONCLUSIONS

This environmental assessment was conducted to identify potential environmental effects of development of the proposed Highway 104 at Antigonish. This assessment fulfills the requirements for a Class II Undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. It also fulfills the requirements for a Screening under the *CEAA*. A preliminary environmental screening, functional analysis, and public consultation, have been completed by NSTPW as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the proposed South River crossing.

This assessment considered both biophysical and socioeconomic issues. It focussed on issues of greatest concern, otherwise known as VECs and VSCs. The issues were identified through a scoping process subsequent to NSTPW's preliminary environmental screening. Each of the following eight VECs and four VSCs selected for this assessment were evaluated for potential Project-related effects.

VECs

- Atmospheric Resources
- Groundwater Resources
- Fish and Fish Habitat
- Rare Herpetiles
- Rare Mammals and Critical Habitat
- Rare and Sensitive Birds
- Rare Plants and Plant Communities
- Wetlands

VSCs

- Local Economy
- Land Use
- Archaeological and Heritage Resources
- Transportation Infrastructure

Mitigation and monitoring have been proposed to reduce or eliminate potentially adverse effects (refer to Table 12.1) for each VEC/VSC. The significance of residual environmental effects (*i.e.*, after mitigation has been applied) including cumulative effects was also predicted for each VEC/VSC.

In general, potential adverse environmental effects on these VECs/VSCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods described in this report. Adverse residual effects therefore are predicted to be not significant for both construction and operation phases of the Project for all VECs and VSCs. Adherence to standard construction and operational procedures, the Project EPP, and contingency procedures will minimize the likelihood of malfunctions and accidental events. No significant adverse residual environmental effects are therefore predicted for any VEC/VSC with respect to malfunctions and accidental events.

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements

VEC/VSC	Mitigation	Follow-up and Monitoring
Atmospheric Resources	•• Application of water and dust suppressant to control dust as required •• Complaint resolution policy •• Cleanup of mud and dirt from paved roadways •• Noise controls and restricted working hours, especially at Sites 5 and 8	•• Dust monitoring as required to respond to community concerns
Groundwater Resources	•• Bedrock will be excavated by ripping where possible rather than blasting •• Avoidance of blasting within 500 m of residential wells and Lower South River wellfield to the extent possible •• Measures will be taken to minimize sedimentation and erosion potential •• Pre-blast survey •• Minimal exposure of slate bedrock or water table lowering •• Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed •• Apply drainage and vibration controls	•• Pre-construction well water survey and follow-up water level monitoring as required •• Blast monitoring •• Monitoring of dug wells during and following construction to ensure quality and quantity
Fish and Fish Habitat	•• Schedule instream work between June 1 through September 30 •• Adhere to the EPP •• Establish a 75 m buffer zone to exclude grubbing and grading from watercourse areas until watercourse crossing structures are installed •• Acid drainage risk testing during geotechnical program; application of management program if necessary •• Adhere to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) •• Exclusion of fish from area during blasting •• Acidic drainage management if necessary •• Habitat restoration •• Appropriate crossing method to minimize flow disruption •• Culvert alignment and sizing to accommodate fish passage as per DFO guidelines •• No application of herbicides: 1) within 30 m of any watercourse; 2) as prescribed on product label; and 3) within 60 m of a protected water supply. •• Installation of permanent erosion and sediment control measures •• Adhere to sediment and erosion control measures and vegetation management plans detailed in the EPP •• Maintain vegetated buffer zone around watercourses	•• Surface water quality monitoring during construction for total suspended solids and acid rock drainage as required •• Follow-up inspections to evaluate site and habitat restoration, bank protection and stability, and to ensure culvert installation allows fish passage where required
Rare Herpetiles	•• Conduct wood turtle presence/absence surveys •• Construction worker training and wood turtle relocation •• Consider design modifications to structures at Stream Crossing No. 11 (*e.g.*, open bottom culvert) at West River and at South River •• Public awareness campaign to decrease turtle strikes on road, and removal of turtles from habitat	•• Development of a wood turtle risk management program by NSTPW in coordination with NSDNR at the South River and the West River and its unnamed tributary at 8+150 (Stream Crossing No. 11)
Rare Mammals and Critical Habitat	•• Minimize vegetation clearing as practical for RoW preparation •• Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	•• None required

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements		
VEC/VSC	**Mitigation**	**Follow-up and Monitoring**
Rare and Sensitive Birds	•• Schedule clearing, grubbing, and grading to avoid breeding seasons •• Minimize the width of the cleared RoW •• Establish 200 m radius buffer zones around Osprey nests near route within which no construction is permitted •• Identify and mark minimum safe working area around bridge pier construction sites; approach roads to these sites will avoid habitat suitable for Nelson's Sharp-tailed Sparrow •• Where feasible, do not mow cleared RoW between April 1 and August 1 to avoid destruction of the nests of ground nesting species such as Bobolink •• Implement TPW's Integrated Roadside Vegetation Management program to reduce the necessity of mowing and brush cutting	•• None required
Rare Plants	•• Preferred mitigation to shift RoW to avoid rare or sensitive plants (shift RoW 125 m north at West River, 100 m south to avoid black ash at 12 + 700) is not feasible given presence of other constraints. •• Alternative mitigation for West River: 1) Design bridge structure to minimize the amount of intervale habitat disturbed by the bridge; 2) Plan the bridge pier construction sites to minimize the amount of habitat disturbed; 3) Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species; 4) Direct bridge drainage away from areas where rare or uncommon species are present; 5) Minimize amount of brine and salt contaminated slush and snow thrown over side of bridge by snow plows and vehicles; 6) Identify the West River section where rare species occur as a salt sensitive area to be a candidate for pre-wetting and anti-icing agents to reduce exposure to salt laden runoff •• Alternative mitigation for black ash is to plant black ash seedlings to replace the black ash lost to highway construction •• Purple milkweed: do not clear the portion of Wetland 2 that is located within the RoW but outside of the footprint of the highway; do not mow or brush cut wetland habitat at Wetland 2 •• Water loosestrife: carefully place and size culverts to ensure that the hydrology of Wetland 1 is not altered •• Marsh mermaid-weed: infill only the amount of wetland habitat required to construct a safe roadbed; carefully place and size culverts to ensure that the hydrology of Wetland 1 is not altered •• Minimize width of RoW to be cleared within mature climax and climax dominated forest	•• Monitor abundance and distributions populations of rare and uncommon plant species at West River crossing site as part of intervale habitat enhancement program

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements		
VEC/VSC	**Mitigation**	**Follow-up and Monitoring**
Wetlands	•• Avoid wetland habitat wherever feasible •• Where avoidance is not feasible, mitigate loss through Wetland Compensation Plan •• Implement erosion and sediment controls to prevent sedimentation of wetlands •• Design the highway and associated drainage system to avoid altering wetland hydrology •• Consider type of structure at Wetland 11 to reduce the incidence of roadkill •• Wetlands 1, 6, 11, and 12: salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities •• Wetlands 1, 2, 6, 7, and 19: salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat. Test salvaged soil to ensure that toxic concentrations contaminants will not be released when the soil is moved •• Wetlands 1, 2, 10, 15, and 17: minimize the amount of wetland habitat affected by clearing, grubbing and infilling only the portion of the wetland required for construction of the roadbed •• Wetland 21 (South River): design bridge structure to minimize amount of habitat affected; minimize infilling of flood plain; locate the bridge structure as close as possible to the existing structure to minimize footprint	•• Development of Wetland Compensation Plan •• If applicable, monitoring and functional analysis of replacement wetland habitat to determine if constructed wetlands are suitable compensation
Local Economy	•• Open and early communication with landowners •• Ongoing Liaison/information through a CLC and municipal officials to reduce disruption and promote economic planning •• Underpasses/overpasses to maintain or improve access where practical •• Appropriate signage, lighting, landscape design at interchanges •• Explore construction of a visible Visitor Information Centre •• Strategic planning for new economic growth •• Fair and reasonable compensation and/or land swap •• Adequate planning time •• Traffic Management	•• Monitoring during construction phase by the Project Engineers to ensure that access to businesses and other establishments are adequately maintained and signage is provided as necessary •• Monitoring of long term effects on local businesses and the economy through the CLC and periodic reporting of findings to NSTPW and municipal officials who will jointly determine remedial actions needed
Land Use	•• Open and early communication with landowners through the CLC and other mechanisms •• Adequate relocation time •• Fair and reasonable compensation and/or land swap •• Noise and dust controls including restricted working hours •• Traffic management •• Overpass/underpasses to maintain access •• Maintain, to the extent possible, existing access roads •• Maintain access to properties; negotiate with landowners to realign/construct replacement access roads during construction	•• CLC to remain in close consultation with property owners along the RoW to discuss scheduling, temporary and permanent alternate access roads, and to monitor other Project elements of concern to local residents and landowners

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements		
VEC/VSC	**Mitigation**	**Follow-up and Monitoring**
Archaeological and Heritage Resources	•• Documentation and test excavation of standing heritage resources prior to disturbance (*i.e.*, additional archival research, test excavations) •• Monitoring of area of nineteenth century carriage house during construction at South River crossing	•• Monitoring during construction activities if necessary
Transportation	•• Alignment location and access roads will minimize impacts to severed properties •• Kell and Cunningham Roads traffic volumes are low and a convenient service road to Trunk 7 will be provided •• Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual* •• Locate paving batch plants adjacent to new alignment	•• Traffic counts will be done every three years as per NSTPW standard procedure

The mitigative measures contained in this report, along with standard mitigative construction and operation procedures will be documented in an EPP for construction and operation of the highway.

Operation of a four-lane controlled access highway in the study area will provide safe, convenient, economic and efficient movement of persons and goods through the area. Thus a positive effect will be provided to the province with the development of this Project. Decreased traffic along the existing Highway 104, will contribute to a quieter, safer living environment for most residents. Most of the heavy trucks (through traffic) that traverse the existing Highway 104 will divert to the new highway reducing public concerns for safety and noise.

In summary, this Project will provide a long term public benefit by reducing current traffic volumes on the existing Highway 104. It will also provide infrastructure to handle future traffic volumes and patterns, thereby improving public safety.

13.0 REFERENCES

13.1 Literature Cited

Antigonish County Museum. 2002. Antigonish County Book 5, District 5, Site # 191 - 290. Antigonish, NS.

Antigonish Regional Development Authority (ARDA). 2002. Antigonish Demographics, Industry, and Services. Internet Publication: http://www.antigonishrda.ns.ca Accessed October, 2002.

Atlantic Canada Conservation Data Centre (ACCDC). 2002a. Species Lists and Rare Species. Internet Publication: http://www.accdc.com/products/lists/. Last updated February 19, 2003.

ACCDC. 2002b. Zoological Data Developed by the Association for Biodiversity's Central Zoology Group, in Cooperation with US Natural Heritage Programs and Canadian Conservation Data Centres and Other Contributors and Cooperators. Sackville, NB

Atlantic Road and Traffic Management. 2002. Antigonish Education Centre Access Road Study. Prepared for Nova Scotia Department of Transportation and Public Works.

Barnes, J.L., M. Stephenson and L.H. Davey. 2000. An Integrated Approach to Cumulative Environmental Effects Assessment, Meeting the Requirements of the Canadian Environmental Assessment Act. In: Proceedings of the 27th Annual Toxicity Workshop: October 1-4, 2000, St. John's, NF. Canadian Technical Report of Fisheries and Aquatic Sciences, 2331.

Beanlands, G.E. and P.N. Duinker. 1983. An Ecological Framework for Environmental Impact Assessment in Canada. Institute for Resource and Environmental Studies, Dalhousie University, in cooperation with the Federal Environmental Assessment Review Office. 132 pp.

Beasy Nicoll Engineering Limited. 1999. Highway 104 Antigonish Safety Review. Prepared for Nova Scotia Department of Transportation and Public Works.

Boehner, R.C. and P.S. Giles. 1993. Geology of the Antigonish Basin, Antigonish County, Nova Scotia, Mines and Energy Branch Memoir 8. Nova Scotia Department of Natural Resources, NS. 109 pp.

Canadian Environmental Assessment Agency (CEA Agency). 1999a. Cumulative Effects Assessment Practitioners Guide. Prepared by Canadian Environmental Assessment Working Group and AXYS Environmental Consulting Ltd.

CEA Agency. 1999b. Addressing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*. Operational Policy Statement OPS-EPO/3-1999.

CEA Agency. 1997. Guide to the Preparation of a Comprehensive Study for Proponents and Responsible Authorities.

CEA Agency. 1994. Responsible Authority's Guide. Hull, QE. November 1994.

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines. Ottawa, ON.

CCME. 1987. Canadian Environmental Quality Guidelines. Ottawa, ON.

Carroll, J.E. and D.H. Ehrenfeld. 1978. Intermediate and Range Homing in the Wood Turtle , Clemmys insculpta. Copein 1978; pp. 117-126.

Church, A.F., c 1869-1873. Topographical Township Map of Antigonish County, Nova Scotia. Halifax: A.F. Church and Company.

C.J. MacLellan and Associates Inc. 2002. Lower South River and St. Andrews Water Supply Investigation and Infrastructure Upgrade Draft Report.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. Internet Publication. http://www.sis.ec.gc.ca/msapps/ec_species/htdocs/ec_species_e.phtml. Last updated May, 2002.

Conrad, V. and Jansen H. 1994. Fish Passage and Habitat Preservation for Highway Culverts, Eastern Canada. Doc. No. 94-01. Department of Fisheries and Oceans. Halifax, NS.

Cowan, J.P. 1994. Handbook of Environmental Acorestics. Van Nostrand Reinhold, New York. 283 pp.

Crowell, M. Roadkill data collected for a 100 Series Highway, secondary highway and city streets in Nova Scotia over a two year period (1993-1994). Unpublished data.

Davis, D and S. Browne. 1996. The Natural History of Nova Scotia. Nimbus Publishing and the Nova Scotia Museum.

Environment Canada. 2004. Code of Practice for the Environmental Management of Road Salts. EPSI/CC/5. April 2004.

Environment Canada. 2003. Climate Data Online Monthly Data Report for 2002 (Collegeville, Nova Scotia). Internet Publication.
http://www.climate.weatheroffice.ec.gc.ca/climateData/monthlydata_e.html. Last updated Jul 23, 2003.

Environment Canada. 2002. Canadian Climate Normals 1971-2000 for Collegeville, Nova Scotia. Internet Publication. http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html. Last updated December 31, 2002.

Environment Canada. 1979. Environmental Code of Good Practice for General Construction. EPS Report 1-EC-79-2.

Environment Canada and Health Canada. 2001. Priority Substances List Assessment Report. Road Salts.

Environmental Design and Management. 1998. A Visibility Analysis of Alternative Alignments for Highway 104 at Antigonish. Prepared for Nova Scotia Department of Transportation and Communication.

Erskine, A.J. 1992. Atlas of Breeding Birds of The Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS. 270 pp.

Federal Highway Administration (FHWA). 2000. Critter Crossings: Salamander Tunnels. Internet Publication: http://www.fhwa.dot.gov//////environment/wildlifecrossings/salamand.htm Last updated March 21, 2000.

Fisheries and Oceans Canada. 1986. Policy for the Management of Fish Habitat. Ottawa, ON.

Fisheries and Oceans Canada, Nova Scotia Department of the Environment and Nova Scotia Department of Transportation and Communications. 1981. Province of Nova Scotia Environmental Construction Practice Specifications. Halifax, NS.

Fletcher and Fairbault. 1893. Map of Antigonish. Prepared for the Geological Service of Canada.

Forbes, D.L., J. Shaw and R.B. Taylor. 1997. Climate change in the coastal zone of Atlantic Canada In: R.W. Shaw (ed.). Climate Change and Climate Variability in Atlantic Canada. Environment Canada-Atlantic Region. Occasional Report No. 9.

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna in Nova Scotia. Draft internal document. Nova Scotia Museum of Natural History, Halifax, NS.

Gibb, J.E. and J. F. Jones. 1974. Pollution hazard to groundwater in Nova Scotia. Nova Scotia Department of Environment Water Planning and Management Bulletin No. 1-74.

Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, NS 162 pp.

Gilhen, J. and F. Scott. 1981. Distributions, habitats and vulnerability of amphibians, reptiles, and small native mammals in Nova Scotia. Curatorial Report Number 45. Nova Scotia Museum. Halifax, NS.

Grant, D.R. 1975. Recent coastal submergence of the Maritime Provinces. Proceedings, Nova Scotia Institute of Science 27: 83-102.

Health Canada, 1999. Guidelines for Canadian Drinking Water Quality, Internet Ed. Prepared by Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health. Canada Communications Group Pub., Ottawa, ON.

Jacques Whitford Environment Limited (JWEL). 2001. Environmental Background Study, Gunningsville Bridge Replacement. Prepared for the New Brunswick Department of Transportation.

JWEL. 1998. Northumberland Strait Crossing Project Terrestrial Environmental Effects Monitoring Program: 1997 Results. Prepared for Northumberland Strait Crossing Inc.

Leedy, D.L. and L. W. Adams. 1982. Wildlife considerations in planning and managing highway corridors. Report No. FWHA-TS-82-212. Office of Research, Federal Highway Administration. US Department of Administration, Washington.

Lewis, P. J. 1997. Trends. In: Shaw, R.W. (ed.). Climate Variability and Climate Change in Atlantic Canada. Proceedings of a Workshop Halifax, Nova Scotia, 3-6 December 1996. Prepared for Environment Canada.

Lord, B.N. 1985. Highway runoff/drainage impacts. p. 387-390. In Perspectives on nonpoint source pollution. Proceedings of a National Conference. Kansas City, Missouri, May 12-22, 1985. EPA 440/5-85-001. pp. 514.

Louis Berger (Canada) Ltd. 1996. An Assessment of the Economic Impact of Upgrading the Trans Canada Highway 104 to a Four-Lane, Divided, Controlled Access Highway Through Antigonish County. Prepared for the Antigonish Chamber of Commerce.

Maltby, L., Forrow, D.M., Boxall, A.B.A., Calow, P., and Betton, C.I. 1995. The Effects of Motorway Runoff on Freshwater Ecosystems: 1. Field study. Environ. Toxicol. Chem. 14(6):1079-1092. Ibid. 2: Identifying major toxicants. Environ. Toxicol. Chem. 14(6):1093-1101)

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters- Taxa Tolerance Values, Metrics, and Protocols. Project H-1, Soil & Water Conservation Society of Metro Halifax. xviii, 48p., Appendices A-B. 120p total.

Maritime Resource Management Service. 1975a. Strait of Canso Natural Environment Inventory: Geological Resources. Canada-Nova Scotia Strait of Canso Environment Committee.

Maritime Resource Management Service. 1975b. Strait of Canso Natural Environment Inventory: Water Resources. Canada-Nova Scotia Strait of Canso Environment Committee.

May, D. N. 1978. Handbook of Noise Assessment. VanNostrand Reinhold Company, Toronto, ON.

Municipality of the County of Antigonish. 2002. Beaches Parks, Trails and Nature Sites. Internet Publication. http://www.antigonishcounty.ns.ca/NatureSites.htm. Accessed October, 2002

National Energy Board (NEB) and CEA Agency. 1996. Report of the Joint Review Panel for the Express Pipeline Project.

National Wetlands Working Group. 1987. The Canadian Wetland Classification System. Lands Conservation Branch, Canadian Wildlife Service, Environment Canada; Ecological Land Classification Series No. 21, 17 pp.

Neill and Gunter Ltd. 2001. Highway 104 Antigonish South River Impact Study. Prepared for Nova Scotia Department of Transportation and Public Works.

Nova Scotia Department of Agriculture and Fisheries (NSDAF). 2002. Aquaculture Sites of Nova Scotia. http://www.nsgc.gov.ns.ca/fishaqua/ Last Updated January 17, 2002

NSDAF. 2000. The Nova Scotia Fishery Statistical Overview 1999. Nova Scotia Department of Agriculture and Fisheries. October 2000. 61pp.

Nova Scotia Department of Environment (NSDOE). 1999. Pit and Quarry Guidelines. Halifax, NS.

NSDOE. 1998. The State of the Nova Scotia Environment 1998. Halifax, NS.

NSDOE. 1997. Nova Scotia Watercourse Alteration Specifications (1997).

NSDOE. 1996. Guidelines for the Management of Contaminated Sites in Nova Scotia. Halifax, NS.

NSDOE. 1995a. Wetlands Directive. Halifax, NS.

NSDOE. 1995b. Ambient Air Quality in Nova Scotia 1995. Industrial and Air Quality Branch. Halifax, NS.

NSDOE. 1989. Guideline for Environmental Noise Measurement and Assessment.

NSDOE. 1988. Erosion and Sedimentation Control Handbook for Construction Sites. Halifax, NS.

NSDOE and Environment Canada. 1991. Guidelines for Development on Slates in Nova Scotia.

Nova Scotia Department of Environment and Labour NSDEL. 2002a. Terms of Reference As Required by the *Environment Act*. Highway 104, Antigonish. Antigonish, NS.

NSDEL. 2002b. Comments Submitted on the Proposed Terms of Reference and Environmental Registration Document. Highway 104, Antigonish. Antigonish, NS

NSDEL. 2002c. Heritage Rivers in Nova Scotia. Internet Publication. http://www.gov.ns.ca/enla/pareas/protmap.htm. Last updated November 08, 2002

NSDEL. 1973 - 2001. Pumping Test Inventory. Open File Reports 1973-2001.

NSDEL. 1969 - 2000. Well Driller Records.

Nova Scotia Department of Natural Resources (NSDNR). 2002a. General Status Ranks of Wild Species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/ranks.asp.

NSDNR. 2002b. Species at Risk in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/endgrd/specieslist.htm.

Nova Scotia Department of Transportation and Communications (NSDOTC). 1991. Highway Environmental Database Study. Prepared by Porter Dillon.

NSDOTC. 1990. Approval Process for Pits Containing Slates. Halifax, NS.

Nova Scotia Department of Transportation and Public Works (NSTPW). 2002a. Motor Vehicle Collision Rates for Numbered Highways and Sections 1996 to 2000. March 2002.

NSTPW. 2002b. Traffic Volumes Primary Highway System 1992-2001. March 2002.

NSTPW. 2001a. Environmental Assessment Registration Document for the Highway 104 at Antigonish. November 2001.

NSTPW. 2001b. Highway 104 Fact Sheet Open House May 2001. Antigonish, NS.

NSTPW. 2001c. Permanent Counter Data from Marshy Hope. Highway 104 West of Antigonish, NS.

NSTPW. 1999. Highway 104 Antigonish Alignment Recommendation Report. April 1999.

NSTPW. 1997 and revisions. Highway Construction and Maintenance Standard Specifications.

NSTPW. 1997a. Environmental Screening. Highway 104, Antigonish.

NSTPW. 1997b. Motor Vehicle Accident Rates for Numbered Highways and Sections 1992 to 1996. July 1997.

Nova Scotia Tourism and Culture. 2002. 2000 Nova Scotia Visitor Traffic Flow. Internet Publication: http://www.nstpc.com/docs/Traffic_Flow_Report.pdf. Prepared by Corporate Research Group. February 2002.

Pronych, G. and A. Wilson. 1993. Atlas of Rare Vascular Plants in Nova Scotia. Nova Scotia Museum of Natural History, Halifax, NS, Curatorial Report No. 78, 331 pp.

Reijnen, R. and R. Foppen. 1994. The effects of car traffic on breeding bird populations in woodland. I. Evidence of reduced habitat quality for Willow warblers breeding close to a highway. Journal of Applied Ecology. 31:85-94.

Scott, F.W. 1994. Provisional annotated list of plant and animal species considered to be rare in Nova Scotia. Nova Scotia Museum of Natural History, Halifax, Nova Scotia, 12 pp.

Scott, A. and J. DeChiara. 2000. Peer Review Highway 104 at Antigonish. Prepared for Nova Scotia Department of Transportation and Public Works.

Shaw, J. and Forbes, D.L. 1999. Short-and long-term relative sea-level trends in Atlantic Canada. Proceedings, Canadian Coastal Conference 1990, Kingston. National Research Council Canada, Ottawa. p 291-305.

Spencer, I. 2000. Estimating the Impact of Upgrading the Trans Canada Highway Near Antigonish. Submitted to the Consulting Team, Accessing TCH Routes Through Antigonish, Nova Scotia.

Statistics Canada. 2001. Community Profiles, Antigonish, Nova Scotia, Statistics Canada, 1996 and 2001. www.statcan.ca

Statistics Canada. 1999. The Daily. Monday, December 13, 1999. Household spending, dwelling characteristics and household facilities. Internet Publication: http://www.statcan.ca/Daily/English/991213/d991213a.htm.

Storgaard and Associates. 1979. Environmental Code of Good Practice for Highways and Railways. Environmental Protection Service, Environment Canada.

Taylor, B.R. and M.A. Juurlink. 2004. An Ecological Survey of West Street Marsh, Antigonish, NS.

Transportation Research Board. 1991. Highway Deicing: Comparing Salt and Calcium Magnesium Acetate, Special Report 235. Transportation Research Board, Washington, DC.

Tufts, R.W. 1986. Birds of Nova Scotia, 3rd Edition. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS, 478 pp.

Trails Nova Scotia. http://www.trails.gov.ns.ca. Accessed February 25, 2003

Wilcox, D.A. 1986. The Effects of Deicing Salts on Vegetation in Pinhook Bog, Indianna. Canadian Journal of Botany. 64(4): p. 865-874.

Wright, D.G. and G. F. Hopky. 1998. Guidelines for the Use of Explosives in Canadian Fisheries Waters. Canadian Technical Report of Fisheries and Aquatic Sciences. 2107.

Yahner, R. 1988. Changes in wildlife communities near edges. Conservation Biology 2(4): 333-9.

13.2 Personal Communications

Arisz, Hans. Hydrocom Technologies Inc. 2002

Gerriets, Stefen. Atlantic Canada Conservation Data Centre.

Gilhen, John. Retired from the Nova Scotia Museum of Natural History. 2002.

Goth, Danielle. Department of Fisheries and Oceans. 2002.

Hebda, Andrew. Nova Scotia Museum of Natural History. 2002

Macdonald, Mike. Jacques Whitford Environment Limited. 2002.

MacInnis, Charles. Department of Fisheries and Oceans. 2004

Munroe, Marion. Nova Scotia Museum of Natural History. 2002.

Poder, Tiiu. Enterprise Development Centre. 2002

Parker, John. Antigonish Regional Development Authority. 2002

Pulsifer, Mark. Nova Scotia Department of Natural Resources. 2002

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