6.0 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

6.1 Methodology

Section 16(1)(a) of *CEAA* requires that every comprehensive study of a project shall include a consideration of any 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. The *Cumulative Effects Practitioners Guide* (Hegmann *et al*. 1999) offers guidance on how to meet this requirement. The following numbered list outlines the framework that was used for the assessment of Project-related cumulative environmental effects in consideration of the requirements of the Act, the guidance of the Agency, and the Guidelines.

1. Identify the issues through scoping and select VECs on which to focus the cumulative environmental effects assessment.
2. Identify those past, present and future projects and activities that will be carried out, that could result in cumulative environmental effects in combination with those of the Project.
3. Summarize the residual environmental effects of the Project.
4. Identify issues and select indicators to focus the cumulative environmental effects analysis for each VEC.
5. Establish temporal and spatial assessment boundaries for each indicator.
6. Identify the likely interactions (*i.e.*, overlapping effects) between the Project and other past, present and future projects and activities that will be carried out.
7. Evaluate and analyze the cumulative environmental effects on each indicator based on historical trends and the existing conditions.
8. Evaluate and analyze the cumulative environmental effects on each indicator of the residual environmental effects of the Project in combination with those of other future projects and activities that will be carried out.
9. Summarize the cumulative environmental effects of all past, present and future projects that will be carried out, for each indicator.
10. Determine the significance of the cumulative environmental effects on the VEC by applying the residual environmental effects rating criteria, as applicable.
11. Outline any follow-up that is recommended in respect of cumulative environmental effects, beyond that recommended in relation to the Project.

6.2 Selection of Valued Environmental Components

The Guidelines were developed in consultation with the federal and provincial regulators of the Technical Review Committee. The selection of cumulative environmental assessment VECs represents the concerns of those regulators and are reflective of the likelihood and magnitude of potential environmental effects of the Project on the environment, as predicted at that time. The following list includes all VECs required by the Guidelines for the analysis of cumulative environmental effects:

- Moose and moose habitat;
- Species of special conservation concern (including migratory birds) and their habitat;
- Fish habitat and water quality;
- Agricultural land;
- Appalachian Hardwood Forest; and
- Wetlands.

For convenience of analysis, the suggested Species of Special Conservation Concern VEC is considered in three different VECs. Atlantic Salmon was selected as a VEC to address concerns regarding this species raised by DFO and during public consultation, and due to the likelihood that they may soon be under the protection of *SARA*. There are no other fish species of special conservation concern that have the potential to be affected by Project-related activities. Vascular plant species of special conservation concern (as designated by COSEWIC and ACCDC), are largely associated in the vicinity of the Project in the Appalachian Hardwood Forest. As a consequence, these vascular plant species are considered in this cumulative environmental effects assessment as a part of the Appalachian Hardwood Forest VEC. Migratory Birds of Special Conservation Concern was selected as a VEC to address concerns regarding these species as raised specifically by Environment Canada. There are no other wildlife species of Special Conservation Concern with Project-related residual environmental effects.

Table 6.2.1 provides the indicators that have been selected in consultation with the Technical Review Committee. The rationale for their selection is provided in each VEC section.

Table 6.2.1 VECs and Indicators for Cumulative Environmental Effects Assessment

Valued Environmental Component	**Indicator(s)**
Fish Habitat and Water Quality	Sedimentation
Atlantic Salmon	Upper Saint John River Atlantic Salmon Returns
Appalachian Hardwood Forest	Loss of AHF Habitat
Wetlands	Loss of Wetland Area
Moose and Moose Habitat	Moose Population
Migratory Birds of Special Conservation Concern	Mature Forest Migratory Bird Habitat Loss and Fragmentation
Agricultural Land	Agricultural Land Area

6.3 Identification of Past, Present and Future Projects and Activities

The selection of past projects and activities that may have had environmental effects that interact with those of the Project are selected separately for each VEC. The level of inclusion of these past projects in the cumulative environmental effects analysis is limited by the availability of data and information.

The selection of current and future projects was accomplished in consultation with NBDELG personnel (David Maguire and Bernie Doucet, pers. comm.). These other projects were selected based on their proximity to the Project, the possibility of interactions with the environmental effects of the Project, and the likelihood of the other project(s) being carried forward (*i.e.*, the project is registered with the Province under the *Environmental Impact Assessment Regulation*). In addition, the Technical Review Committee requested that all NBDOT Trans-Canada Highway projects between Saint-Léonard and Longs Creek (near Fredericton), also be included. These Projects are described although in several instances, Project-related environmental effects do not overlap with these other projects. As a consequence, other projects are considered within defined, VEC-specific environmental assessment boundaries, in a manner that affects both the availability of data regarding the environmental effects of past projects, and the degree to which Project environmental effects may overlap with those of other projects. The Moncton to Fredericton section of the TCH was determined to be unlikely to interact cumulatively with the residual environmental effects of the Project, and is therefore not included in the cumulative environmental effect assessment.

Current and future activities (*e.g.*, hunting and fishing) were selected based on public and regulatory consultation, and the professional observations and opinions of members of the field study teams.

The other projects and activities that potentially act in combination with the environmental effects of the Project have been grouped into the following five categories:

- Existing Highways and Roads;
- Current and Future Highway Projects;
- Planned Development along Proposed TCH;
- Adjacent Land Uses; and
- Other Planned Development.

Figure 6.3.1 presents the location of each of the other current and future selected projects, and all sections of the Trans-Canada Highway (including the existing Trans-Canada Highway) between Saint-Léonard and Longs Creek. In addition, the locations of hydroelectric facilities are also presented. The location of activities is not presented in Figure 6.3.1 as they are dispersed or diffuse and not possible to effectively depict cartographically. Where possible within each VEC analysis, more specific location descriptions, or reference to other figures within this report, are provided.

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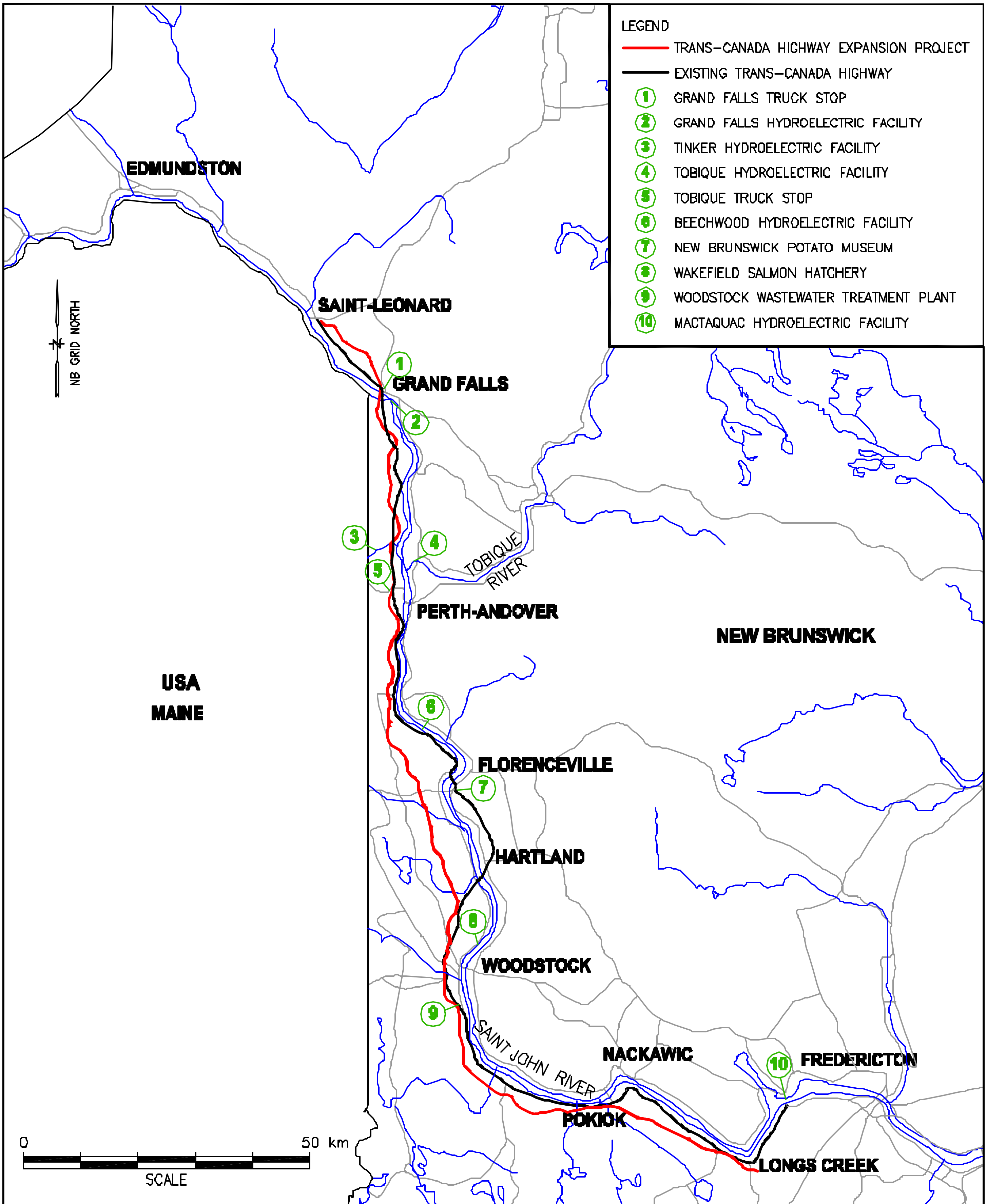

LOCATIONS OF OTHER PROJECTS AND ACTIVITIES

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Job No.: 14677	Fig. No.: 6.3.1

Jacques Whitford
Consulting Engineers
Environmental Scientists

6.3.1 Existing Highways and Roads

This category includes the existing TCH, as developed in the 1960's, other highway types (arterial, local and collector), secondary roads, and recently completed TCH projects.

The existing highways and roads carry traffic loads and therefore have associated noise, contaminant and greenhouse gas emissions, and the potential for wildlife encounters (*e.g.*, vehicle-wildlife accidents). The construction of these roads resulted in the loss of forest and agricultural lands from service, the further division of the landscape, and the crossing of multiple watercourses. Some watercourse crossings may be acting as barriers or partial barriers to fish passage.

Activities that are ongoing or that are likely to occur on the existing highways and roads are primarily related to general maintenance. These include resurfacing, repainting of lines, maintenance of culverts and bridges, replacement of signage or guiderails, summer vegetation maintenance (*e.g.*, mowing and tree cutting), and winter safety maintenance (*e.g.*, sanding, salting and plowing).

6.3.1.1 Existing TCH

The existing TCH between Perth-Andover and Woodstock is approximately 76 km (between Route 190 and Route 550) in length, is a two-lane highway with occasional passing lanes (*i.e.*, 3 lanes for short distances) and has an average purchased RoW width (including area of vegetation maintenance) of 80 m. It began its operational phase in the late 1960s. The total footprint is approximately 610 ha. The existing TCH crosses over to the east bank of the Saint John River between Florenceville and Hartland. It crosses a total of 43 watercourses (at district mapping 1:50,000 scale), not including the Saint John River, which it crosses in both Florenceville and Hartland. Fish passage has been impeded (*e.g.*, from debris) at many of the smaller watercourses crossed by the existing TCH.

6.3.1.2 Local Highways and Roads

There are two arterial highways between Saint-Léonard and Longs Creek. These are Highway 95 (between Woodstock and Houlton, Maine), and Highway 3 (between Longs Creek and McAdam).

There are also some collector highways within this region. The collector highways that are within the region between Saint-Léonard and Longs Creek, in order of increasing distance from the Project, are Highway 190 (at Perth-Andover), Highway 107 (at Bristol), Highway 110 (at Florenceville), Highway 103 (between Florenceville and Bull's Creek near Woodstock), Highway 105 (along the east shore of the Saint John River between Grand Falls and Longs Creek), and Highway 122 (at Meductic).

There are six local highways that cross the Existing TCH or proposed TCH between Saint-Léonard and Longs Creek. The local highways that are within the region between Saint-Léonard and Longs Creek, in order of increasing distance from the Project, are Highway 560 (between River de Chute and Woodstock, Highway 555 and 550 (near Woodstock), Highway 375 (between Grand Falls and Aroostook), and Highway 635 (near Lower Prince William).

There are relatively few paved secondary roads in the vicinity of the Project. The majority of secondary roads are unimproved and were developed as access roads for agricultural or forestry use.

6.3.1.3 Saint-Léonard to Grand Falls TCH

The project includes highway upgrading activities between Saint-Léonard and Grand Falls to increase the capacity of the TCH and to improve the safety of the motoring public. The nearest location of this section of highway is approximately 35 km from the Project. This section of highway opened in December 2003. This project included the construction of a new section of four-lane divided paved highway, totaling approximately 17 km in length. The total footprint of the project is approximately 240 ha. The project crosses 13 watercourses. A twin structure crossing the Saint John River was required on the south side of the existing structure at Grand Falls. The project was subject to a screening level environmental assessment under *CEAA*, and was screened out under the New Brunswick environmental impact assessment process (NBDOT 2001, 1999a, b).

6.3.1.4 Perth-Andover By-Pass TCH

Recent activities included upgrading the existing by-pass over Route 190 to facilitate access for motorists departing Perth-Andover. The nearest location of this section of highway is immediately adjacent to the northern limits of the Project. This 7.3 km section of the proposed TCH is a component of NBDOT's four-lane initiative, and carries traffic on new eastbound lanes. However, the project included some twinning on portions of both the east and west-bound lanes. The total footprint of the project is approximately 50 ha. The project crosses 9 watercourses, the majority of which are unnamed tributaries of the Saint John River. The project was opened in November of 2003. The project was subject to a screening level environmental assessment under *CEAA*, and was registered under the New Brunswick environmental impact assessment process.

6.3.1.5 Woodstock to Pokiok TCH

This stretch of the TCH was opened in late 2003. The nearest location (Bull's Creek) is approximately 5 km south of the southern limits of the Project. This section was divided into 2 sections (Bull's Creek to Meductic, and Meductic to Pokiok) during the planning and environmental assessment phase. The project included the construction of a new section of four-lane divided paved highway, totaling 28.5 km in length and the twinning of a 5.2 km section of the existing TCH. The total footprint of the project is approximately 425 ha. The project crosses 17 watercourses (9 watercourses for Bull's Creek to Meductic and 8 watercourses for Meductic to Pokiok). The projects were subject to screening level environmental assessments under *CEAA*, and under the New Brunswick environmental impact assessment process (NBDOT 1998a, b).

6.3.2 Current and Future Highway Projects

This category includes sections of the TCH that are currently under development, or that are scheduled for development within the next 5 years.

6.3.2.1 Grand Falls to Aroostook TCH

Plans are in place (pending regulatory approval) for the future construction of a 30 km long stretch of twinned, divided and paved highway located between Grand-Falls and Aroostook to increase the capacity of the TCH and to improve the safety of the motoring public. The nearest location (Aroostook) of this section of highway is 7.3 km north of the northern limit of the Project (Perth-Andover). The project will result in the permanent loss of 331 ha, of which approximately 250 ha are forested land and 35 ha are agricultural/grass land. The project crosses 15 watercourses, the largest being the Aroostook River. Clearing and grubbing may begin as early as the fall/winter of 2004. The project will be completed during 2007. The project is the subject to a screening level environmental assessment under *CEAA*, and was registered under the New Brunswick environmental impact assessment process (JWEL 2004).

6.3.2.2 Florenceville Bridge and Route 110 Interchange

The undertaking will consist of upgrading the interchange movements for the TCH and Route 110 in the Village of Florenceville. This project is located within the spatial limits of the Project. A short on ramp from the existing Route 110 to the TCH will be removed. It will be replaced with a realignment of Route 110 and Hume Road, as well include new on/off ramps to and from the eastbound lane of the TCH and a left-turning lane from the westbound lane. This project is scheduled for completion in 2005.

6.3.2.3 Lockhart Mill Interchange TCH

The Lockhart Mill Interchange project is proposed to improve conditions at that location in the immediate future, and provide for improved functionality when the Perth-Andover to Woodstock TCH project is completed. This project is located within the spatial limits of the Project. The proposed upgrade consists of a number of elements. These include the construction of 2 km of adjacent sections of the existing TCH and an interchange at the Lockhart Mill Road with on and off ramps, removal of the existing TCH eastbound on ramp, upgrading of 230 m of the Sawyer Road, and construction of a watercourse crossing. The project crosses one unnamed watercourse. This project will be completed in 2004. The project was subject to a screening level environmental assessment under *CEAA*, and was registered under the New Brunswick environmental impact assessment process (ACER 2002).

6.3.2.4 Meduxnekeag River Bridge TCH

The existing 45 year-old Meduxnekeag River Bridge No 2. (east bridge structure) is showing indications of progressive deterioration. The roadway surface is narrow compared with today's standards and the lightweight metal guide rail system does not present the confinement to prevent errant vehicles from exiting the bridge deck, in the event of an accident.

The undertaking will consist of the complete replacement of the east bridge structure with a new modern bridge structure. The bridge is a major structural element of the Provincial Highway System carrying the westbound lanes of the TCH across the Meduxnekeag River Valley near the Town of Woodstock, New Brunswick. This will involve the removal of the existing 11 pier foundations and the installation of 5 new pier foundations. The total length of the proposed new bridge structure is approximately 353 m, which is slightly longer than the original structure, and will be designed to meet the current Canadian Highway Bridge Design Code. The new bridge structure will also be designed to be aesthetically similar to the existing Meduxnekeag River Bridge No. 1 (west bridge structure). In addition, the west bridge structure will undergo some refurbishment. This project was registered in January 2004, and will require federal funding and therefore will require an environmental assessment under *CEAA*.

6.3.2.5 Route 95 (Woodstock to Houlton)

Route 95 (Woodstock to Houlton) is an existing paved highway consisting primarily of two lanes. The nearest location (Woodstock) of this section of highway is immediately adjacent to the southern limit of the Project. The highway is approximately 12.2 km in length stretching from Woodstock, NB to Houlton, Maine. Potential future plans for this highway are to upgrade it to a four-lane highway to facilitate traffic flow between the Interstate 95 at Houlton and the TCH at Woodstock. The highway will be twinned by widening the RoW on the north side of the existing road. The total footprint of the project is approximately 200 ha. The project will cross 5 watercourses, and two additional watercourses are likely within 30 meters of the RoW. The project may also cross the edge of a wetland. This project was registered in January 2004, and will require federal funding and therefore will require an environmental assessment under *CEAA*.

6.3.2.6 Pokiok to Longs Creek TCH

Plans are in place for the future construction of a 33 km long stretch of four-lane, divided and paved highway, located between Pokiok and Longs Creek, New Brunswick, to increase the capacity of the TCH and to improve the safety of the motoring public. The nearest location (Pokiok) of this section of highway is 25 km east of the southern limit of the Project. Longs Creek is 58 km from Woodstock. The project will result in the permanent loss of approximately 450 ha of forested land and 4 ha of agricultural/grass land. The project crosses 16 watercourses, the closest to the Project being Allandale Stream. Clearing commenced in the winter of 2004. The project will be completed during 2006. The project was subject to a screening level environmental assessment under *CEAA*, and was registered under the New Brunswick environmental impact assessment process (JWEL 2003e).

6.3.3 Adjacent Land Uses

This category includes all adjacent land uses, that are not related to a specific project, that may have overlapping environmental effects with those of the Project.

6.3.3.1 Forest Resource Harvesting

Forest resource harvesting activities in the vicinity of the Project is extensive (Section 5.11.3.6) and consists of both the harvesting of wood for commercial profit (*e.g*., woodlots) and for domestic (*e.g*., personal) use.

6.3.3.2 Agriculture

Agricultural land use in the vicinity of the Project is extensive (Section 5.11.3.5) and consists of both high yield commercial farming activities for profit and of low yield domestic (for personal consumption only) activities. The majority of the agricultural land located in the vicinity of the Project is used for the cultivation of potatoes in rotation with barley and fallow crops. Other agricultural activities on the adjacent or nearby land include the cultivation of wheat, berries, and vegetables, as well as the rearing of livestock.

6.3.3.3 Hydroelectric Power Generation

A series of hydroelectric power developments were constructed by, or purchased by, the New Brunswick Electrical Power Commission (NBEPC) along the Saint John River. Table 6.3.1 provides general operating information for each facility. The first of these was constructed in the early 1950's on the Tobique Maliseet Nation Reserve at the Tobique Narrows of the Tobique River. The next facility was constructed at Beechwood and has a head of 17 m and is located 130 km upriver of what is now the

Mactaquac generating station. The Beechwood generating station contains a fish collection gallery and a mechanical skip-hoist that lifts fish over the dam into the headpond. The NBEPC purchased the Grand Falls generating station from International Paper in the late 1950's. The Mactaquac generating station was built between 1967 and 1980 and is located approximately 20 km upriver of downtown Fredericton. It has a maximum head of 35 m. Fish passage occurs through a fish collection facility situated at the base of the dam, which is comprised of a collection gallery, holding pool, crowder and hopper.

In addition to these NBEPC/NB Power owned stations, there is a small generating station at Tinker, NB, on the Aroostook River. The American-owned, WPS Hydroelectric Power Dam at Tinker is operated as a "peaking" station, where water is discharged for power generation during periods of high demand, and has no fish passage facilities.

Table 6.3.1 Saint John River Hydroelectric Facilities

Location	Operation	Generating Capacity	Fish Passage
Tinker	1925 to present	34 MW	No
Grand Falls	1931 to present	63 MW	Not required
Tobique	1953 to present	20 MW	Pool and weir
Beechwood	1957 to present	113 MW	Fish lift
Mactaquac	1967 to present	672 MW	Fish lift

There was a substantial amount of riparian land and vegetation lost due to the installation of hydroelectric generating stations in the 1950s and 1960s in the Upper Saint John River Valley. The greatest extent of flooding occurred as a result of the Mactaquac generating station and resulting Mactaquac Headpond. The upriver extent of flooding from Mactaquac is located between Woodstock and Beechwood. Riparian land loss upriver of the Beechwood generating station extends to Perth-Andover. This flooding was not as extensive as the Mactaquac Headpond because of the more steeply sloped topography, less river discharge, and natural upstream barrier at Grand Falls.

6.3.3.4 Pits and Quarries

A number of gravel pits and a few quarries have been developed in the region over the years. These are usually small operations (typically less than 10 ha), and historically, have not likely been approved by NBDELG. The one identified quarry is located south of the Meduxnekeag River. It is approximately 27 ha in size and was partially constructed within an AHF site.

6.3.3.5 Residential

Residential land use in the vicinity of the Project consists primarily of single unit residential dwellings.

6.3.3.6 Commercial

Commercial land use in the vicinity of the Project consists of various retail, service and hospitality businesses, including truck services, gas bars, convenience stores, motels, and restaurants.

6.3.3.7 Industrial

Industrial land use in the vicinity of the Project is limited to the McCain Foods production plant and the Potato Technology Centre. The Potato Technology Centre is located on Route 110 in Florenceville while the McCain production facility, also located in Florenceville, is located on the opposite side of the Saint John River from the proposed Project.

6.3.3.8 Hunting

The Project is located within Wildlife Management Zone 10. Zone 10 runs from Grand Falls to Woodstock from the US border east to Plaster Rock and Juniper Station. Zone 10 is an active hunting area (NBDNR 2003b) for deer (566 registered deer kills out of a provincial total of 6,443), black bear (125 kills out of provincial total of 1,905) and moose (65 kills out of a provincial total of 2,020). This hunting takes place on the wooded lands, both private and Crown land. This includes the private woodlots located along the proposed TCH and adjacent lands.

Aboriginal hunting within the area of influence of the Project has been identified for moose, deer and partridge. Hunting occurs throughout this range, however, the area south of Big Presque Isle has been identified as a key location.

There is some trapping activity within the proposed RoW and surrounding area for a range of furbearer species, such as fox, marten, fisher, beaver and bobcat. This is for recreation, commercial and animal control purposes.

6.3.3.9 Fishing

Historically, the Saint John River provided an excellent fishery for Atlantic salmon. Recreational fishing was popular along the main river, and many tributaries including the Aroostook River, Tobique River, Meduxnekeag River, and Big Presque Isle River. There was also an Aboriginal fishery in the Tobique and Aroostook Rivers. However, due to a diminishing stock, all fishing for Atlantic salmon within the Saint John River system has been suspended pending in-season review, since 1996.

6.3.4 Planned Development Along the Proposed TCH

This category includes planned developments along those sections of the TCH that have been recently developed, or are scheduled for development within the next 5 years.

6.3.4.1 Tobique Truck Stop (Perth-Andover)

The construction of the Tobique Truck Stop is expected to be completed in the Spring of 2004. The Tobique Truck Stop will consist of a retail gas outlet; diesel card lock system, car wash, convenience store, family-style restaurant, and truckers' lounge. The truck stop development is located in Perth-Andover, west of the Route 190/TCH intersection, directly south of the junction of the TCH east-bound lane on/off ramp from Route 190. The site has an area of 3.6 ha and was formerly an agricultural (potato) field.

6.3.4.2 Grand Falls Big Stop

The construction of the Grand Falls Big Stop is expected to commence in the spring of 2004. The Grand Falls Big Stop will be a typical Irving Big Stop consisting of a retail gas outlet, a diesel card lock system, a convenience store, a family-style restaurant, and truckers' lounge. The Big Stop development will be located in Powers Creek just north of Grand Falls adjacent to the recently constructed interchange section of the TCH. The site has an area of 5.4 ha and is currently an active agricultural (potato) field.

6.3.5 Other Planned Development

This category includes all other planned development that is likely to occur within the spatial assessment boundaries of the cumulative environmental effects analysis.

6.3.5.1 New Brunswick Potato Museum and Learning Center on Route 110

Plans are in place for the construction of a Potato Museum adjacent to the existing Potato Technology Centre located on Route 110 in Florenceville. The facility will be constructed on a 0.8 ha previously cleared field. The potato museum and learning centre will endeavour to promote all aspects of the potato industry with programming aimed at tourists, students, and those within the agricultural community. The facility will feature potato-related exhibits, potato food products, and interactive displays and is expected to attract tourism and visitors to the area.

6.3.5.2 Wakefield Salmon Hatchery

There is a proposed plan to construct and operate an Atlantic salmon hatchery in Wakefield, N.B. Wakefield is on the western shore of the Saint John River between Woodstock and Hartland. The salmon smolts would be sold for restocking purposes. The total project footprint is 0.8 ha of agricultural field, and is located 190 meters from the existing TCH. The source of water is groundwater and the project will require a water supply assessment. The project would likely be constructed in the summer of 2004.

6.3.5.3 Woodstock Wastewater Treatment Plant

There is a proposed plan to construct and operate a wastewater treatment facility between Beardsley Road and the Saint John River, just south of the town of Woodstock, New Brunswick. The facility will provide secondary treatment using a 6 acre irrigated lagoon. The treated water will be discharged directly to the Saint John River. The total cleared area for the project is 8 hectares of previously cut, mixed forest. Facility construction will result in the direct removal of fish habitat on an unnamed tributary of the Saint John River. Construction is likely to begin in the spring of 2004, and finish by December 2004.

No other current or planned future projects are known in the area based on consultations with the Project Assessment Branch and the Rural Planning District Commission of NBDELG.

6.4 Cumulative Environmental Effects Analysis of Fish Habitat and Water Quality

6.4.1 Summary of Residual Environmental Effects of Project

The residual environmental effects of the Project on fish habitat and water quality are primarily related to sediment from construction activities entering watercourses. Extensive best practice mitigation for preventing sediment from entering watercourses will be used during all phases of construction near watercourses. However, extreme weather conditions such as intense rain events coupled with spring snow melt may reduce the effectiveness of sediment control techniques. Winter conditions, including sporadic thaw events, also present additional challenges for the prevention of sedimentation. Project-related sediment will also enter watercourses during the operational phase from sand used for winter safety and from combustion-generated particulate matter. Therefore, sediment entering watercourses was considered to be a potential residual environmental effect of the Project.

The Project will require the installation of watercourse crossing structures (including culverts) on 43 watercourses. There are no existing data available on fish movement in watercourses crossed by the

Project, or in watercourses crossed by adjacent projects. However, the design of watercourse crossing structures will provide for the passage of diadromous and resident fish. Therefore, the obstructed or diminished movement of fish was not considered a potential residual environmental effect of the Project.

The operation of the existing TCH, provincial and municipal roads, and future TCH has the potential to contribute to salinization of watercourses immediately adjacent and downstream of the roadways, as a result of salt application for winter safety.

The Project will result in the direct loss of fish habitat where the streambed is replaced by a culvert, or where the streambed is relocated. However, any identified HADD will be compensated for so that no net loss of fish habitat would occur. Therefore, fish habitat loss was not considered a residual environmental effect of the Project.

6.4.2 Identification of Issues and Selection of Indicators

Based on the potential residual environmental effects of the Project, sediment entering watercourses has been identified as an issue for the assessment of cumulative environmental effects.

Atlantic salmon, brook trout and other salmonids require clean gravel for the successful incubation of eggs. Sedimentation may fill in the pore space in gravel with sand and fines, and thereby reduce the ability of water to flow through gravel, a process that is thought to supply the egg with oxygen and regulate temperature. Also, the eggs may become covered with sediment during the incubation period, which may reduce the survival rates of the eggs. For the purposes of this assessment, sedimentation is defined as the deposition of sand and fine particulate matter (“fines”) on the streambed. This measure indirectly considers the related water issue of suspended sediment in the water column.

Sedimentation has been selected as an indicator to focus the assessment of the potential cumulative environmental effects of the Project on Fish Habitat and Water Quality. Sedimentation addresses the primary issue of sediment entering watercourses for both water quality and fish habitat. Sediment substrate data are available for most watercourses between Grand Falls and Longs Creek. Non-salmonid species of fish that may be present are less susceptible than salmonids to sedimentation and therefore the analysis focuses on this important issue for salmonids.

NBDOT is committed to developing and implementing best salt management practices in a continued effort to reduce the cumulative environmental effects of road salt on the environment. Data on historical trends in the salinization of watercourses in the Assessment Area are not available. Since the improvement in the management of salt is expected to slow or perhaps reverse possible past operational effects of other roads, operational environmental effects of other projects and activities including salinization is not considered further in this cumulative environmental effects assessment.

Table 6.4.1 identifies the potential interactions between the indicators and the other projects and activities identified in Section 6.3.

Table 6.4.1 Cumulative Environmental Effects Potential Interactions Matrix for Fish and Fish Habitat VEC

Past, Present of Future Project or Activity	FISH AND FISH HABITAT VEC INDICATOR
	Sedimentation
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	✓
Saint-Léonard to Grand Falls TCH	✓
Perth-Andover By-Pass TCH	✓
Woodstock to Pokiok TCH	✓
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	✓
Lockhart Mill Interchange TCH	✓
Meduxnekeag River Bridge TCH	✓
Route 95 (Woodstock to Houlton)	✓
Pokiok to Longs Creek TCH	✓
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	
Pits and Quarries	✓
Residential	
Commercial	
Industrial	
Hunting	
Fishing	
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	✓
Grand Falls Big Stop	
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	
Wakefield Salmon Hatchery	
Woodstock Wastewater Treatment Plant	

6.4.3 Assessment Boundaries

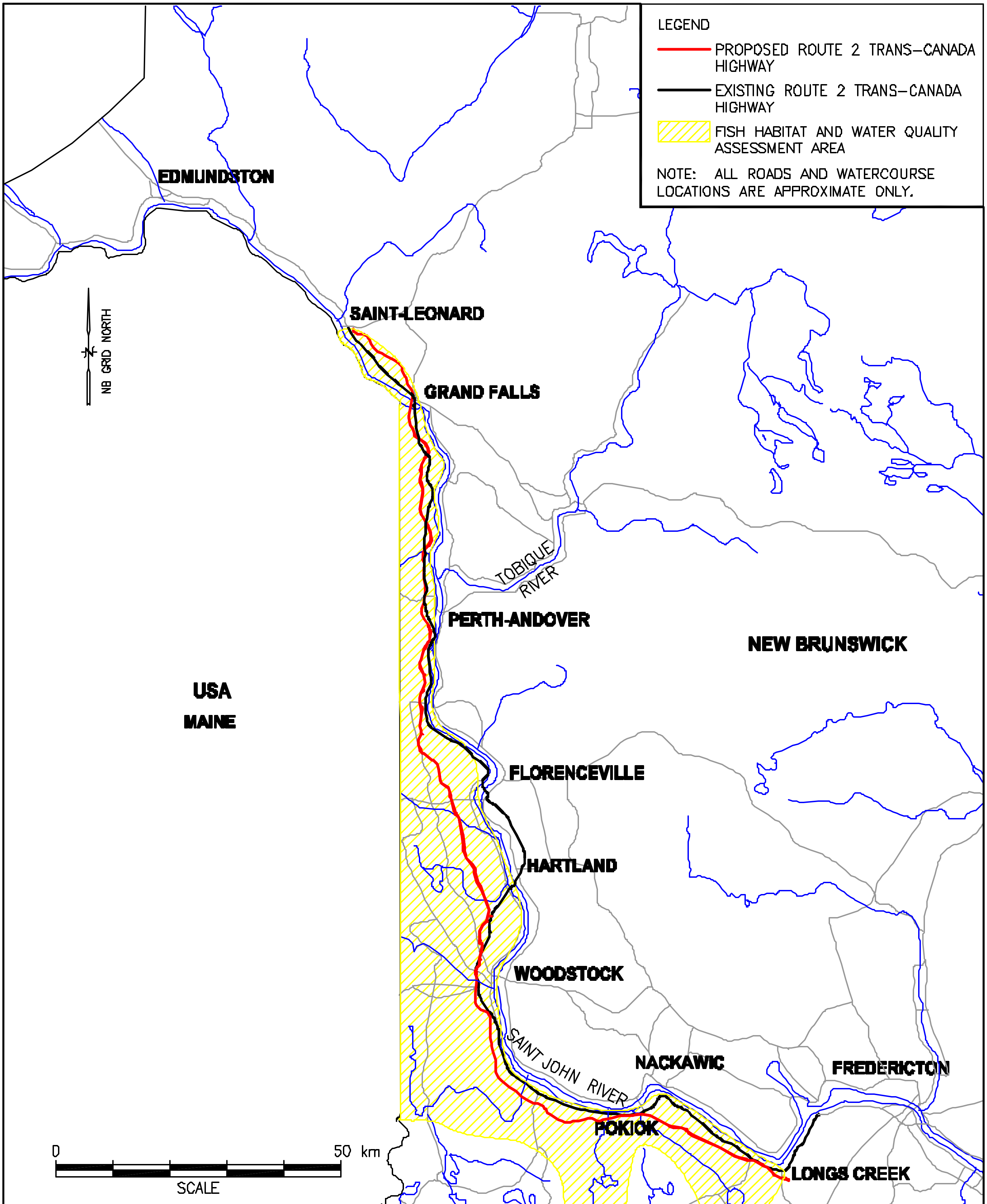
Data regarding substrate type data were collected during baseline surveys for all sections of the expanded TCH, using the NBDNR and DFO stream survey and habitat assessment method (Hooper *et al.* 1995). No additional data of this type have been identified to be available for this region. Fish that reside in watercourses above Grand Falls do not interact with those below. Therefore, the Assessment Area for the assessment of the potential cumulative environmental effects assessment of sedimentation includes all watercourses, from their headwaters (or the Maine border if the watercourse extends into Maine) to the confluence with the Saint John River, between Grand Falls and Longs Creek that are (or will be) crossed by the expanded TCH (Figure 6.4.1).

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other past and present projects and activities is from the time of the baseline survey for watercourses crossed (or that will be crossed) by sections of the expanded TCH, to the present. Specifically, the temporal boundaries are:

- 2002 for the Project and the Grand Falls to Aroostook sections;
- 1998 for the Perth-Andover Bypass section;
- 1997 for the Woodstock to Pokiok section; and
- 2001 for the Pokiok to Longs Creek section.

No known data are available before that collected in baseline studies. However, it is argued that with respect to sedimentation, the conditions measured at the time of survey are to some considerable extent, representative of past and present projects and activities proximal to these streams, and reflect a temporal boundary that although indeterminate, may extend for many years prior to the year of the surveys, listed above. Therefore, the cumulative environmental effects assessment does relate these data to antecedent land use and projects.

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other future projects and activities on sedimentation includes the next 5 years, beyond which forecasting of the likeliness of other projects to be carried out is not reliable.



SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF FISH HABITAT AND WATER QUALITY

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Consulting Engineers
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6.4.4 Sedimentation

6.4.4.1 Historic Trends and Existing Conditions

Sediment grain size data for watercourses crossed by the proposed Project, the Grand Falls to Aroostook TCH, the Pokiok to Longs Creek TCH, and the Woodstock to Pokiok TCH, were obtained in pre-construction baseline surveys, using the NBDELG/DFO stream survey method (Hooper *et al.* 1995), that involves the estimation of grain size and percent total of the substrate through field observation. As such, there may be variation in recorded values due to biases of different field survey teams.

Hooper *et al.* (1995) suggest that road construction and forestry operations are primary causes of increased sediment in watercourses. Other anthropogenic activities cited as sediment sources in the CCME Guidelines for Total Particulate Matter (for the protection of aquatic life) include gravel pit operations, agriculture, dredging, industrial wastewater, and mining. Within the Assessment Area, the relevant dominant activities are forestry and agriculture. It should be noted that the expanded TCH crosses all watercourses upstream of the existing TCH. Therefore, it can be assumed that any degradation of fish habitat in the past from sedimentation, as observed during the stream surveys, has not been the result of the existing TCH. There are some secondary roads and other highways within the Assessment boundaries. For example, the Big Presque Isle Stream is crossed by Highway 560, improved secondary roads, and unimproved roads, upstream of the proposed TCH crossing. In such a case, the conditions measured at the time of the survey, reflect the total historical contribution of sediment from those roads (in combination with other adjacent land use) on the sedimentation within the watercourse.

In addition to anthropogenic causes, there are natural sources of sediment such as the natural erosion of bedrock and changes in flow patterns from vegetative obstructions (*e.g.*, beaver ponds or digger log pools). The bedrock geology within the Assessment Area is primarily from one geological unit that is Upper Ordovician or Lower Silurian in age and is described as sedimentary rock deposited in a deep marine basin. This rock is well indurated (*i.e.*, hard and resistant to erosion) and is not likely to readily release substantial sediment into watercourses by way of natural erosion processes where bedrock is exposed. The overburden throughout the Assessment Area is a discontinuous veneer (*i.e.*, less than 0.5 m thick) of till that is comprised of silt, sand and gravel. In areas where the vegetative mat is removed, typically from agriculture or some forestry practices, this till is highly susceptible to erosion and may find its way to watercourses where it may settle to the substrate as sedimentation.

Table 6.4.2 provides the averaged degree of sedimentation (sand + fines) as a percentage of the total observable substrate in watercourses within sections of the proposed or completed TCH projects. Only those watercourses where data were recorded and where fish were observed were included in the analysis of percent sediment. The standard deviation was calculated to provide an indication of the variance of sedimentation across watercourses. Specific data for watercourses crossed by the Project are in 5.4.3 (Fish and Fish Habitat VEC). Data for all watercourses in other sections are included in the environmental assessment reports specific to those projects (JWEL 2003a; JWEL 2004; NBDOT 1999a; NBDOT 1999b; NBDOT 1998a; NBDOT 1998b). These values are evidently reflective of the past and present input of sediment from adjacent land uses, including agriculture, forestry and other highways and roads. The percent sediment values suggest that sedimentation within watercourses crossed by the Project between Woodstock (Tributary to Meduxnekeag) and River de Chute (Tributary to Upper Guisiguit) are substantially higher than those in other sections. Appendix C (Figures 3.2A-D) depicts the land use surrounding each watercourse crossed by the Project. The maps clearly demonstrate that the density of agricultural land decreases from Woodstock to River de Chute. The area between River de Chute and Perth-Andover is predominantly covered by forest. This is due to the steep topography of that region. The most likely cause for the elevated percent sediment levels in watercourses between Woodstock and River de Chute appears to be the intensive agricultural land use within that area. An example is WC35 (Tributary to Little Presque Isle) that flows entirely through agricultural land. The substrate of WC35 is 100% fines. This pattern is observed in watercourses throughout this region.

The percent sediment values also suggest that watercourses between Woodstock and Grand Falls have experienced more sedimentation than those between Woodstock and Longs Creek, and the degree of sedimentation is most consistent between Pokiok and Longs Creek. The area between Woodstock and Longs Creek has very little agricultural land use. This would seem to support the hypothesis that agriculture is the largest contributor of sediment to watercourses in the Assessment Area.

Table 6.4.2 Average Percent Sediment in Watercourses Within the Assessment Area

TCH Section	Number of Fish Bearing Watercourses with Sediment Data	Average Observed Substrate Composition			
		% Sand	% Fines	% Sediment (sand+fines)	Standard Deviation of % Sediment (68%)
Grand Falls to Aroostook	13 / 15	18	17	35	17
Perth-Andover Bypass	5 / 9	23	17	40	8
Perth-Andover to Woodstock Wark Brook to River de Chute	14 / 18	15	13	28	15
Perth-Andover to Woodstock Tributary to Upper Guisiguit to Tributary to Meduxnekeag	21 / 24	22	36	58	40
Woodstock to Pokiok *	4 / 22	13	0	13	15
Pokiok to Longs Creek ** Allandale Brook to Obrien Brook	13 / 16	5	3	8	3

* Data not available for Woodstock to Meductic section
** Jewitts Creek has a high degree of sedimentation, however it is not included because it is not representative of other watercourses crossed in that section

The Project will contribute some sediment to watercourses that are crossed by the RoW. The contribution of sediment during construction will be prevented through use of sediment control measures as described in Section 5.4.5.2.1. The direct contribution of sediment to watercourses during operation of highways with similar traffic volumes (*i.e.*, 7,000 AADT) has been estimated as 186 kg/ha of highway/year (Kobriger *et. al*. 1981). It should be noted that this value was determined at a time when vehicle exhaust contained more particulate matter than would be emitted by today's cleaner burning engines with advanced emission control devices. Also, not all sediment carried in highway runoff reaches watercourses. Much of the sediment will be trapped by vegetation and become part of the soil layer. The relative amount of contribution of the Project highway runoff to watercourses is discussed in Section 5.3.5.2 (Surface Water VEC). Increased mitigation will be in place in those watercourses where a potential sedimentation problem was identified.

6.4.4.2 Project Interactions with Other Future Projects and Activities

Existing Highways and Roads

There may be an overlapping contribution of sediment to the watercourse substrate, by the Project and the existing TCH, in areas downstream of the existing TCH. Any sediment, in addition to that already generated by the existing TCH, would be a result of winter sanding and not from combustion generated particulate matter as traffic volume is not anticipated to increase as a result of the Project.

Current and Future Highway Projects

Current and future highway projects that cross watercourses not crossed by the Project will contribute additional sediment to those watercourses. However, there will be no direct overlapping contribution of sediment from these other projects with those of the Project. The only exceptions would occur where the Project geographically overlaps, or abuts another project. This is the case at Perth-Andover (Wark Brook), at Florenceville (Saint John River), and near Woodstock (Meduxnekeag River). However, it should be noted that the division of these projects is for design and construction scheduling purposes only. The total environmental effect on specific watercourses (*e.g.*, Wark Brook) of developing these areas would not be greater than what is experienced at watercourses within the limits of the Project, because no additional development is occurring. The only difference would be in the timing of the occurrence, since these projects are being constructed at different times.

The only possible cumulative environmental effect of the Project acting in combination with other current and future TCH projects is the net loss of quality spawning or nursery habitat within the Assessment Area. However, there was no high quality spawning habitat located directly downstream (*e.g.*, within 200 m) of the Project RoW. In addition, the potential release of sediment from Project activities into watercourses will be mitigated as described in Section 5.4.5.2.1, and compliance and follow-up monitoring, where required, will ensure that mitigation is effective. Therefore, the Project is not anticipated to further degrade fish habitat within watercourses crossed by the Project.

Adjacent Land Uses

Agriculture is likely to remain the largest contributor of sediment to watercourses in the Assessment Area during the next 5 years, and may become more of a contributor if forest land continues to be replaced with agricultural.

If additional pits and quarries are developed, which is likely given the need for aggregate by the TCH projects, then additional sediment may enter watercourses in these areas. All pits and quarries developed for the purpose of providing material for the Project will be subject to the same sediment control techniques required for the Project.

6.4.4.3 Summary

Many of the watercourses within the Assessment Area have already experienced substantial amounts of sedimentation, particularly those watercourses between River de Chute and the Meduxnekeag River. Agriculture has likely been the largest contributor to sedimentation to watercourses within the Assessment Area in the past and present. Contributions of sediment from agriculture are likely to remain the same or increase during the next 5 years if current trends in agricultural land development continue. This may be offset by increasing application of Best Management Practices in agriculture (Land Use VEC; Section 5.8). The Project may contribute some additional sediment to the watercourses that it crosses. Sediment contributed from the Project to watercourses in those streams that have already experienced substantial input from agricultural practices will not likely further reduce the quality of fish habitat. There may be some reduction in the quality of fish habitat in those watercourses where sedimentation was not substantial (*i.e.*, less than 10 %) prior to potential sediment generating Project activities. Habitat compensation will be undertaken at a 3:1 ratio for all watercourse crossings where substantial instream work is required (*e.g.*, culvert installation and/or stream diversion). This compensation will ensure that a net gain of productive fish habitat is achieved. In addition, if substantial Project-related sediment accumulates downstream of Project activities, then additional habitat compensation may be required by DFO pursuant to Section 15(2) of the *Fisheries Act*. Therefore, any Project-induced sedimentation to watercourses will not result in a net loss of productive fish habitat.

Watercourses within the Assessment Area that are not crossed by the Project will not be directly affected by Project activities. The amount of sediment in watercourses between Woodstock and Pokiok should remain consistent into the near future, as there is not likely to be a substantial increase in agricultural land in that area. The amount of sediment in watercourses between Grand Falls and Aroostook is likely to increase as a result of increasing agricultural land use in that area.

6.4.5 Determination of Significance

The results of the stream substrate surveys suggest that there has already been significant cumulative environmental effects on fish habitat and water quality as evidenced by sedimentation in some watercourses between Grand Falls and Woodstock, including those crossed by the Project. However, no sensitive salmonid spawning habitat was identified within the RoW of the preferred Project alignment, or within 200 m downstream of the RoW. Sediment that results from Project-related activities will be controlled and monitored, where required, to ensure that further degradation of fish habitat within watercourses crossed by the Project does not occur. If Project-related destruction of fish habitat from sedimentation is identified, then DFO will require that habitat compensation be undertaken to ensure no net loss of fish habitat under Section 35(2) of the *Fisheries Act*. Therefore, the Project is not expected to have a net contribution to what are already significant cumulative environmental effects on fish habitat and water quality within the Assessment Area.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.3 (Surface Water VEC) and Section 5.13.3.4 (Fish and Fish Habitat VEC), for the verification of the accuracy of the cumulative environmental effects analysis of fish habitat and water quality.

6.5 Cumulative Environmental Effects Analysis of Atlantic Salmon

6.5.1 Summary of Residual Environmental Effects of Project

The Project will involve the installation of watercourse crossing structures in 43 watercourses. Juvenile Atlantic salmon were identified in 3 of these watercourses, and may exist in others. The RoW alignment selection process, as detailed in Section 2.2, avoided sensitive Atlantic salmon habitat as identified in the baseline field survey. Furthermore, DFO (under Section 35(2) of the *Fisheries Act*) has required that habitat compensation must be completed to ensure that there is no net loss of fish habitat as a result of the Project where it is determined that the Project would result in a HADD. The Project is not anticipated to result in any likely residual environmental effects on Atlantic salmon populations or individuals. It is possible, but unlikely, that there could be mortality of juvenile Atlantic salmon, particularly during the construction phase of the Project, from accidents or unplanned events (*e.g.*, chemical spills).

6.5.2 Identification of Issues and Selection of Indicators

Due to the extremely low numbers of Atlantic salmon in the Saint John River, concerns raised during public and regulatory consultation, and the likelihood that this stock will soon be under the Protection of *SARA*, the potential for the Project to contribute to cumulative environmental effects on the movement of Atlantic salmon has therefore been identified as an issue.

Atlantic salmon in the Saint John River is considered as the "Outer Bay of Fundy" stock by COSEWIC. The health of this stock is currently under investigation by COSEWIC, however it is not yet listed as a species of special conservation concern. Current threats identified by COSEWIC (2003) include:

- alteration of habitat by forestry and agriculture practices;
- damming of rivers and estuaries;
- by-catch in Shad and Herring fisheries;
- potential salmon farm threats such as disease or competition; and
- illegal fishing of wild salmon.

Marine survival in Canadian and international waters has also had a profound effect on Bay of Fundy salmon stocks in the past (DFO 2001). In the Bay of Fundy, commercial salmon fisheries have been suspended since 1990 in an attempt to conserve this diminishing stock. The Atlantic salmon commercial fishery along the eastern seaboard of the U.S. was closed in 1947. The last remaining large-scale fishery is off the coast of west Greenland. The Greenland fishery was closed in 2003, pending further review. There can be little doubt that all of these activities have had a cumulative environmental effect on the health of the Saint John River Atlantic salmon stock. However, specific data are lacking and there is little agreement amongst fishery biologists and other stakeholders as to the magnitude of these interactions. Therefore, this assessment will make no pretense at differentiating between the causality of declining stocks, and will instead focus on the overall health of the stock and the potential for the Project to affect the health of the stock. For this purpose, the Upper Saint John River Atlantic salmon returns has been selected as an indicator to focus the assessment of the potential cumulative environmental effects of the Project. This selection has been made because this is the stock within the watersheds crossed by the Project, and data (wild and hatchery salmon return numbers) are available.

Table 6.5.1 identifies the potential interactions between the indicator and the other projects and activities identified in Section 6.3.

Table 6.5.1 Cumulative Environmental Effects Potential Interactions Matrix

Past, Present of Future Project or Activity	ATLANTIC SALMON VEC INDICATOR
	Upper Saint John River Atlantic Salmon Returns
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	✓
Saint-Léonard to Grand Falls TCH	
Perth-Andover By-Pass TCH	✓
Woodstock to Pokiok TCH	✓

Table 6.5.1 Cumulative Environmental Effects Potential Interactions Matrix

Past, Present of Future Project or Activity	ATLANTIC SALMON VEC INDICATOR
	Upper Saint John River Atlantic Salmon Returns
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	✓
Lockhart Mill Interchange TCH	
Meduxnekeag River Bridge TCH	✓
Route 95 (Woodstock to Houlton)	✓
Pokiok to Longs Creek TCH	✓
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	✓
Pits and Quarries	
Residential	
Commercial	
Industrial	
Hunting	
Fishing	✓
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	
Grand Falls Big Stop	
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	
Wakefield Salmon Hatchery	✓
Woodstock Wastewater Treatment Plant	

6.5.3 Assessment Boundaries

For the purpose of this assessment, it is reasonably assumed that all Atlantic salmon collected at the Mactaquac facility were migrating to destinations upstream of the facility. Adult salmon were historically known to spawn in the Meduxnekeag, Big Presque Isle, Aroostook and Tobique Rivers. Juvenile salmon likely used many of the smaller tributaries as rearing and nursery habitat. Atlantic salmon cannot traverse the waterfalls at Grand Falls. Therefore, the spatial boundaries for the assessment of the potential cumulative environmental effects of the Project on Atlantic salmon includes all watercourses, from their accessible headwaters (or the Maine or Quebec border) to the confluence with the Saint John River, between Grand Falls and Mactaquac (Figure 6.5.1).

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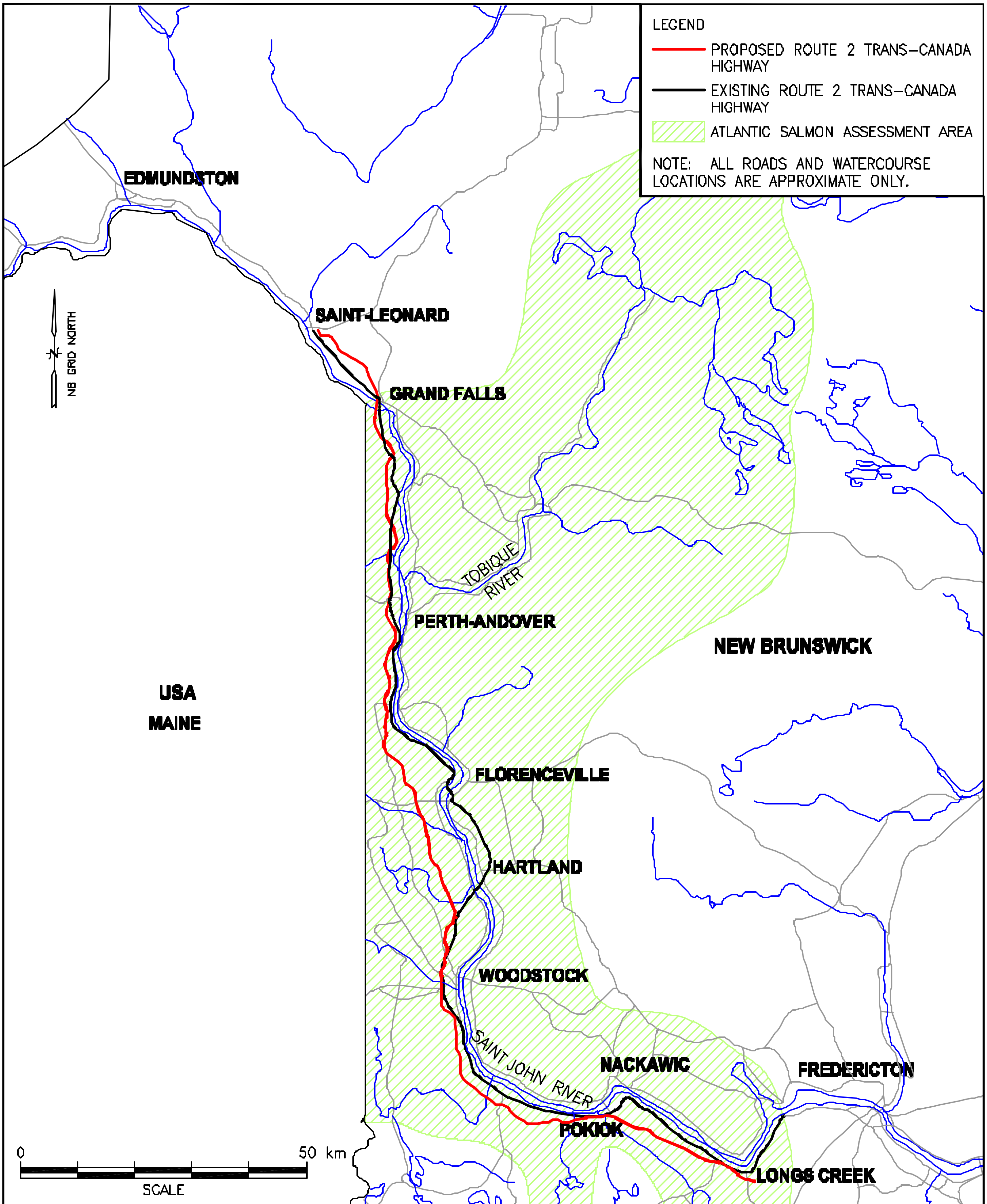


SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF ATLANTIC SALMON	Date: 2004 04 15	Scale: AS SHOWN	Jacques Whitford Consulting Engineers Environmental Scientists
	Job No.: 14677	Fig. No.: 6.5.1	THIS DRAWING IS THE PROPERTY OF JACQUES WHITFORD AND IT SHALL NOT BE GIVEN OUT, COPIED OR DUPLICATED FOR THE USE OF ANOTHER BUT SHALL BE USED ONLY BY THE RECIPIENT FOR THE PURPOSE TO WHICH IT REFERS.

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other past and present projects and activities on Atlantic salmon includes the time from the initial collection of salmon return data at the Mactaquac Hydroelectric Generating Station fish collection facility ("Mactaquac facility"), from 1970 to the present.

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other future projects and activities on Atlantic salmon includes the next 5 years, beyond which forecasting of the likeliness of other projects or activities to be carried out is not reliable.

6.5.4 Upper Saint John River Atlantic Salmon Returns

6.5.4.1 Historic Trends and Existing Conditions

The size of the yearly Atlantic salmon returns in the Saint John River prior to settlement by people of European descent is not known. However, it is thought to have been as much as 1 million adult salmon. At least two centuries of intense harvesting occurred prior to the earliest reliable salmon return information in the Saint John River, which began with the construction and operation of the Mactaquac facility.

The Mactaquac facility is operated by the scientific and technical staff of the Diadromous Fish Division of DFO (Scotia-Fundy Region) who are responsible for research, assessment and free passage of the diadromous fish stocks, which include Atlantic salmon in the New Brunswick rivers flowing to the Bay of Fundy. The Mactaquac mitigation programs include live gene banking of New Brunswick's Inner Bay of Fundy Atlantic salmon (not Saint John River), the culture of salmon to replace the production lost to hydroelectric development on the Saint John River and trapping and trucking to transport upriver migrating fish whose passage is blocked by the Mactaquac dam. The hopper lifts upstream migrants into tank trucks for upriver distribution. All adult salmon captured in the migration channel at the Mactaquac Main Salmon Hatchery are sorted for broodstock and for transportation to a release site above the dam.

Recorded counts of adult Atlantic salmon stocks in the Saint John River were provided by DFO (Ross Jones, pers. comm.). The stock status was measured, from 1970 to 2002 (Figure 6.5.2), for both wild and hatchery adult salmon. In 1971, the return of wild salmon was 4,715 individuals while the return of hatchery salmon was 77 individuals. In 1980, both wild and hatchery returns were the highest on record, and had increased to 10,924 and 2,992 respectively. Since 1985, both wild and hatchery stocks have declined at an average rate approaching 50% per year. This trend continued into the 21st century with the most recent stock counts showing a return of 199 wild adult salmon and 177 hatchery adult salmon (DFO 2002).

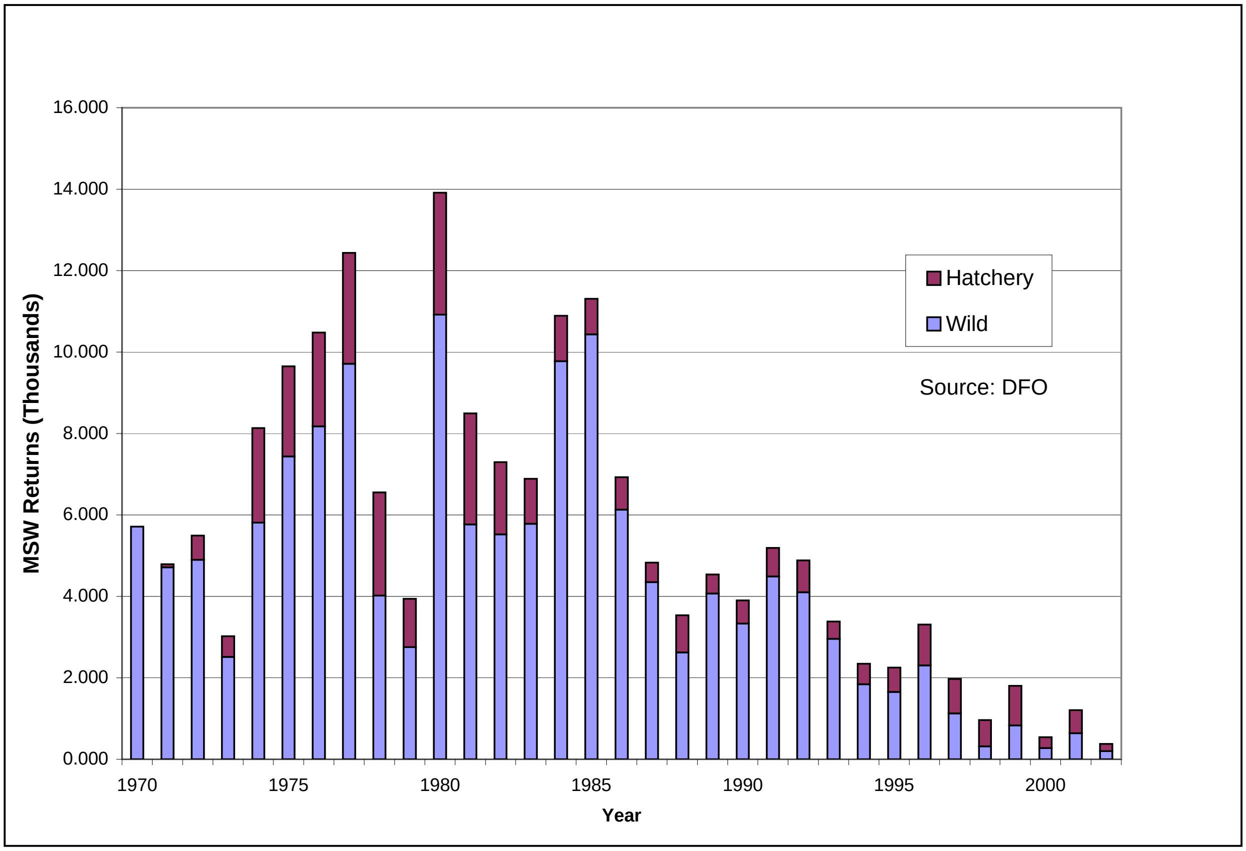


Figure 6.5.2 Atlantic Salmon Stock Returns (1970-2002): Saint John River at Mactaquac

6.5.4.2 Project Interactions with Other Future Projects and Activities

Existing Highways and Roads

The construction of the existing TCH and other highways (*e.g.*, Highway 103) may have resulted in lost Atlantic salmon habitat and have, in some cases, created impediments to fish passage. The Big Presque Isle, Meduxnekeag, and Aroostook Rivers are all known to have been used for spawning and nursery habitat by Atlantic salmon. The installation of bridges in these watercourses may have removed some spawning habitat in the area of the bridge piers. However, the Project is not expected to result in the net loss of any spawning habitat, and therefore will not contribute cumulatively to the loss of spawning habitat in the Assessment Area.

There are more than 100 watercourses on the west bank of the Saint John River between Grand Falls and Mactaquac. Many of these provide nursery and rearing habitat for juvenile salmon before these fish begin their migration to the sea. Watercourse crossing structures, installed along the existing TCH, may obstruct migratory routes of Atlantic salmon in some watercourses. The watercourse crossing structures of the Project will be designed to provide for passage of all fish, including Atlantic salmon, and will therefore not contribute cumulatively to the impediment of Atlantic salmon migration in the assessment area.

Atlantic salmon mortality could result from the unlikely event of a chemical spill along an existing highway or road, into a watercourse bearing Atlantic salmon. The Project is not anticipated to create additional traffic in the Assessment Area or increase the number of hazardous material transports. It is anticipated that the Project will result in a decreased accident rate. Therefore, the contribution of the Project to the cumulative environmental effect of spills in watercourses is considered neutral or slightly positive.

Current and Future Highway Projects

Current and future highway projects will be mitigated to allow for the successful migration of Atlantic salmon, and to ensure that there is no net loss of sensitive Atlantic salmon habitat. These projects may also help to reduce the likelihood of a hazardous material spill occurring during transport. Therefore, the Project is not anticipated to have overlapping adverse environmental effects on Atlantic salmon with those of the other highway projects.

Adjacent Land Use

The primary environmental effects from forest harvesting activities and agriculture activities on Upper Saint John River Atlantic salmon stocks are related to the loss or degradation of sensitive Atlantic salmon habitat (*i.e.*, for spawning or nursery). The RoW alignment selection process avoided any identified sensitive Atlantic salmon habitat. The Project will be mitigated such that there is no net loss, in area or function, of sensitive Atlantic salmon habitat by way of a compensation plan. Therefore, the Project is not anticipated to have any adverse residual environmental effects that overlap with those of forest resource harvesting and agriculture activities.

The primary environmental effects from hydroelectric generating stations on Atlantic salmon in the Saint John River are the obstruction to upstream and downstream migration, or mortality associated with downstream passage through turbines (Therrien and Bourgeois 2000). There is much disagreement amongst fisheries biologists and stakeholders regarding the environmental effects that the Saint John River hydroelectric generating stations have had on Atlantic salmon stocks. However, it has been determined that a series of small hyrdroelectric facilities within a single migratory route, can have a cumulative environmental effect on mortality rates (Therrien and Bourgeois 2000). This would be the case for any Atlantic salmon trying to reach a destination upstream of the Beechwood facility. A summary of the fish passage facilities at each of the major hydroelectric generating stations within the Assessment is provided in Table 6.3.1 (Section 6.3).

All watercourse crossing structures required for the Project will be designed so that fish passage is not impeded. As a result of mitigation, including seasonal scheduling of construction activities and the avoidance of Atlantic salmon habitat during the RoW alignment selection process, the Project is not anticipated to result in any Atlantic salmon fatalities. Therefore, the Project is not anticipated to have any environmental effects that overlap with those of hydroelectric facilities. It is possible, but unlikely, that there could be mortality of juvenile Atlantic salmon in particular during the construction phase from accidents or unplanned events. However, if this did occur, the event would be local and unlikely to affect more than a few individuals. Such an occurrence, albeit unlikely, would not be expected to exacerbate the current trends experienced by this stock.

Fishing for Atlantic salmon on the Saint John River has not been permitted since 1996, pending further review. Given the current status and trend of this stock, it would seem unlikely that fishing for Atlantic salmon in the Saint John River would be permitted within the next 5 years. Therefore, fishing is not likely to have any environmental effects that overlap with those of the Project on the Upper Saint John River Atlantic salmon stock.

Wakefield Salmon Hatchery

The Wakefield Salmon Hatchery will produce juveniles for restocking programs in the Saint John River. This may have a positive environmental effect on the number of hatchery salmon that return annually to the Mactaquac facility. The Project is not anticipated to have any adverse environmental effects that overlap with those of the proposed hatchery.

6.5.4.3 Summary

The current declining trend of the Upper Saint John River Atlantic salmon stock suggests that the stock may be near extirpation within the next 5 to 10 years. The contributions of the identified causes to this decline are not fully understood. The operation of a series of hydroelectric generating facilities will continue to impede the migration of Atlantic salmon within the Saint John River system. However, it should be noted that Atlantic salmon stocks in the lower Saint John River tributaries are declining at similar rates, and these fish are not affected by hydroelectric developments. Also, live gene banking capabilities at the Mactaquac facility may help prevent the extirpation of this stock if required.

There are no likely adverse residual environmental effects of the Project on any lifestage of the Atlantic salmon in the Upper Saint John River. There may be some localized mortality of juvenile Atlantic salmon associated with accidents or unplanned events during construction activities near watercourses, however this is considered unlikely due to mitigation such as seasonal scheduling of work near watercourses.

6.5.5 Determination of Significance

It is widely accepted that there have already been substantial cumulative environmental effects on Upper Saint John River Atlantic salmon stock from activities such as hydroelectric power generation and commercial fishing. However, there were no identified adverse residual environmental effects of the Project on this stock. Any environmental effects on this stock from Project-related accident or unplanned event are considered extremely unlikely. Furthermore, these environmental effects would be localized (within 1 watercourse) and short in duration (a few days). Therefore, the Project will not likely act cumulatively with any other projects or activities to exacerbate the current or predicted status of this stock (*i.e.*, contribute to or increase the current annual rate of decline of 50%). As such the Project is not expected to contribute to what are already significant cumulative environmental effects on the Upper Saint John River Atlantic salmon stock, and therefore all Atlantic salmon.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.4 (Fish and Fish Habitat VEC), for the verification of the accuracy of the cumulative environmental effects analysis Atlantic salmon.

6.6 Cumulative Environmental Effects Analysis of Appalachian Hardwood Forest

6.6.1 Summary of Residual Environmental Effects of Project

The residual environmental effects of the Project on Appalachian Hardwood Forest (AHF), following mitigation (including route selection and avoidance), are the loss of 6.8 ha of AHF in two moderate priority AHF sites. The mitigation proposed for the Project to protect rare vascular plant populations involves the purchase, for the purpose of conservation and protection, of 72.4 ha of currently unprotected private forest land considered to be very high priority and high priority AHF. These sites include rich assemblages of rare vascular plant species that would otherwise have no regulatory protection from future forest harvesting. These sites include (from north to south):

- the rich hardwood stand north of Demerchant Brook, containing a population of Canada violet;
- the rich hardwood stand north of Bryson Brook; and
- the stand containing bottle-brush grass, south of River de Chute and Route 560.

The first two sites are approximately 1 km apart, and therefore the land joining the sites is also being negotiated for purchase with the landowners, that will result in one large parcel totaling 48.8 ha. These sites contain a large number of rare species including Canada violet (S1/“May Be At Risk” species). The property purchased that encompasses the bottle-brush grass site south of River de Chute and Route 560, and west of the alignment totals 23.6 ha in area. This compensation ensures that there are no unmitigated residual environmental effects on AHF and the associated rare vascular plant species. Most of the vascular plant species of concern recorded during field studies near the Project are species that characterize AHF, and that are in many cases persisting in the landscape despite the lack of a mature tolerant hardwood forest canopy.

6.6.2 Identification of Issues and Selection of Indicators

The key cumulative environmental effects issues regarding AHF are the direct loss of AHF from developments such as the Project and activities such as forestry and agriculture, as well as the associated loss of plant species of special conservation concern. Work commissioned by the Nature Trust of New Brunswick (NTNB) (MacDougall 1997; MacDougall and Loo 1998; Betts 1999) provides good information on the history of AHF in the region and the ongoing threats to this habitat. The indicator chosen to address cumulative environmental effects on AHF and associated vascular plants of special conservation concern is the loss of AHF habitat (and by association its associated vascular plants of special conservation concern).

Table 6.6.1 indicates the projects and activities that may act cumulatively with the Project on AHF habitat as indicated by the loss of AHF habitat.

Table 6.6.1 Cumulative Environmental Effects Potential Interactions Matrix for AHF

Past, Present of Future Project or Activity	AHF VEC INDICATOR Loss of AHF Habitat
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	
Saint-Léonard to Grand Falls TCH	
Perth-Andover By-Pass TCH	
Woodstock to Pokiok TCH	
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	
Lockhart Mill Interchange TCH	
Meduxnekeag River Bridge TCH	
Route 95 (Woodstock to Houlton)	✓
Pokiok/Nackawic to Longs Creek TCH	
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	
Residential	✓

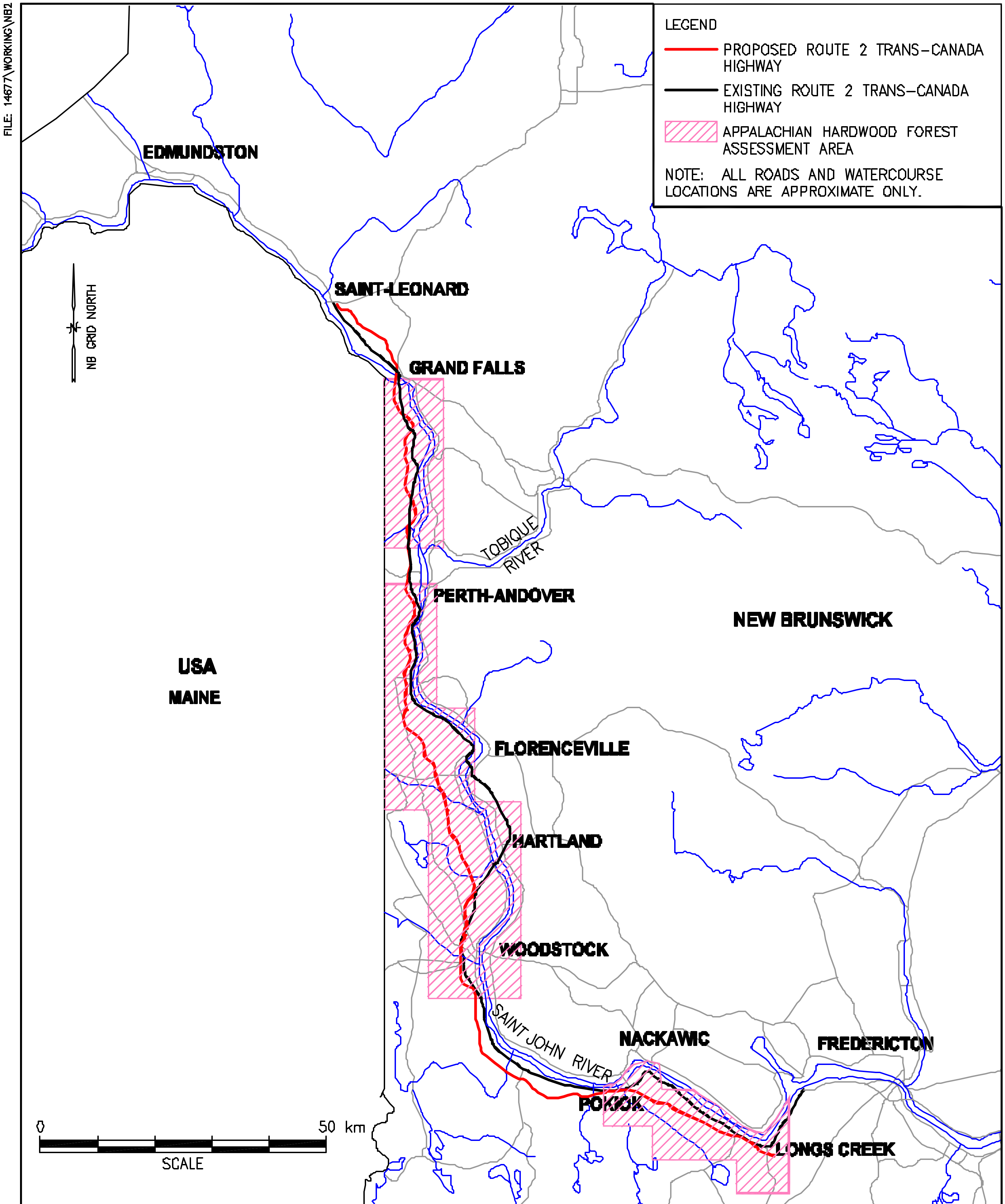
Table 6.6.1 Cumulative Environmental Effects Potential Interactions Matrix for AHF

Past, Present of Future Project or Activity	AHF VEC INDICATOR Loss of AHF Habitat
Commercial	
Industrial	
Recreational (Including hunting/fishing)	
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	
Grand Falls Big Stop	
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	
Wakefield Salmon Hatchery	
Woodstock Wastewater Treatment Plant	

6.6.3 Assessment Boundaries

The spatial boundaries for the assessment of cumulative environmental effects assessment on AHF is the combined Assessment Areas used for the Perth-Andover to Woodstock and Grand Falls to Aroostook TCH project environmental assessments, the area within which detailed data have been analyzed for AHF. This Assessment Area was selected because of the data analysis conducted within those areas as they quantify AHF area losses due to past, present and future projects that overlap with the Project. Data for the larger area of AHF in the central Saint John River Valley are presented for historical trends and context (Figure 6.6.1).

Temporal boundaries for the cumulative environmental effects assessment of AHF include the period from the early 1980's to the present. This is based on available information on known stands of AHF within that time frame. Forest inventory mapping used for the Appalachian Hardwood Forest Conservation Stewardship Project (MacDougall 1997) was based on 1980's photography. The more recent Forest Inventory Database based on 1996 (north of River de Chute) and 2000 (south of River de Chute) aerial photography is used to describe changes in AHF habitat from land use activities to that point from the early 1980's. Temporal boundaries for the cumulative environmental effects assessment of future projects and activities that will be carried out include the next 5 years, beyond which forecasting is not reliable.



SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF APPALACHIAN HARDWOOD FOREST

Date: 2004 04 15	Scale: AS SHOWN
Job No.: 14677	Fig. No.: 6.6.1

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6.6.4 AHF Area

6.6.4.1 Historic Trends and Existing Conditions

Based on topography and soil type, MacDougall (1997) concluded that AHF historically occupied at least 200,000 ha in western New Brunswick. Much of this land was cleared in the 19th century and early 20th century for settlement, agriculture and forestry. In the 1930's and 1940's, much of these cleared lands were allowed to reforest. Based on the 1997 field surveys of the AHF Conservation Stewardship Project (MacDougall 1997), only 1,174 ha (0.8%) of land classified as suitable for AHF in the central St. John River Valley (147,338 ha) supported mature AHF stands (Betts 1999). Of the suitable land available, 55% has been cleared permanently for agriculture, settlement or roads (MacDougall and Loo 1998). MacDougall and Loo (1998) suggest that the AHF that remained after the period of intense clearing in the 19th century has remained stable for most of the 20th century. However, between 1981 and 1997, 44 of the 114 potential mature AHF sites identified from the 1980's forest inventory data had been partially or completely clearcut, and only seven sites showed no evidence of past cutting (MacDougall 1997).

Sixty-five known AHF sites were remaining in 1997. The mature hardwoods that make up the AHF stands are commercially valuable trees and there is pressure on landowners to clearcut (Peabody 1998). There are no regulatory restrictions on the harvesting of AHF on private land. NTNB has encouraged landowners to protect these remaining AHF sites by such measures as entering into stewardship agreements, but this has resulted in no substantive private conservation measures (J. Simpson, pers. comm.). The AHF sites are highly fragmented within the area studied. Betts (1999) calculated a mean nearest neighbour (the average distance that separates patches of the same type) of 1.28 km, demonstrating that the sites are widely spaced and isolated. Distance between patches is important because of the limited dispersal distances for many AHF plant species, depending on the dispersal method. A patch size distribution of the remaining AHF shows that 48% of the patches are under 10 ha, and 86% are under 40 ha (Figure 6.6.2). The smaller the patches the less forest interior is present, which is often required by most AHF species (Haase 1965 in Betts 1999).

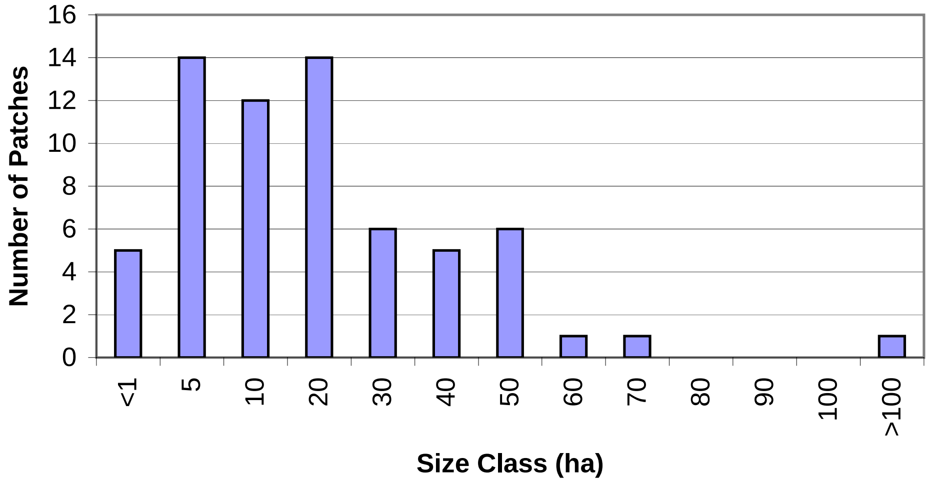

Figure 6.6.2 Distribution of known AHF patches from 1980's Forest Inventory Data and based on 1997 field visits, but not taking into account partially cut or clearcut portions of the sites, from Betts (1999).

AHF (as benchmarked by the 1980's forest inventory) was laid over the recent 1996/2000 forest inventory database. The analysis covers the Assessment Area. A total of 627.7 ha or 53.4% of the AHF is within the Assessment Area. This analysis shows that in this 15-20 year period, 67.8 ha of mature forest was lost from AHF sites due to forest harvesting. With other losses, the total AHF loss is 86.9 ha. This total loss includes 2.5 ha from agricultural land, 5.4 ha from other occupied land such as residential (mostly in a few AHF sites already in close proximity to roads and other residential development), 10.9 ha from a quarry site at the edge of the Meduxnekeag River AHF site, and 0.3 ha from a TCH twinning project.

The two AHF sites (AHF#30a and #28) that would be affected by the Project have been reduced in size since their delineation in 1997 from a total of 47.5 ha to 28.5 ha (a loss of 19 ha). The small AHF #30a comprised two small patches (3.8 and 5.2 ha) separated by a transmission line RoW and surrounded on three sides by agricultural land. These patches are currently 1.3 and 2.7 ha (respectively) due to forest cutting before 2000. AHF #28 at Big Presque Isle Stream also comprises two fragments (15.1 and 23.4 ha, historically) separated by a transmission line RoW. The smaller patch has been bisected by a large clearcut prior to 2000, and reduced to approximately 8.3 ha. The larger patch has been subjected to selective cutting over the recent past, resulting in a 16.2 ha stand as delineated in 2000; the landowner has more recently conducted selective cutting in this stand. Thus, as noted earlier, the total loss from the 1980's to 2000 for these two AHF sites is 19 ha, all attributable to clearcutting or partial clearcutting.

Currently, there are no Provincial regulations that manage or limit the extent of the conversion from forest to agriculture. Between 1991 and 2001 there was a 15% increase in potato production in the region as noted in the Land Use VEC (Section 5.8) resulting in part from the conversion of forestland to agriculture. This trend is likely to continue into the near future as forestland is cleared to provide for the more profitable business of growing crops (particularly potatoes) on agricultural land. However, as noted above, only 2.5 ha of AHF has been converted to agricultural land in the Assessment Area between the 1980's and 1996/2000.

The existing TCH and most other local highways and roads were built prior to the temporal boundaries of the assessment. However, the twinning of the TCH just south of the Meduxnekeag River in 1996 resulted in the loss of approximately 0.3 ha of the Meduxnekeag River-Woodstock AHF site, due to the widening of the RoW. Although the recently completed Woodstock to Pokiok, Perth-Andover Bypass, and Saint-Léonard to Grand Falls TCH projects are near or within the historical distribution of AHF, there are no known AHF sites that were affected by the projects.

In summary, Betts (1999), based on the work by the Appalachian Hardwood Forest Conservation Stewardship Project (MacDougall 1997; MacDougall and Loo 1998), identified 65 AHF sites totaling 1,174 ha within his study area. Using the most recent available forest inventory data (based on 1996 aerial photography north of River de Chute and 2000 aerial photography south of River de Chute), there has been an estimated 86.9 ha reduction in AHF area in the Assessment Area since the early 1980's. Of the 627.7 ha of AHF within the Assessment Area, 67.8 ha has been lost from forest harvesting, 2.5 ha from agricultural land, 5.4 ha from other occupied land such as residential, 10.9 ha from a single quarry, and 0.3 ha due to the widening of the existing TCH. The 67.8 ha lost from forest harvesting includes the 19.0 ha of the two AHF sites affected by the Project, lost before 2000.

6.6.4.2 Project Interactions with Other Future Projects and Activities

As noted in Section 6.6.4.1, two AHF sites located within the Assessment Area proximal to the Project, were reduced by 19 ha before 2000. The small AHF #30a is made of two small patches (3.8 and 5.2 ha) separated by a transmission line RoW, and currently 1.3 and 2.7 ha (respectively) due to forest cutting. This site would be further reduced by the Project to approximately 1.1 and 1.5 ha, respectively. This is a net loss of 1.4 ha, attributable to the Project. AHF #28 at Big Presque Isle Stream is currently made of 2 fragments (8.3 and less than 16.2 ha) separated by a transmission line RoW. An access road would reduce the smaller patch by less than 0.5 ha at its western edge, as the site has already been bisected by a large clearcut prior to 2000. The larger patch, already subjected to selective cutting before 2000 (totaling 7.2 ha), would be bisected by the Project, resulting in two patches approximately 5.2 ha and 6.1 ha in size. Portions of the 6.1 ha patch have been selectively harvested in recent years, however this has not been quantified. The total loss of AHF #28 attributable to the Project is approximately 5.4 ha. The total loss of mature AHF habitat attributable to the Project is therefore 6.8 ha.

A third AHF site in the Assessment Area, affected by the proposed Grand Falls to Aroostook TCH Project, comprises two patches (5.1 and 15.0 ha) that have been subjected to selective cutting over much of the site since 1996, the year of available forest inventory data. The 5.1 ha patch east of a transmission line RoW will not be affected by construction, however 7.2 ha (previously affected by selective cutting since 1996) would be lost from the 15.0 ha site, leaving two patches of 2.0 and 5.8 ha.

The cumulative loss of AHF in these three sites due to these proposed TCH projects since the identification of the AHF in 1997 is 14.0 ha. The resulting patch size distribution is shown in Figure 6.6.3. Overall there will be a slight shift in the patch size distribution due to the future TCH projects, with a reduction in the 10-30 ha size class and increase in the 1-10 ha size class.

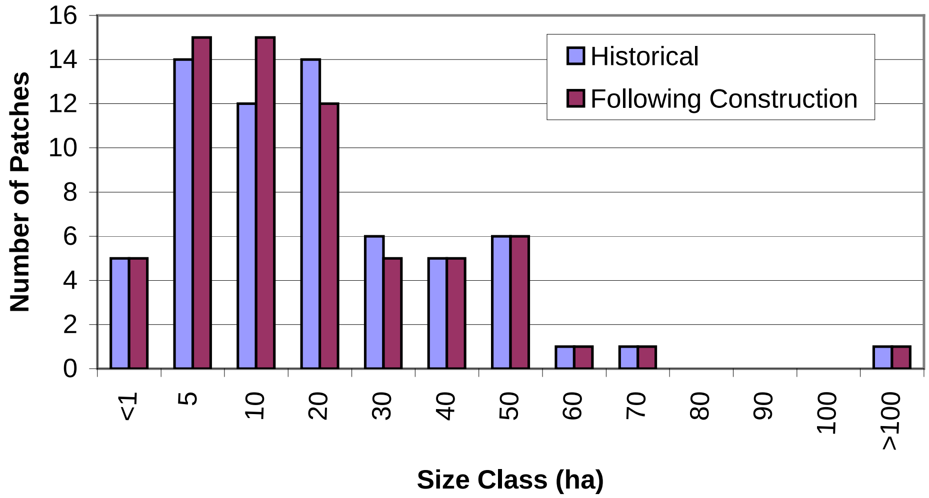

Figure 6.6.3 Change in AHF Patch Size Distribution due to Future TCH Projects (based on Betts 1999)

The existing Route 95 highway is located within the Meduxnekeag River watershed, and is considered a "hotspot" for AHF sites (MacDougall 1997). Two AHF sites are immediately adjacent to the existing highway (Richmond Corner and Highway 95 Woods). The two AHF sites (immediately south of the existing lanes) will not be directly affected by highway construction, as current plans are to position the new lanes north of the existing highway. The Meduxnekeag River bridge replacement project involving the replacement of the east bridge will not affect the nearby Woodstock-Meduxnekeag Bridge AHF site located west of the existing west bridge (Figure 2.1-D, Appendix B). There are no known AHF sites in the vicinity of the Woodstock to Pokiok and Pokiok to Longs Creek TCH projects.

The contributions of land use activities to the future loss of AHF habitat is difficult to predict, as land use plans are not available for the private land that makes up the AHF sites. Based on the recent losses of AHF attributable to other land uses between the 1980's and 1996/2000 (Section 6.6.4.1), the loss of

AHF in the next 5 years is likely to be negligible for agriculture, quarries, and residential or other similar land uses. For forest harvesting, assuming a rate of 67.8 ha in 13 years continues, 26 ha could be lost within the AHF subset in the next 5 years.

6.6.4.3 Summary

Table 6.6.2 provides a summary of the known cumulative losses of AHF within the Assessment Area. Adding the historic losses (since the 1980's) to the losses associated with the future projects and activities results in an estimated total loss of 125.6 ha. This estimate accounts for projected losses due to forest harvesting in the future. Attempts by NTNB to convince private and freehold landowners to protect the known AHF areas from forestry have been generally unsuccessful, however a few landowners do intend to continue to minimize disturbance in their sites (J. Simpson, pers. comm.).

Table 6.6.2 Summary of Cumulative Environmental Effects on Area of AHF in the Assessment Area.

Project or Activity	Known Loss of AHF from 1980's to Present.	Projected Loss of AHF from Future Projects and Activities	Total loss of AHF Habitat
Perth-Andover to Woodstock TCH	N/A*	6.8 ha	6.8 ha
Grand Falls to Aroostook TCH	N/A	7.2 ha	7.2 ha
Existing TCH	0.3 ha	0	0.3 ha
Forest Resource Harvesting	67.8 ha	26 ha estimated	92.8 ha
Agriculture	2.5 ha	Negligible**	2.5 ha
Pits and Quarries	10.9 ha	Negligible	10.9 ha
Residential	5.4 ha	Negligible	5.4 ha
Totals	86.9 ha	39.0 ha	125.9 ha
		Project Compensation	72.4 ha
		Net loss of AHF in Assessment Area	53.7 ha

*N/A – not applicable
**based on the low rates of change observed from an analysis of the available data.

The protection of 72.4 ha of AHF of very high to high priority AHF not previously identified by MacDougall (1997) will contribute to conservation efforts, and should be considered more than adequate compensation for the loss of 6.8 ha of moderate priority sites by the Project. This AHF contains a large number of vascular plant species of conservation concern that would otherwise be at risk of future forest harvesting pressures. The two sites that make up the 72.4 ha of AHF are also relatively large patches, (48.8 and 23.6 ha respectively), and therefore also assures improved overall patch size distribution for AHF in the landscape. This compensation equals five times the loss of AHF attributable to both NBDOT Perth-Andover to Woodstock and Grand Falls to Aroostook TCH projects combined. These sites will be donated to the Province and recommended for formal environmental protection as a protected area.

Taking into account this compensation, the net cumulative loss of AHF habitat within the Assessment Area since the early 1980's is 53.7 ha, or 8.6%, but represents a reversal of cumulative trends that without the NBDOT projects are estimated to be 110.9 ha. Based on the trends for AHF since the 1980's, it is likely that the previously unknown AHF sites that will be conserved due to the Project would otherwise be cut for forestry operations in the future, further future mitigating cumulative environmental effects. Also, as demonstrated by the identification of AHF not selected as suitable AHF and therefore not investigated by MacDougall (1997), the area of AHF is potentially much larger than previously documented (Section 5.5.4.4).

In consideration of planned mitigation and compensation, the Project is not anticipated to have any net adverse environmental effects on AHF or associated vascular plants of conservation concern that would overlap with those of other projects or activities.

6.6.5 Determination of Significance

Based on the above discussion, the contribution of the Project to cumulative environmental effects are, based on mitigation and compensation, considered positive in respect of the loss of AHF and associated vascular plant species of conservation concern. Cumulative environmental effects trends of other past, present, and future projects on AHF are lessened by the planned compensation. With Project compensation for loss of AHF, the net cumulative environmental effects of past, present and future projects are estimated to be 53.7 ha, or 8.6% of AHF (as determined by Betts (1999)) in the Assessment Area. As such, the cumulative environmental effects of the Project, in combination with other past, present, and future projects in the Assessment Area, are rated not significant.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.5 (Vegetation VEC), for the verification of the accuracy of the cumulative environmental effects analysis on Appalachian Hardwood Forest.

6.7 Cumulative Environmental Effects Analysis of Wetlands

6.7.1 Summary of Residual Environmental Effects of Project

The residual environmental effects of the Project on Wetlands, following mitigation, are the direct loss of approximately 22 ha of wetlands to construction. The wetland functional analysis of these wetlands found that only one wetland may be considered "significant". The direct environmental effects of the Project on the residual unaffected parts of the "significant" wetland are small and mitigation will be in place during Construction and Operation to mitigate potential environmental effects on wetland function, including additional monitoring, resulting in no net loss of wetland function. Wetland evaluations of the remaining wetlands determined that there would be no loss of wetland function on adjacent remnants (*e.g.,* provision of habitat for wetland-dependent flora and fauna). Compensation measures planned for the Project totaling 66 ha (3:1 ratio) is expected to adequately compensate for the direct losses and ensures that the Project will result in no net loss of wetland. Wetlands have been carried forward in the cumulative effects assessment due to Guideline requirements and regulatory concern, even though there will be no net loss of wetland habitat or function.

6.7.2 Identification of Issues and Selection of Indicators

The key issues for wetlands in the vicinity of the Project and surrounding areas are the loss of wetland function caused by either the direct reduction in wetland area from the conversion to other habitat (*e.g.*, the filling in of wetlands for road construction and agriculture), or indirect environmental effects caused by adjacent land use practices (*e.g.*, forestry, agriculture and road operations). The *New Brunswick Wetlands Conservation Policy* (NBDNRE and NBDELG 2002) applies to all wetlands greater than 1 ha in size, as does the *Watercourse and Wetland Alteration Regulation*. Although one of the goals of the provincial policy and the *Federal Policy on Wetland Conservation* is the maintenance of wetland function, the practical implementation and measurement of these losses is based on wetland area, especially for wetlands not considered provincially "significant".

The available data on wetlands do indicate historical trends that enable consideration of the cumulative environmental effects of other projects and activities of past, present and future projects that may overlap with those of the Project. Therefore wetland area has been chosen as the indicator for cumulative environmental effects on Wetlands.

The operation of the existing TCH, provincial and municipal roads, and future TCH has the potential to contribute to salinization of wetlands immediately adjacent to the roadways, as a result of salt application for winter safety. However, NBDOT is committed to developing and implementing best salt management practices in a continued effort to reduce the cumulative environmental effects of road salt on the environment. Data on historical trends in the salinization of wetlands in the assessment boundaries are not available. Since the improvement in the management of salt is expected to slow or perhaps reverse possible past operational effects of other roads, operational environmental effects of other projects and activities including salinization is not considered further in this cumulative environmental effects assessment.

Table 6.7.1 indicates which projects and activities may act cumulatively with the Project on Wetlands.

Table 6.7.1 Cumulative Environmental Effects Potential Interactions Matrix for Wetlands

Past, Present of Future Project or Activity	WETLAND VEC INDICATOR Loss of wetland area
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	✓
Saint-Léonard to Grand Falls TCH	✓
Perth-Andover By-Pass TCH	
Woodstock to Pokiok TCH	✓
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	
Lockhart Mill Interchange TCH	
Meduxnekeag River Bridge TCH	✓
Route 95 (Woodstock to Houlton)	✓
Pokiok to Longs Creek TCH	✓
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	✓
Residential	✓
Commercial	✓
Industrial	✓
Hunting	
Fishing	
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	
Grand Falls Big Stop	
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	
Wakefield Salmon Hatchery	
Woodstock Wastewater Treatment Plant	

6.7.3 Assessment Boundaries

The spatial boundaries for cumulative environmental effects assessment on Wetlands are based on the NBDNR wetland and forest inventory information compiled for the assessment of three current and future TCH projects. These include the Project, the Grand Falls to Aroostook TCH Project, and the Pokiok to Longs Creek TCH Project (Figure 6.7.1). These data provide a good representation of the diversity of wetlands potentially affected by the TCH projects and to some considerable extent the activities identified in Table 6.7.1 above that are in proximity to these projects. A summary of wetland change based on aerial photos from the 1930's to the 1980's was completed for agricultural areas of Carleton County (R. Caposi, pers. comm.). Those data are helpful for benchmarking cumulative environmental effects but are limited to Carleton County.

Temporal boundaries for the cumulative environmental effects assessment of wetlands are from the 1930's to present for historic trends and uses recent NBDNR Wetland and Forest Inventory Data from 1994 to 2000 as current data. Wetland and Forest Inventory Data for the different TCH projects are based on different years of recent aerial photography (Table 6.7.2). Temporal boundaries for the cumulative environmental effects assessment of future projects and activities include the next five years, beyond which forecasting is not reliable.

Table 6.7.2 Years of Aerial Photography used as the Basis of the Wetland and Forest Inventory Databases

TCH Project	Year(s) of available aerial photography
Grand Falls to Aroostook	1996
Perth-Andover to Woodstock	1996 (north end) and 2000 (south end)
Pokiok to Longs Creek	1999 (north end) and 1994 (south end)

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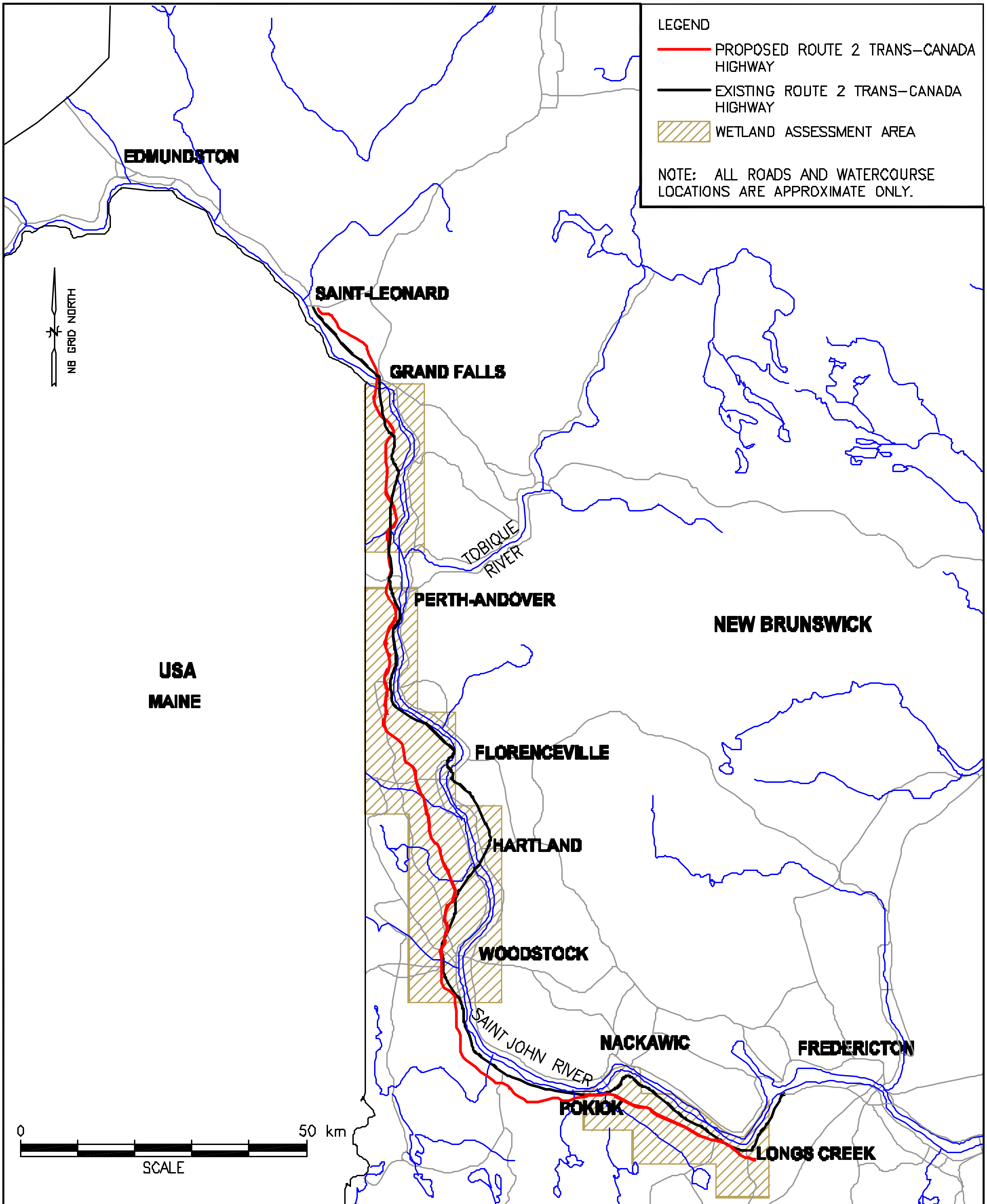

SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF WETLANDS	Date: 2004 04 15	Scale: AS SHOWN
	Job No.: 14677	Fig. No.: 6.7.1

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6.7.4 Wetland Area

6.7.4.1 Historic Trends and Existing Conditions

Aerial photos are available for New Brunswick from the 1930's. Analysis of aerial photos from the 30's to the 80's in the agricultural-dominated Carleton County indicated that there had been approximately a 4% net loss of wetlands (R. Caposi, pers. comm.). The loss of wetlands in this area of the Province is mostly due to agriculture, including the ditching of wetlands to drain them. This loss relates mostly to wetlands not associated with watercourses. There has been little creation of wetlands except for those resulting from beaver activity. However, Ducks Unlimited has a number of past wetland projects that at least partially offset historic losses of wetlands. Examples of DU sites in the vicinity of the Project include Carlisle Lake and Tweedie Lake Flowage. Two sites are also located in the vicinity of the Pokiok to Longs Creek TCH project (Pokiok Deadwater and Prince William).

Although there has also likely been losses of floodplain wetlands along the Saint John River due to hydroelectric dam construction in the 60's, the analysis by R. Caposi (pers. comm.) did not focus on those losses. There is no known summary of losses of wetlands from hydroelectric dams.

Based on current available data from air photo interpretation (1996/2000), there are approximately 394 wetland complexes totaling 1,863 ha, in the Assessment Area for the Project. Analysis of the Assessment Area for changes to wetlands associated with other projects indicates that 52.5 ha of wetland habitat, within 91 wetland complexes or singular wetlands, are within 30 m of a provincial, local or forest road. Seventy-three of these wetlands are immediately adjacent, suggesting that road construction may have had direct environmental effects on wetlands. However in some cases roadways have resulted in the creation of open water wetlands from impeded drainage and beaver activity.

In the vicinity of Grand Falls to Aroostook project, there are approximately 69 wetland complexes totaling 300 ha based on 1996 data. Analysis of the proximal portion of the Assessment Area for changes to wetlands indicates that 16.8 ha of wetland habitat, within 28 wetland complexes or singular wetlands, are within 30 m of a provincial, local or forest road. Thirteen wetlands are immediately adjacent, suggesting that road construction may have had direct environmental effects on wetlands.

In the vicinity of Pokiok to Longs Creek there are approximately 140 wetland complexes totaling 2,212 ha based on 1996/1999 data. There is a large proportion of wetland habitat south of the TCH Project, associated with the Pokiok Stream. A total of 27.5 ha of wetland habitat, within 51 wetland complexes or singular wetlands, are within 30 m of a provincial, local or forest road, and 38 wetlands are immediately adjacent.

Table 6.7.3 summarizes this information and for the Assessment Area overall.

Table 6.7.3 Summary of Wetland Data

	Perth-Andover to Woodstock Area	Grand Falls to Aroostook Area	Pokiok to Longs Creek Area	Total
Total number of wetland complexes	394	69	134	597
Total area of wetland (ha)	1,863	300	2,212	4,375
Number of wetlands intersected by roads*	73	13	38	124
Number of wetlands within 30 m of roads*	91	28	51	170
Area of wetland habitat within 30 m roads* (ha).	52.5	16.8	27.5	96.8
* includes provincial, local and forest roads.				

The existing TCH and some of the provincial and municipal roads have likely had at least some direct environmental effects on wetlands located adjacent to these roads. Construction of these roads may have contributed to habitat loss, reduced habitat quality and loss of wetland function. For example, of the 24 wetlands and wetland complexes located within 30 m of the proposed Project RoW, four (WL12, WL16, WL20, WL24) have been bisected by other roads, including one (WL24) bisected by the existing TCH, which will be twinned as part of the Project.

The Perth-Andover By-pass TCH project is mostly the twinning of the existing road, and does not affect any wetland habitat. During the route selection for the Saint-Léonard to Grand Falls and Woodstock to Pokiok TCH projects, known wetlands were avoided. No concerns regarding wetlands were expressed by Environment Canada or NBDNR during the environmental review of these projects (NBDOT 1998b, c, 1999a, b).

6.7.4.2 Project Interactions with Other Future Projects and Activities

Wetlands are one of the constraints that NBDOT planners try to avoid (or minimize the environmental effects to the extent possible) when selecting alignment corridors for highways (Section 2.2.2). During the route selection for the Grand Falls to Aroostook and Pokiok to Longs Creek TCH projects, most wetlands have been avoided, or will likely have minor indirect environmental effects. There will be a direct loss of less than 3 ha (2.1 ha for Pokiok to Longs Creek and 0.85 ha for Grand Falls to Aroostook) of wetland habitat on those two projects. None of these wetlands were considered “significant”, following wetland evaluations (JWEL 2003b; 2004).

The Route 95 (Woodstock to Houlton) twinning project (currently in the planning stages) has the potential to affect approximately 1 ha of a wetland surrounding Morrison Lake, based on available wetland information. The Florenceville Bridge and Route 110 Interchange is not expected to affect any wetlands.

Adjacent land uses that may in the past have had, or may in the future have, environmental effects that act cumulatively with those of the Project include forest resource harvesting, agriculture, hydroelectric power generation, residential, commercial and industrial development. There is a potential for any of these activities to contribute to losses of wetland area and degradation of wetland quality. Only seven wetlands (WL 1, 12, 19, 20, 21, 23 and 24) within 30 m of Project RoW are also in close proximity to agricultural land and/or other occupied land. A number of the wetlands have also likely been subjected to some degree of cutting in adjacent forestland. The functional assessment of each of the wetlands accounted for these other land uses.

Only one wetland crossed by the Project (WL3) is considered "significant", following wetland evaluations (Section 5.6.4.3), however would not be considered a "provincially significant" wetland (NBDNRE and NBDELG 2002). This wetland is controlled by a man-made structure that created the open water habitat. Forest harvesting is the only past activity identified as having some environmental effects on this wetland, however the environmental effects have not appeared to have affected wetland function of this wetland. There are no residual environmental effects of the Project on this wetland, following mitigation and compensation.

The use of provincial and federal mitigative practices, including managing activities within or leaving 30 m buffer zones (as per the *Watercourse and Wetland Alteration Regulation* of the *Clean Water Act*) adjacent to wetlands, during future forest harvesting, agricultural activities, and land development will preserve wetland area and minimize degradation of wetland quality. Where wetland losses are considered necessary for a project, wetland compensation would likely be required as part of conditions of approval of permits. Future projects registerable under the NB *Environmental Impact Assessment Regulation* that will necessitate the loss of wetlands would also require compensation if the project is permitted to proceed.

6.7.4.3 Summary

Table 6.7.4 summarizes the known contributions of future projects to loss of wetland area.

Table 6.7.4 Summary of Wetland Loss from Current and Future Projects

Project	Wetland Loss Area (ha)
Grand Falls to Aroostook TCH	0.85
Perth-Andover to Woodstock TCH	22
Route 95 (Woodstock to Houlton)	1.0 (est.)
Meduxnekeag River Bridge TCH	Negligible
Pokiok to Longs Creek TCH	2.1
Total	25.95

Information on a representative portion of the spatial boundaries of this cumulative environmental effects assessment suggests the historic loss wetlands from the 30's to the 80's was approximately 4%. Another 96.8 ha of wetland habitat are located within 30 m of existing roads in the Assessment Area.

Overall, the historic loss may be considered significant but cannot be quantified due to the lack of data. The total projected loss of wetland habitat from the various current and future TCH projects is 25.95 ha. However, all of this loss has or will require compensation at a 3:1 ratio, resulting in an equivalent of 78 ha of wetland area replaced or improved, as will be determined through consultation with NBDNR and CWS. Therefore, the contribution of the Project to cumulative environmental effects that may already be significant will be fully mitigated and compensated.

6.7.5 Determination of Significance

Based on the above discussion, the contribution of the Project to cumulative environmental effects are fully mitigated and compensated. Cumulative environmental effects trends of other past, present, and future projects on wetlands, although potentially significant are lessened by the planned Project-related compensation.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.6 (Wetlands VEC), for the verification of the accuracy of the cumulative environmental effects analysis of wetlands.

6.8 Cumulative Environmental Effects Analysis of Moose and Moose Habitat

6.8.1 Summary of Residual Environmental Effects of Project

The residual environmental effects of the Project on Moose and Moose Habitat, taking into account mitigation, are the fragmentation of habitat due to the use of fencing and wildlife crossing structures, and some residual mortality due to vehicle collisions and increased hunter access. However, the environmental assessment of the Project has concluded that the residual environmental effects of the Project are not significant.

Mitigation for moose includes route selection and refinement of the highway, and the use of wildlife fencing and crossings. The highway was realigned in the vicinity of Dryer road to Raymond Road in response to public concern that this was an area of high use by moose. This was confirmed during aerial surveys and during field surveys for migratory birds. NBDOT is also working closely with NBDNR biologists to select appropriate locations for fencing and wildlife crossings based on the results of aerial surveys conducted during early 2003 and 2004, taking into account recent guidelines developed by NBDNR. Experience from road construction north of Saint-Léonard is that routing highways through areas of older uncut forests may result in cutting of adjacent habitats by the woodlot owners, due to the opportunistic access. The result is the attraction of moose to the edge of the RoW for browse, where their presence was not previously reported. Given the changes in the landscape that are occurring and are likely to occur in the near and distant future due to forestry practices and the highway construction activities themselves, NBDNR has recommended that the details of where to locate corridors and fencing be developed over the course of Project development, where possible. Corridors, however, will have to be selected relatively early in the design process. Following construction, NBDOT is committed to conducting follow-up to determine the use of the surrounding habitat by moose, to verify the environmental assessment conclusions and evaluate the effectiveness of planned mitigation.

6.8.2 Identification of Issues and Selection of Indicators

The key issues for moose in the vicinity of the Project and surrounding areas are moose mortality and fragmentation of their habitat. Moose winter foraging habitat is generally not limiting in the ever-changing forested environment where regenerating clearcuts provide a shifting food source, and moose movement is also generally not limited in the existing environment. Another important related issue is public safety. In this part of the Province, the interaction of moose and the travelling public results in a high number of deaths every year along the existing TCH highway, for both people and moose. Information collected on moose during the route selection stage as well as more recent aerial surveys conducted for the environmental assessment have demonstrated that there are no feasible routes for the new highway that will completely avoid all areas inhabited by moose at some time of the year. The key is the mitigation of moose mortality, usually in the form of fencing, which necessitates the use of crossing structures to reduce the fragmentation of habitat and facilitate the seasonal movements of moose. Moose population itself is selected as the indicator for Moose and Moose Habitat, based on the available data on moose in the area.

Table 6.8.1 summarizes those projects and activities that may act cumulatively with the Project on Moose and Moose Habitat. The other TCH projects located in areas with a high incidence of moose activity and resultant highway collisions include Saint-Léonard to Grand Falls, and Grand Falls to Aroostook. Forest harvesting has an influence on moose distribution due to the resultant changes in forest as cover and a food source, while hunting (including licensed hunts, poaching, and the Aboriginal hunt) contributes to mortality.

Table 6.8.1 Cumulative Environmental Effects Potential Interactions Matrix for Moose and Moose Habitat

Past, Present of Future Project or Activity	MOOSE AND MOOSE HABITAT VEC INDICATOR
	Moose Population
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	
Saint-Léonard to Grand Falls TCH	
Perth-Andover By-Pass TCH	
Woodstock to Pokiok TCH	

Table 6.8.1 Cumulative Environmental Effects Potential Interactions Matrix for Moose and Moose Habitat

Past, Present of Future Project or Activity	MOOSE AND MOOSE HABITAT VEC INDICATOR
	Moose Population
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	
Lockhart Mill Interchange TCH	
Meduxnekeag River Bridge TCH	
Route 95 (Woodstock to Houlton)	
Pokiok to Longs Creek TCH	
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	
Residential	
Commercial	
Industrial	
Hunting	✓
Fishing	
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	
Grand Falls Big Stop	
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	
Wakefield Salmon Hatchery	
Woodstock Wastewater Treatment Plant	

6.8.3 Assessment Boundaries

The spatial boundaries for cumulative environmental effects assessment of moose populations is NBDNR Wildlife Management Area #10 (WMA 10), which encompasses the two future highway projects in the areas of high incidents of vehicular collisions with moose (Figure 6.8.1). This area is reflective of the main areas where moose interact with the Project and other projects, in this region of the Province. Data on moose population are based on Wildlife Management Areas, however data for New Brunswick are provided for context.

Temporal boundaries for the cumulative environmental effects assessment of moose populations include the period from 1960 to the present based on available hunting statistics. Temporal boundaries for the cumulative environmental effects assessment of future projects and activities include the next five years, beyond which forecasting is not reliable.

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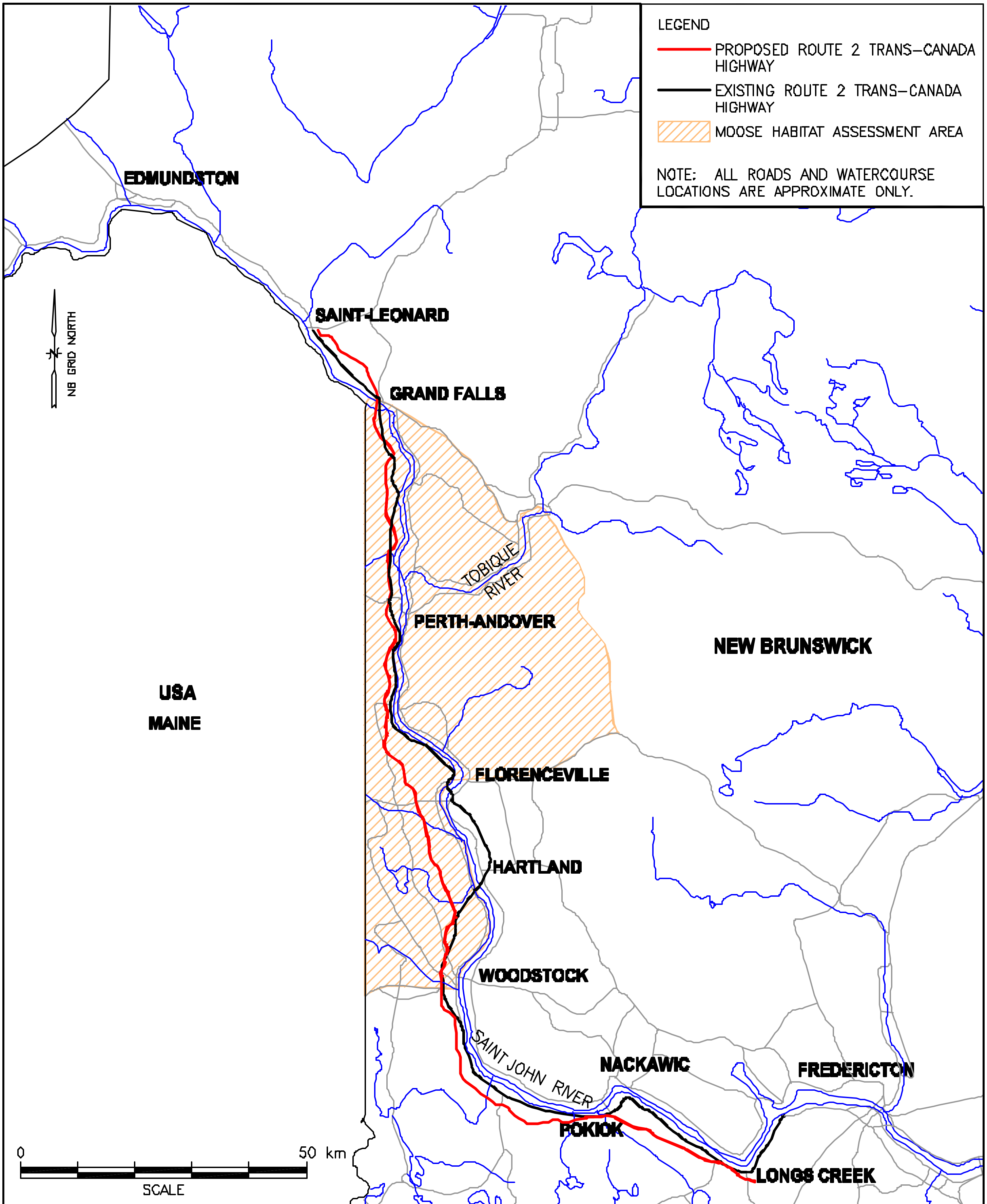


SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF MOOSE HABITAT	Date: 2004 04 15	Scale: AS SHOWN	Jacques Whitford Consulting Engineers Environmental Scientists
	Job No.: 14677	Fig. No.: 6.8.1	THIS DRAWING IS THE PROPERTY OF JACQUES WHITFORD AND IT SHALL NOT BE GIVEN OUT, COPIED OR DUPLICATED FOR THE USE OF ANOTHER BUT SHALL BE USED ONLY BY THE RECIPIENT FOR THE PURPOSE TO WHICH IT REFERS.

6.8.4 Moose Populations

6.8.4.1 Historic Trends and Existing Conditions

Trends in the New Brunswick moose population are derived mainly from hunting statistics. There is little information on the size of the moose population prior to 1960. As settlement in New Brunswick increased, it is likely that moose were heavily harvested. Moose harvesting was first regulated in the Province in the late 1880's. Between 1936 and 1959, the moose hunting season was closed in New Brunswick due to overexploitation. In 1960, the New Brunswick moose population was estimated to be between 3,000 and 5,000 animals (K. Craig, pers. comm.). From 1976 to 2000, the number of moose harvested and the hunter success rates have increased (NBDNR undated). By 1999, the moose population in the Province was estimated to be between 21,000 and 23,000 (K. Craig, pers. comm.). The number of registered moose kills has increased from 174 in 1960 to 2,573 in 2001. The 2002 registered resident moose kill for WMA 10 was 65 moose, compared with 2,020 for the Province, or 3.2% of the provincial registered kill (NBDNR 2003b). The 2003 quota for WMA 10, however was reduced from 111 in 2002 to only 10 in 2003 due to other mortality factors (NBDNR 2003b; N. Prentice, pers. comm.). From 2000 to 2002, hunting success rates have dropped (NBDNR undated). NBDNR has indicated that the New Brunswick moose population has dropped to 21,000 in 2003. However, an accurate assessment of the moose population is difficult due to the unregulated Aboriginal harvest that commenced in 1999 after the Marshall ruling.

Prior to 1999, unlicensed, non-Aboriginal hunting was estimated to harvest approximately 200 moose annually, province-wide (K. Craig, pers. comm.). Although detailed statistics on unlicensed hunting are not available, it is likely that 10 to 15 moose are taken this way annually from WMA 10 (K. Craig, pers. comm.). Most of the Crown land in this WMA is located east of the Saint John River, and is where much of the hunting pressure (both registered and Aboriginal) in this zone occurs (N. Prentice, pers. comm.).

The existing TCH and some of the local highways and roads contribute to the fragmentation of the landscape and the operation of these roads represent sources of moose collisions. While this road network does not impede the movement of moose in the landscape, it does increase the probability of collisions. Collision rates on the existing TCH where it is close to the Saint John River are relatively low, and collision rates on local highways and roads are not particularly high due to lower speed limits. Local users may also be more aware of the local potential for collisions. Motor vehicle collision statistics from 1995 to 2000 indicate an average of approximately 250 collisions per year Province-wide (NBDOT 2004), or approximately 1.2% of the current estimate of approximately 21,000 moose in the Province. In contrast, the existing TCH from Grand Falls to Aroostook has one of the highest collision rates in the Province (N. Prentice, pers. comm.). As is the case for most of the existing 2-lane TCH, there is no wildlife fence on this stretch of road. NBDNR has even removed suitable browse where

Crown land is immediately adjacent the TCH, so as to not otherwise attract moose to the edge of the highway.

Aerial surveys conducted in 2003 and 2004 for the Perth-Andover to Woodstock and Grand Falls to Aroostook TCH projects reaffirmed that moose activity in the vicinity of the Perth-Andover overpass is low, and did not warrant mitigation measures for moose.

Adjacent land uses that may have in the past had environmental effects on moose populations include forest resource harvesting and agriculture. Adjacent land use in agriculture development has added to the total cleared land, and resulted in a loss of suitable habitat for moose. Cleared forest suitable for cultivation is often replaced with agricultural fields in this area of the Province. However, many of the more significant wildlife areas within the Assessment Area and just beyond (*e.g.*, Williamstown Lake Wetlands and Clarke Bog), are not suitable for agriculture or have some degree of protection through acts and regulations. These are likely high use areas for moose. In some of the more extensive remaining areas of forest cover, such as in the vicinity of Strong Corner, the low lying wetland areas with surrounding forest habitat are unlikely to be converted to agricultural land. Some landowners have interests other than forestry and agriculture (*i.e.*, hunting and trapping), that will also help to ensure the persistence of forest habitat in the region. As noted in Section 5.7.5.2.1, efforts are made to manage the forest at a sustainable level, and to have a mixture of stand ages.

6.8.4.2 Project Interactions with Other Future Projects and Activities

Of the current and future highway projects, only the Project and the Grand Falls to Aroostook TCH project are likely to have similar environmental effects as described for the operation of the existing TCH and local highways and roads. This is because of the concentration of moose in those as opposed to other areas. Planning and design for the Grand Falls to Aroostook TCH project will follow similar mitigating measures and design standards as are being implemented for the Project. Moose fencing and where possible wildlife corridors will play an important role in reducing collisions in this area.

The areas of highest potential for vehicle collisions with moose are where moose habitat is found on either side of the highways, usually along natural corridors such as river valleys. Fencing and wildlife crossing structures will be used together to keep moose off the highway and direct them through the crossing structures. These crossing structures most often will be associated with watercourse crossings, however some will be associated with severed property access roads. These could have a reduced use by moose if they become highly used by snowmobiles or ATVs. In some cases planned underpasses for local roads may provide a suitable corridor, depending on traffic use.

The increased access, attributable to the future TCH projects, to some areas frequented by moose, but currently relatively remote, will likely result in increased hunting pressure. NBDNR believes, however, that the moose population in this area of WMA 10 can handle the increased hunting pressure (N. Prentice, pers. comm.).

The increased forest harvesting that can accompany highway development will in time, as clearcuts regenerate, increase the available browse. In areas of planned fencing, this will not likely be an issue, however, natural regeneration following clearing in areas that did not demonstrate high moose usage during the aerial surveys, and where no fencing is recommended, could result in the attraction of moose. The use by moose of these regenerating areas could possibly be discouraged by implementing intensive silvicultural practices (N. Prentice, pers. comm.). Incentive programs are apparently currently in place that private landowners can access to offset the associated costs of this mitigation.

Based on the distribution of moose observed during the 2003 aerial survey, specifically the separation of moose between the two projects (*i.e.,* the limited moose activity observed between Aroostook and Perth-Andover), there may not be very much interaction between moose populations in the vicinity of the two projects. Similarly, moose activity was not observed in the highly fragmented agricultural area of the Project, south of Little Presque Isle River. Therefore, the potential environmental effects of the other TCH projects will not likely act cumulatively with those of the Project. The planned developments within the spatial boundaries will not likely have a measurable effect on moose populations, given the size and location of the developments, and planned mitigation.

6.8.4.3 Summary

The management objective for both future TCH projects where moose have been identified as a concern is a net reduction in mortality of moose from vehicle collisions. This will be achieved with the planned mitigation (*e.g.,* wildlife fences and crossing structures) and follow-up. The selection and placement of fences and structures are being developed in consultation with NBDNR biologists. Although improved access will improve hunter access to western areas of WMA 10, NBDNR believes that this area can handle the likely increased hunting pressure. NBDNR will continue to manage the regulated hunt based on hunter success and other mortality factors.

6.8.5 Determination of Significance

Based on the above discussion, the Project residual environmental effects will not act substantively in combination with those of other past, present and future projects to such an extent as to cause an exceedance of the residual environmental effects rating criteria for moose, defined in Section 5.7.3. Therefore, the cumulative environmental effects of the Project in consideration of planned mitigation, in combination with other past, present, and future projects, is rated not significant.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.7 (Wildlife VEC), for the verification of the accuracy of the cumulative environmental effects analysis of moose and moose habitat.

6.9 Cumulative Environmental Effects Analysis of Migratory Birds of Special Conservation Concern

6.9.1 Summary of Residual Environmental Effects of Project

The Project residual environmental effects on Migratory Birds of Special Conservation Concern, taking into account mitigation, are the loss of an estimated 735 ha of forest and 74 ha of undeveloped land (including 22 ha of wetland), and the fragmentation of habitat. The assessment of environmental effects of the Project has concluded that these residual environmental effects are not significant in consideration of planned mitigation. Agricultural land affected by the Project (223 ha) was found to have few migratory birds of special conservation concern, and few of the wetland "target" bird species (as identified by CWS) were directly associated with the wetland habitats. Key mitigation to reduce the potential environmental effects of the Project on Migratory Birds of Special Conservation Concern include limiting the area of critical habitat required for the Project to the extent possible, and conducting most clearing outside the breeding season of migratory birds.

6.9.2 Identification of Issues and Selection of Indicators

The key issues that have been identified with respect to Migratory Birds of Special Conservation concern are habitat loss and fragmentation. More specifically, the three important habitat types that have been identified by CWS and were targeted during the collection of baseline information on birds for this assessment were mature forest, wetland and grassland/agricultural habitats. Particular importance was given to "target" bird species prioritized by CWS and associated with these three habitat types. Few target species associated with wetland and grassland/agricultural habitats were encountered during field surveys. Several target species associated with mature forest habitat were recorded, and of the three habitats, the loss of mature forest (estimated at 206 ha) affected the greatest number of target species of these three target habitats.

The "target" species of mature forest recorded during the field surveys include the Great Crested Flycatcher, Purple Finch, Wood Thrush, and Canada Warbler. Wood Thrush is designated by NBDNR as a "May Be At Risk" species, Great Crested Flycatcher and Purple Finch are considered "Sensitive", however Canada Warbler is considered "Secure". Of these four target species, only Wood Thrush demonstrated a requirement for mature forest in the Project Assessment Area, and is therefore selected as the focus of the cumulative environmental effects assessment. Great Crested Flycatcher, Canada Warbler and Purple Finch were all recorded in a variety of habitat types and as discussed in the environmental assessment of the Project (Sections 5.7.4.1.1 and 5.7.5.1.1) are likely to be relatively abundant in the Assessment Area. Great Crested Flycatcher are secondary cavity nesters, and therefore require old woodpecker cavities to nest, which are most likely to be found in mature forest. In the Assessment Area however, they were found in a variety of forest types and ages, including forested wetland habitats. Wood Thrush was also found in mostly mature forests, but also within younger forest. The indicators selected for the assessment of cumulative environmental effects are the *loss and fragmentation of mature forest habitat*, with respect to the Migratory Birds of Special Conservation Concern dependent on this habitat. Evaluation of these indicators is focused on Wood Thrush because it is a CWS "target" species that is demonstrated to use mature forest habitat in the Project Assessment Area.

Bird mortality during construction of the Project and all other future highway projects recently or currently under assessment should be sufficiently reduced by the planned mitigation. Therefore this issue is not carried forward in the assessment of cumulative environmental effects.

Table 6.9.1 indicates which projects and activities that may act cumulatively with the Project on Migratory Birds of Special Conservation Status.

Table 6.9.1 Cumulative Environmental Effects Potential Interactions Matrix for Migratory Birds of Special Conservation Concern

Past, Present of Future Project or Activity	**MIGRATORY BIRDS OF SPECIAL CONSERVATION STATUS VEC INDICATORS**	
	Mature Forest Habitat Loss	**Mature Forest Habitat Fragmentation**
Existing TCH and Other Provincial and Municipal Roads		
Saint-Léonard to Grand Falls TCH		
Perth-Andover By-Pass TCH		
Woodstock to Pokiok TCH		
Current and Future Highway Projects		
Grand Falls to Aroostook TCH	✓	✓
Florenceville Bridge and Route 110 Interchange	✓	✓
Lockhart Mill Interchange TCH		
Meduxnekeag River Bridge TCH		
Route 95 (Woodstock to Houlton)	✓	✓
Pokiok to Longs Creek TCH	✓	✓
Adjacent Land Uses		
Forest Resource Harvesting	✓	✓
Agriculture	✓	✓
Hydroelectric Power Generation		
Residential		
Commercial		
Industrial		
Hunting		
Fishing		
Planned Development Along Proposed TCH		
Tobique Truck Stop (Perth-Andover)		
Grand Falls Big Stop		

Table 6.9.1 Cumulative Environmental Effects Potential Interactions Matrix for Migratory Birds of Special Conservation Concern

Past, Present of Future Project or Activity	MIGRATORY BIRDS OF SPECIAL CONSERVATION STATUS VEC INDICATORS	
	Mature Forest Habitat Loss	Mature Forest Habitat Fragmentation
Other Planned Development		
New Brunswick Potato Museum/Learning Center on Route 110		
Wakefield Salmon Hatchery		
Woodstock Wastewater Treatment Plant		

6.9.3 Assessment Boundaries

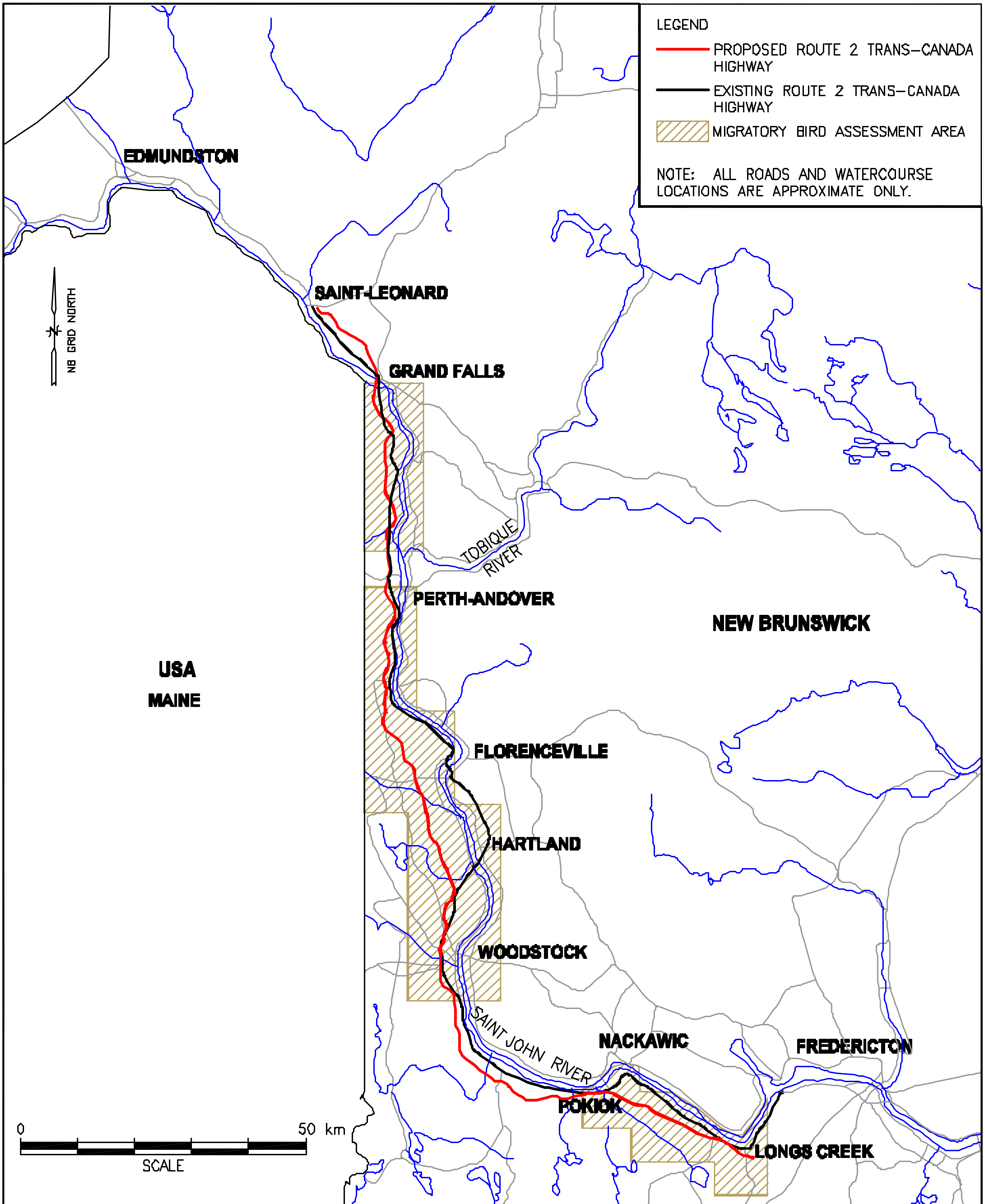
The spatial boundaries of the Assessment Area for cumulative environmental effects assessment of mature forest migratory birds are based on the NBDNR forest inventory information compiled for the assessment of three current and future TCH projects. These include the Project, the Grand Falls to Aroostook TCH Project, and the Pokiok to Longs Creek TCH Project (Figure 6.9.1). The database for these three projects provides a good representation of the diversity of habitat potentially affected by the projects and activities identified in Table 6.9.1 above.

Temporal boundaries for the cumulative environmental effects assessment of mature forest migratory birds include the period from 1968 to the present based on available Breeding Bird Survey information. With respect to mature forest habitat, temporal boundaries for the past and present are changes between 1984 to 1996/2000, based on the available forest inventory data. Temporal boundaries for the cumulative environmental effects assessment of future projects and activities include the next five years, beyond which forecasting is not reliable.

6.9.4 Mature Forest Migratory Bird Habitat

6.9.4.1 Historic Trends and Existing Conditions

Published information on historical trends for migratory bird populations is available for New Brunswick (Downes *et al*. 2003) but was not found specifically for the central Saint John River valley. The greatest effects on migratory bird populations in the Maritimes since European settlement are related to habitat alteration (Erskine 1992). Much of the land in western New Brunswick was cleared in the 19th century and early 20th century for settlement, agriculture and forestry. In the 1930's and 1940's, much of these cleared lands were allowed to reforest. Birds that depend on mature, closed, mixedwood forests were likely more abundant in New Brunswick prior to settlement and those characteristic of younger, open, coniferous forests are likely more abundant presently than prior to settlement (Erskine 1992). Erskine (1992) states that "…few forest bird species have disappeared from or appeared in the Maritimes as a result of forest changes over recent centuries."



SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF MIGRATORY BIRDS OF SPECIAL CONSERVATION CONCERN

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Jacques Whitford
Consulting Engineers
Environmental Scientists

More recent migratory bird trends in New Brunswick are provided by the Canadian Bird Trends Web Site (Downes *et al*. 2003). This database provides population trends based on Breeding Bird Survey in Canada data collected from 1968 to the present (2002 data). Based on the trends for New Brunswick, most migratory bird groups have been declining, at least in recent years, with the exception of short-distance migrants and wetland species. Woodland species populations in New Brunswick increased from 1968 to 1970, remained stable from 1970 to 1990, and declined from 1990 to 2002.

Breeding populations of many forest birds are likely closely linked to the availability of suitable breeding habitat. An analysis of Landsat imagery from 1995 was used by Betts (1999) to determine the amount of clearcutting in the region from 1984 to 1995. Based on this analysis, it was determined clearcutting was occurring at a rate of 10.5% in the area of coverage (encompassing Ecodistrict 19) over the 11-year period, and resulted in a 4% loss of mature tolerant hardwood forest. This method did not account for small selective cutting that can also have an adverse environmental effect on mature forest habitat as suitable breeding habitat at least for some bird species. Using forest inventory data to compare land cover within the Project Assessment Area between the 1980's and 1996/2000, there has been a loss of 1,000 ha or 6.9% of mature forest through cutting or conversion to other uses over this time period. However, this does not account for the increase in mature forest from natural succession.

Most of the forested land in the Assessment Area is managed for timber production by private woodlot owners, industrial freehold landowners, and some Crown land lessees, especially in the south. The CVFPMB recommends an Annual Allowable Cut based on the productive capacity of the forest, so that the resource is managed sustainably. Industrial freehold and Crown licenses are more likely to be managed in this way, and to consider wildlife factors, including maintaining tracts of mature forest.

Agricultural land in the Carleton and Victoria Counties has increased substantially in the past decade; with a 15% increase in area of potato production from 1991 to 2001 (NB Potato Statistics Update, B. Ouellette, DAFA, pers. comm.), in part a result of conversion from forestland. However, using the same data set as above, only 74.5 ha (1.2%) of mature forest identified from 1984 aerial photography was converted to active agricultural land by 1996/2000.

Most residential development is small single dwellings, usually built relatively close to existing roads, or associated with agricultural land. Most commercial development is also on a relatively small scale, close to existing infrastructure. With the exception of a few major industries such as the McCain production facility on the opposite side of the Saint John River at Florenceville, no large scale industrial land use has been identified in the Assessment Area that would have contributed directly to mature forest habitat loss since 1984.

All of the identified past and present projects and activities have contributed to the fragmentation of habitats in the landscape. The landscape is already highly fragmented as has been documented elsewhere (Betts 1999). There is very little unfragmented habitat left in the Assessment Area when considering all road types and anthropogenic development. One way to characterize whether an area can be considered unfragmented is based on a certain distance the area may be from roads. Using 1 km as a critical distance to consider the area of mature forest habitat under human influence (Canadian Council of Forest Ministers 1997), over 99% of the land in the vicinity of the Project is within 1 km of any road. This includes forestry roads, or anthropogenic open habitat (*e.g.,* agricultural land), before Project construction. The land in the vicinity of the Grand Falls to Aroostook project has the same percentage. The Pokiok to Longs Creek area has 8% of the land base that is more than1 km from roads. Most of this habitat is wetland and mature softwood forest on Crown land that will not be bisected by the new TCH.

6.9.4.2 Project Interactions with Other Future Projects and Activities

Habitat Loss

The assessment of habitat loss for the Project was based on the Project Assessment Area, and does not overlap the habitat surrounding most of the other current and future highway projects, excepting the Florenceville Bridge and Route 110 interchange project and the Route 95 (Woodstock to Houlton) highway twinning project. The Florenceville Bridge and Route 110 interchange project will have a very small amount of terrestrial habitat loss (<10 ha), including a few <1-ha patches of mature forest immediately adjacent existing provincial roads. The Route 95 project will likely involve the loss of some mature forest habitat, however this habitat will already border the existing highway. No planned development along the TCH, or other planned development will affect mature forest habitat.

Table 6.9.2 provides a summary of the amount of mature forest habitat estimated to be lost to the three highway projects. The Grand Falls to Aroostook and Pokiok to Longs Creek TCH projects will result in a loss of approximately 142 ha and 145 ha (respectively) of mature or overmature forest.

Table 6.9.2 Summary of Change in Mature Forest Habitat Area Due to TCH Projects

Statistic	Perth-Andover to Woodstock	Grand Falls to Aroostook	Pokiok to Longs Creek	Total
Total Area Assessed (ha)	78,894	23,524	26,285	128,703
Total Mature Habitat (ha)	13,537	3,823	8,572	25,932
Mature Habitat Lost (ha)	216	142	145	503
Mature Habitat Lost (%)	1.6%	3.7%	1.7%	1.9%

Taking the sum total of the mature forest habitat loss (503 ha), this represents the permanent loss of up to 1.9% of the mature habitat in the Assessment Area. This overall percentage is similar to that determined for the Project and therefore the arguments used during the assessment of environmental effects on Migratory Birds due to Construction (Section 5.7.5.2.1) should also be relevant. This habitat, although to be permanently removed, represents a relatively small proportion of the forest land base, and will be removed over a number of years. Forestry within the spatial boundaries is managed differently depending on the landowner. The CVFPMB, representing private woodlot owners, supports an Annual Allowable Cut (AAC) of 4,000 ha per year, or 2% of the forested land base (185,000 ha) in the two counties. This AAC represents the productive capacity of the forest in private hands. This excludes industrial freehold land and Crown land, which is managed for sustainability and considers wildlife habitat in management plans. Although the CVFPMB has no formal management control over how much wood private woodlot owners cut in a year, the annual cut usually fluctuates +/- 5 or 10% around the AAC (*i.e.* from 3,600 to 4,400 ha are actually cut each year). When considering the TCH projects within Carleton and Victoria counties, the 358 ha of mature forest loss represents less than 10% of the AAC. As the RoW has undergone cutting for at least the past 1 ½ years, and the remaining clearing will be spread out over the next two years, the cutting will be spread over several years, and would likely represent an average of 120 ha per year, which is within the year to year variability in the AAC (T. Fox, CVFPMB pers. comm.). Since 64% of the land base near Pokiok to Longs Creek is managed for timber production as Crown and industrial freehold lands (JWEL 2003a), there is a greater chance that the forests in this region are managed for sustainability, and consider wildlife issues such as mature forest. St. Anne-Nackawic which has a large proportion of the industrial freehold land in the area, and also has the Crown land license 8, has been able to modify its cutting plans to accommodate the planned cutting along the TCH RoW.

Habitat Fragmentation

The small future developments identified above are not likely to contribute substantively to this fragmentation. More widespread development such as forestry and agriculture will evidently contribute to fragmentation, but this is impossible to quantify, as large scale land use planning in the private land that makes up a high proportion of the landscape in the Assessment Area are not available. Therefore, an analysis of fragmentation is based on a comparison of the level of fragmentation before and after the construction of the three current and future TCH projects, based on available forest inventory mapping within the Assessment Area.

Betts (1999) looked at fragmentation of the landscape, focussing on the area of known distribution of AHF in the central St. John River Valley. To attempt to quantify fragmentation in the landscape, several of the metrics used by Betts (1999) were calculated for the habitat surrounding the three TCH projects for which forest inventory data was obtained (Perth-Andover to Woodstock, Grand Falls to Aroostook, and Pokiok to Longs Creek TCH projects). The boundaries chosen for the calculations were arbitrary and unbiased, using the available data coverage. The metrics from Betts (1999) and used in this analysis include perimeter/area ratio (metres/hectares), and patch size distribution. Other statistics provided include total number of patches (fragments), the change in the number of patches (percentage), and average patch size. The habitat patches assessed were patches of forest classified as “mature” or “overmature”.

Table 6.9.3 compares the fragmentation metrics for land in the vicinity of all three current or future TCH projects before and after construction, as well as providing the summary statistics. Figures 6.9.2 to 6.9.5 provide the histograms showing the patch size distributions. These statistics and distributions are provided for comparing before and after the construction of the projects, and provide trends only, as there are many variables that are difficult to control (*i.e.*, the accuracy of the forest inventory data), and are dependent on the spatial boundaries of the data used.

The perimeter/area ratios and the shapes of the histograms are comparable to those in Betts (1999). The results support the conclusion that the area in the vicinity of each project is already highly fragmented. Most of the statistics in Table 6.9.3 do not suggest a large increase in fragmentation averaging over the landscape, however the histograms allows one to see how the distribution of patch size will apparently change. The shift in the patch size distribution is mostly an increase in patches 10 ha or less, mostly from the further fragmenting of small patches. The percentage of patches 20 ha or smaller increases by 1% from 83% to 84%. Some of these large patches are deceiving, however, with relatively high perimeter-to-area ratios, as many will have “holes” of younger or open habitats.

Table 6.9.3 Fragmentation Statistics on Mature/Overmature Habitat Patch Type in the Assessment Area

Statistic	Perth-Andover to Woodstock		Grand Falls to Aroostook		Pokiok to Longs Creek		Total	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Total Mature Habitat (ha)	13,537.4	13,321.6	3,822.8	3,681.3	8,571.8	8,426.6	25,932.0	25,429.5
Change in Habitat (%)	NA	-1.6%	NA	-3.7%	NA	-1.7%	NA	-1.9%
Number of Patches	1,087	1,147	232	251	275	306	1,594	1,704
Change in Number of Patches (%)	NA	+5.5%	NA	+8.2%	NA	+11.3%	NA	+6.9%
Average Patch Size (ha)	12.5	11.6	16.5	14.7	31.2	27.5	16.3	14.9
Average perimeter (m)	2,279	2,158	2,806	2,596	4,174	3,745	2,683	2,508
Average* Ratio Perimeter/Area (m/ha)	292	309	261	272	314	349	292	311

NA = not applicable
*** based on average of ratios for each patch**

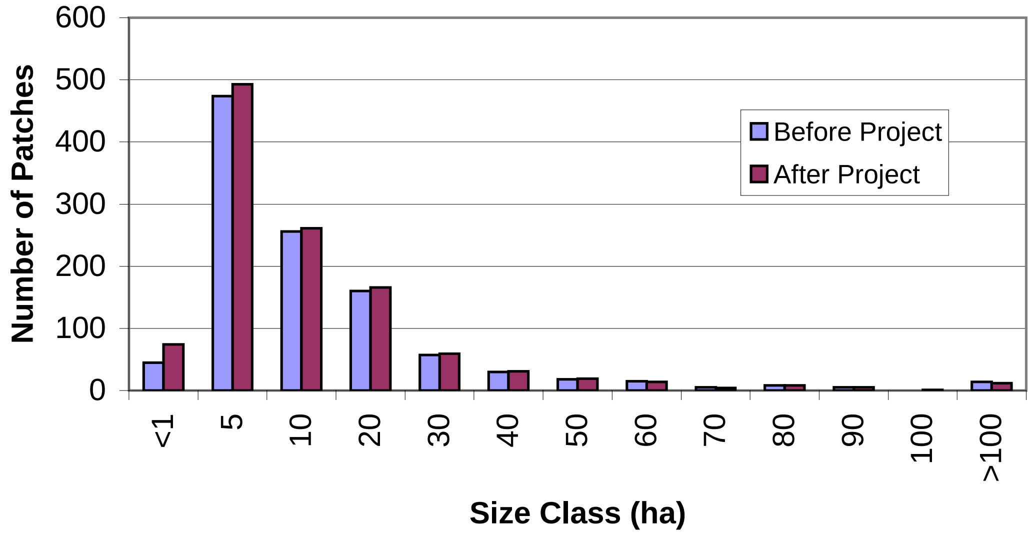

Figure 6.9.2 Mature Forest Patch Size Distribution - Perth-Andover to Woodstock.

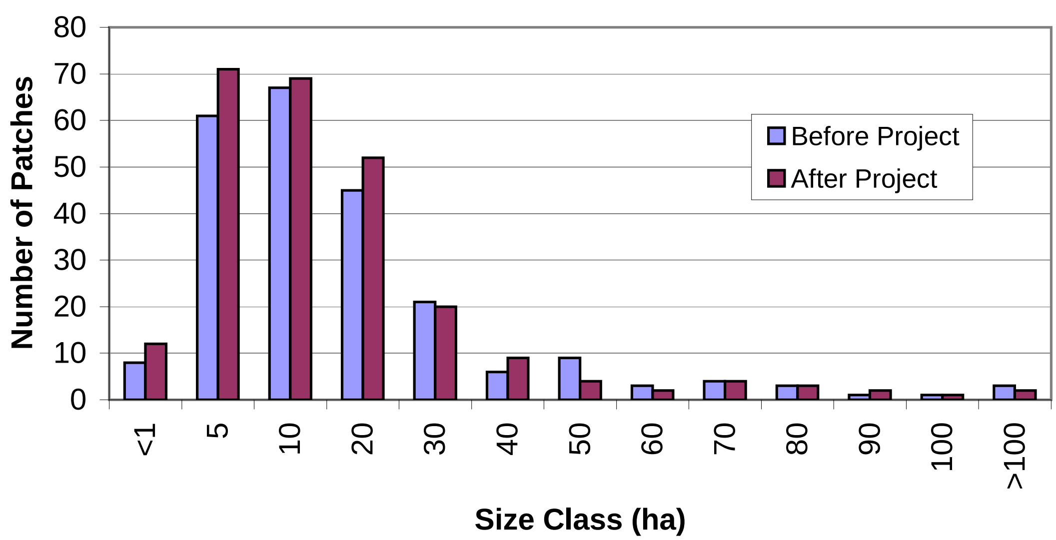

Figure 6.9.3 Mature Forest Patch Size Distribution - Grand Falls to Aroostook

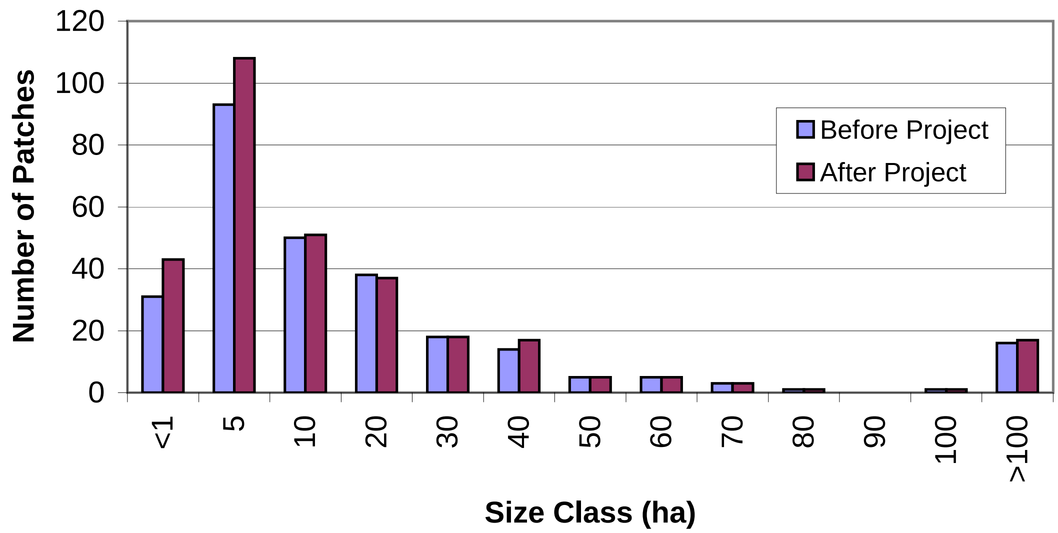

Figure 6.9.4 Mature Forest Patch Size Distribution - Pokiok to Longs Creek

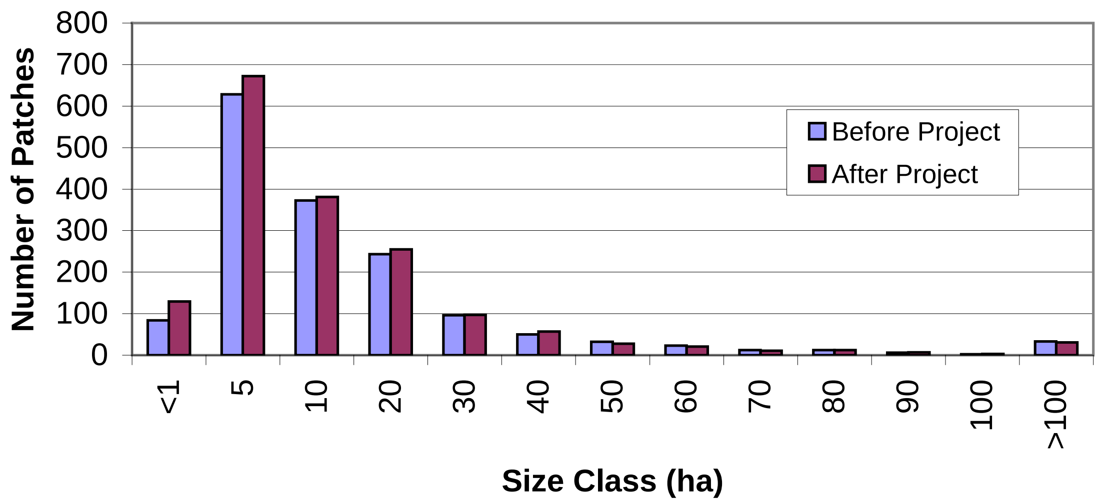

Figure 6.9.5 Mature Forest Patch Size Distribution - 3 TCH Projects Combined

These results demonstrate that it is difficult to evaluate habitat using this metric and GIS, although a powerful tool when evaluating landscape changes, are limited by the available data. Forest roads were not used to divide habitat into patches. Roadways and other linear features only subdivide habitats where a right-of-way is identified as a polygon within the forest inventory database. Nonetheless, it is possible to relate the change in patch size distribution to the potential environmental effects of fragmentation of mature forest migratory birds. The minimum habitat size for migratory birds considered mature forest-dependent vary by species, and also by study. Studies have noted that Wood Thrush are somewhat tolerant of forest fragmentation, as Wood Thrush may be found in habitat patches of 1 to 5 ha (Robbins *et al*. 1989, DeGraaf and Rappole 1995; cited by Banner and Schaller 2001). In a highly fragmented landscape in Ontario, Friesen *et al*. (1999, cited by Banner and Schaller 2001) did not find that Wood Thrush nesting success was related to distance from forest edge or forest size. However, others have found environmental effects that are attributable to edge and patch size in tracts 15 ha or less. Betts (1999) chose a minimum habitat size of 20 ha for Scarlet Tanager, which is approximately the minimum habitat size that would be chosen using the Cornell Lab of Ornithology's "A Land Manager's Guide to Improving Habitat for Scarlet Tanagers and other Forest-interior Birds" (Rosenberg *et al.* 1999) in a region where the landscape is 60% forested, and to have a high probability of encountering Scarlet Tanagers. Scarlet Tanagers are a good indicator for the detection of Wood Thrush, the focus of the cumulative environmental effects assessment, and other mature forest birds. During the field surveys conducted in support of the Project environmental assessment, Wood Thrush was recorded within 50% of the study sites where Scarlet Tanager was reported. Considering a 20 ha minimum habitat size, there are relatively few remaining large patches of mature forest in the landscape, however the TCH projects generally result in the further fragmentation of small patches, and in very few cases are larger tracts substantively reduced in size. Forest interior birds such as Wood Thrush and Scarlet Tanager are using the smaller fragments, according to the bird survey results, however breeding success was not investigated or confirmed. Also, these apparently small fragments may be adjacent to younger forests, essentially increasing the apparent size of the habitat patch, if the adjacent forest is old enough to not be considered edge habitat.

Fragmentation of habitats is inevitable when the habitat matrix is dominated by agricultural land in much of the landscape, which was avoided to the extent possible due to its high value in the region. As noted in other sections, had agricultural land not been avoided, the result would likely be the clearing and conversion of more forestland to agriculture.

During the breeding season, some species may be reluctant to cross clearings, causing populations to be isolated in resultant habitat fragments. Studies by the Canadian Wildlife Service (CWS) in Quebec of bird use of forest patches in agricultural areas found that bird movement between patches decreased with increasing distance between patches (Duchesne *et al*. 1999). The CWS study determined that 97.7% of the movements between habitat patches were concentrated in gaps smaller than 200 m and some species traveled up to three times as far to avoid a gap. Physical isolation of a population combined with the deleterious environmental effects of edge may eliminate species in habitat fragments. To ensure that adjacent habitat patches will be used as a travel corridor by birds, the study suggested that the critical distance between two woodlands must not be greater than 200 m. The total width of the cleared RoWs for the TCH projects are near the 200 m threshold where the preferred 82.5 m between centrelines is used, depending on the terrain, and assuming there are no forested mediums planned or feasible. Wide medians are typically kept vegetated where possible for safety reasons (*i.e.*, as a barrier to oncoming headlights).

Within the areas surveyed in the Assessment Area, the most important area by far for Wood Thrush and Scarlet Tanager was bird survey site B2 south of Perth-Andover (Section 5.7.4.1 and Figure 5.7.1B), containing 50% and 40% (respectively) of the records of each species in the Project Assessment Area. Individuals were predominately recorded on the west part of the survey site, on the sloped areas. The tolerant hardwood forest up the slope and west of the mature mixedwood (the basis of the survey site delineation) is classified as immature in the forest inventory data, however is likely the preferred Wood Thrush habitat in this area. Mitigation for rare plant concentrations in this area included shifting of the alignment to the east, towards the existing TCH, minimizing the fragmentation of the mature habitat in this area. Further mitigation/compensation has included protecting the land from inevitable forest harvesting by arranging the purchase of a 48.8 ha section of this site, for conservation purposes.

Another concentration of Wood Thrush was recorded near bird survey site B6, where there was very little mature habitat. As was the case at Site B2, the Wood Thrush at this location were recorded west of the alignment at the time. However, due in part to the discovery of an S1/"May Be At Risk" plant species, among other rare plants just to the north, the alignment was shifted further east, increasing the distance between the Wood Thrush habitat and the Project. In addition, the habitat containing the rare plant concentrations and Wood Thrush are within a 23.6 ha parcel of land that has been purchased for conservation purposes, and protected from further forest harvesting. Most other records of Wood Thrush in the remaining survey locations (including those for Grand Falls to Aroostook and Pokiok to Longs Creek) were single individuals, or individuals recorded well outside of project boundaries. In fact, only a single Wood Thrush was recorded during surveys for each of the other two TCH projects.

6.9.4.3 Summary

Breeding populations of many forest birds are likely closely linked to the availability of suitable breeding habitat. Forest harvesting is likely the key activity that introduces change to the mosaic of different forest patches and ages, however other more permanent changes resulting in the conversion from forest to other land uses such as agriculture and roadbuilding. Within the Assessment Area, there has been a loss of 1,000 ha or 6.9% of mature or overmature forest, not accounting for the increase in mature forest from succession. Within this same area, only 74.5 ha (1.2%) of forest land has been converted to agricultural land. Residential, commercial, and industrial development account for a relatively small amount of mature habitat conversion. Within the Assessment Area, the three current and future TCH projects will collectively result in the loss of 503 ha or 1.9% of the available mature habitat, over a period of several years. In the short term, this harvesting of mature forest will not likely increase the loss of mature forest in the landscape at a much higher rate than is currently occurring due to forest harvesting. The remaining planned projects will affect a negligible amount of mature forest.

A comparison of the current level of fragmentation of mature/overmature forest with the resultant fragmentation following the three current and future TCH projects was completed using the available forest inventory databases. The region is already highly fragmented. Very little of the landbase is located more than 1 km from a road, which can be used to define an unfragmented landscape, with respect to human disturbance. The patch size distributions were comparable to the analyses by Betts (1999). Average patch sizes are small to begin with, and reduced only slightly by the TCH projects.

Overall, there will be an increase in the number of habitat patches by 6.9%, mostly from the division of small patches into smaller patches. There was relatively little change in the number of large patches of mature forest, with no net change in habitat patches greater than 40 ha in size. With respect to mature forest migratory birds this information is related to minimum patch sizes, which can vary by species. Scarlet Tanager has recently been selected as an indicator species for investigations of fragmentation and the management of forest-interior birds (Betts 1999; Rosenberg *et al.* 1999), and Wood Thrush is to varying degrees found in similar habitat, depending on the region. Based on a minimum patch size of 20 ha, suitable patches are remaining relatively stable, with most of the fragmentation occurring in smaller, apparently unsuitable patch sizes. However according to bird survey results, smaller fragments are being used by forest interior birds such as Wood Thrush and Scarlet Tanager. Breeding success was not investigated. Based on this analysis, the region is already highly fragmented, but the further fragmentation as a result of the projects is not likely to substantially affect the number of larger fragments best suited for forest-interior birds.

The TCH projects will increase the distance between forest patches, and could form a barrier to the movement of forest birds, however the average width of the cleared RoW is likely below the threshold, beyond which birds are less likely to cross. Mitigation to reduce the overall width of the gap includes the use of forested mediums, especially where these medians are quite wide.

Examination of the available location information for Wood Thrush collected for the Project demonstrates that the risk of loss and fragmentation of critical habitat for Wood Thrush has been minimized through Project mitigation. This included moving the alignment and protecting the avoided habitat by purchasing and protecting the habitat from future harvesting at the two largest concentrations of Wood Thrush. The protection of these habitats from other future land uses (*i.e.*, forest harvesting or conversion to agriculture) would at least partially compensate for the loss of potential Wood Thrush habitat by the Project.

6.9.5 Determination of Significance

The residual environmental effects of the Project include the loss of mature forest habitat, considered important habitat for selected migratory birds requiring mature forest as breeding habitat, and fragmentation of mature habitat. Analyses of fragmentation of mature forest (minimum patch size) and use of important habitat by Wood Thrush with respect to mitigation (habitat avoidance and minimizing fragmentation) and compensation (protection from other land uses) demonstrate that the Project will not contribute to cumulative environmental effects on Wood Thrush. Therefore, the cumulative environmental effects of the Project, in combination with other past, present, and future projects, is rated not significant.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.7 (Wildlife VEC), for the verification of the accuracy of the cumulative environmental effects analysis on migratory birds.

It is acknowledged that the Project will contribute to cumulative environmental effects on migratory birds due to habitat fragmentation and habitat loss in the Upper Saint John River Valley. Although the Project will not result in significant environmental effects, including cumulative environmental effects on migratory birds, it remains that these issues are important. Recognizing this, NBDOT will participate in an initiative to study the environmental effects of linear development on habitat fragmentation and habitat loss. It is understood that Environment Canada would lead such a study, in cooperation with other federal and provincial agencies, and that NBDOT will work cooperatively with them to consider the results in the planning of future highway projects in New Brunswick. NBDOT also recognizes that such a study may identify potential improvements to its current mitigation strategy that could be applied to the Project and other recent or planned TCH Projects in the Upper Saint John River Valley. Following the principles of adaptive management, NBDOT is willing to consider suggested improvements to mitigation that may come out of the study, provided it is technically and economically feasible, and reasonable to do so.

6.10 Cumulative Environmental Effects Analysis of Agricultural Land

6.10.1 Summary of Residual Environmental Effects of Project

The primary environmental effect of the Project on agricultural land is the direct loss of 223 ha of agricultural land within the RoW. This loss occurs during the construction phase (site preparation) and remains in perpetuity. Landowner compensation is accomplished primarily through land acquisition. However, despite economic compensation, the removal of agricultural land from production remains. In addition to land lost within the RoW, the development of the Project RoW may create remnant agricultural parcels (*i.e.*, severed properties without road access). However, NBDOT has agreed to compensate through provision of financial compensation (land acquisition) or provision of alternate access. In those cases where financial compensation is awarded, the severed parcel of agricultural land may still be taken out of production, or it may be purchased by an adjacent landowner and kept in production. Therefore, the loss of agricultural land is considered to be a residual environmental effect of the Project. Due to compensation, the residual environmental effects of land loss and severances are considered not significant.

There is also the potential of cold air pooling as a residual environmental effect of the Project. Cold air pooling is a weather condition where a cold air mass, being heavier than the surrounding air, flows along the ground in a down gradient direction and experiences a resistance to flow and forms a shallow pool. The topography, land use and projected cut and fill locations (Figures 3.5A-D; Appendix C) of the planned RoW were examined to assess the potential for cold air pooling. The locations of the planned cuts are in areas where there are large differences in the terrain elevations such that the roadbed would present a relatively small barrier to drainage flows of cold air. Thus in these instances, the existing drainage flows would not be substantially affected. There are three areas along the RoW where the terrain and fill locations coincide to cause a potential for cold air pooling. The land use at these locations is expected to be potato farming with rotation crops such as grain, oil seed and hay. Since these are considered frost resistant, no substantial crop damage is expected to occur from cold air pooling, and cold air pooling is not identified as an issue for consideration in the cumulative environmental effects assessment for agriculture.

Damage to crops may occur where salt spray from winter safety applications is in close proximity to salt sensitive vegetation. In instances where it is demonstrated that salt damage has caused crops to fail, fair and reasonable compensation for damaged crops will be negotiated. Therefore, damage to crops from salt spray is not identified as an issue for consideration in the cumulative environmental effects assessment.

6.10.2 Identification of Issues and Selection of Indicators

The Project RoW, in combination with the RoW's of concurrent TCH projects, extends across Carleton and Victoria counties. This region plays an important role in provincial agricultural production (particularly potatoes and beef), as identified through concerns raised during provincial and public consultation. Therefore, the loss of agricultural land is identified as an issue for consideration in the assessment of cumulative environmental effects.

Agricultural land area has been selected as the indicator to focus the assessment of the potential cumulative environmental effects of the Project on loss of agricultural land in the region.

Table 6.10.1 identifies the potential interactions between the indicator and the other projects and activities identified in Section 6.3.

Table 6.10.1 Cumulative Environmental Effects Potential Interactions Matrix for Agriculture VEC

Past, Present of Future Project or Activity	AGRICULTURAL LAND VEC INDICATOR
	Agricultural Land Area
Existing Highways and Roads	
Existing TCH	✓
Local Highways and Roads	✓
Saint-Léonard to Grand Falls TCH	✓
Perth-Andover By-Pass TCH	✓
Woodstock to Pokiok TCH	✓
Current and Future Highway Projects	
Grand Falls to Aroostook TCH	✓
Florenceville Bridge and Route 110 Interchange	✓
Lockhart Mill Interchange TCH	✓
Meduxnekeag River Bridge TCH	
Route 95 (Woodstock to Houlton)	✓
Pokiok to Longs Creek TCH	✓
Adjacent Land Uses	
Forest Resource Harvesting	✓
Agriculture	✓
Hydroelectric Power Generation	
Pits and Quarries	✓
Residential	✓
Commercial	✓
Industrial	
Hunting	
Fishing	
Planned Development Along Proposed TCH	
Tobique Truck Stop (Perth-Andover)	✓
Grand Falls Big Stop	✓
Other Planned Development	
New Brunswick Potato Museum/Learning Center on Route 110	✓
Wakefield Salmon Hatchery	✓
Woodstock Wastewater Treatment Plant	

6.10.3 Assessment Boundaries

The spatial information used for the detailed assessment of Project-related cumulative environmental effects on agricultural land was derived from the NBDNR forest cover map tiles that were analyzed for the environmental assessment of vegetation for the Project, the Grand Falls to Aroostook TCH, and the Pokiok to Longs Creek TCH. Figure 6.10.1 depicts the combined area of these map tiles that comprise the Assessment Area for the potential cumulative environmental effects of the Project on agricultural land.

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other past and present projects and activities on agricultural land is 1993, the time from which initial collection of agricultural land-use data was obtained by NBDNR, until the present. It is argued that with respect to agricultural land area, the conditions represented in the NBDNR maps are to some considerable extent, representative of past and present agricultural land development, and reflect a temporal boundary that although indeterminate, may extend for many years prior to the year of the surveys, listed above. Therefore, the cumulative environmental effects assessment does relate these data to antecedent land use and projects. Although current spatial data were not available for comparison with the NBDNR maps, description of regional trends was possible based on extensive public and stakeholder consultation, and the observations and professional opinions of the study team.

The temporal boundaries for the assessment of the potential cumulative environmental effects of the Project with other future projects and activities on agricultural land includes the next 5 years, beyond which the forecasting of the likeliness of other projects or activities to be carried out is not reliable.

6.10.4 Agricultural Land Area

6.10.4.1 Historic Trends and Existing Conditions

Section 6.6.4.1 (Appalachian Hardwood Forest VEC) provides an overview of human settlement patterns and activities during the 19th and 20th century. These activities greatly influenced the conditions that were present at the time the maps were generated. Presently, agriculture dominates the landscape through most of the Assessment Area. Over the last fifty years, agriculture in Carleton and Victoria counties has grown to become the most important agriculture production area in the Province (George Maicher, pers. comm. 2003). Agricultural production in Carleton and Victoria counties has been predominantly located on the west side of the Saint John River, and is potato or potato-related through crop rotation. Between 1991 and 2001 there was a 15% increase in potato production area in these counties (NB Potato Statistics Update, Benoît Ouellette, DAFA, documentation) resulting in part from the conversion of forestland to agriculture.

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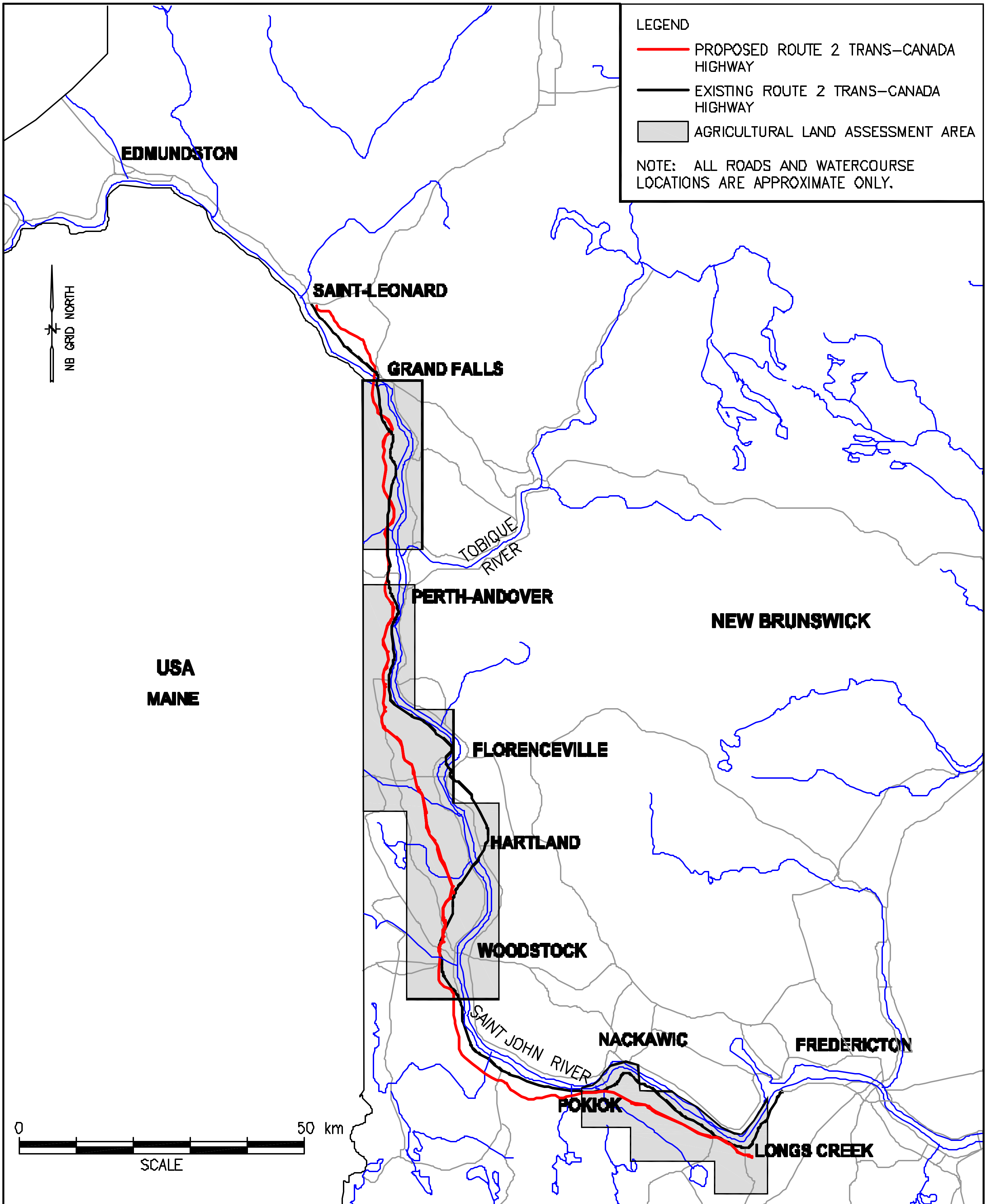

SPATIAL BOUNDARIES FOR THE CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT OF AGRICULTURAL LAND	Date: 2004 04 20	Scale: AS SHOWN	Jacques Whitford Consulting Engineers Environmental Scientists
	Job No.: 14677	Fig. No.: 6.10.1	THIS DRAWING IS THE PROPERTY OF JACQUES WHITFORD AND IT SHALL NOT BE GIVEN OUT, COPIED OR DUPLICATED FOR THE USE OF ANOTHER BUT SHALL BE USED ONLY BY THE RECIPIENT FOR THE PURPOSE TO WHICH IT REFERS.

As determined from the Canada Land Inventory (CLI), 97% of soils in the Assessment Area between Perth-Andover and Woodstock are class 4 or better. The total area of agricultural land in the Assessment Area between Perth-Andover and Woodstock is 29,191 ha, or 37% of the environmental effects Assessment Area (Section 5.8).

6.10.4.2 Project Interactions with Other Future Projects and Activities

6.10.4.2.1 Existing Highways and Roads

This category includes the existing TCH, as developed in the 1960's, local highways and roads, and collector, secondary roads, and recently completed TCH projects. The existing TCH and other existing roads have permanently removed land for agricultural use. Specific spatial data is not available for this category. However, the agricultural land area as determined from the NBDNR maps reflects the loss of agricultural land area from these projects. No future interaction is anticipated.

6.10.4.2.2 Current and Future Highway Projects

The total amount of agricultural land area that will be removed from production within the RoW's of the Project in combination with the Grand Falls to Aroostook TCH Project and the Pokiok to Longs Creek TCH Project is 263 ha. This amounts to a 0.73% loss of agricultural land area within the Assessment Area, as seen in Table 6.10.2. The Route 95 Project is outside of the Assessment Area, and the potential loss of agricultural land is not known as the RoW has not been selected at this time.

Table 6.10.2 TCH Project-related Agricultural Land Loss within the Assessment Area

	Perth-Andover to Woodstock TCH Project	Grand Falls to Aroostook TCH Project	Pokiok to Longs Creek TCH Project	Combined Projects
Assessment Area*	78,894 ha	23,524 ha	26,285 ha	128,703 ha
Agricultural Land within Project Specific Assessment Area	29,191 ha	6,587 ha	63 ha	35,841 ha
% Agricultural Land in Project Specific Assessment Area	37 %	28 %	0.24 %	28 %
Project Footprint**	1,053 ha	331 ha	468 ha	1,852 ha
Agricultural Land in RoW**	223 ha	36 ha	4 ha	263 ha
% Agricultural Land in RoW**	21 %	11 %	0.9 %	14 %
% of Agricultural Land within Project RoW** of the Total Agricultural Land within the Total Assessment Area	0.62 %	0.1 %	0.01 %	**0.73 %**

* as seen in Figure 6.10.1. is based on map tiles used in environmental effects analysis
** RoW includes area for access road development

According to the Canada Land Inventory (CLI), 97% of soils in the Assessment Area between Perth-Andover and Woodstock, and 90% of the soils in the Assessment Area between Grand Falls and

Aroostook are class 4 or better. As such, both stretches of highway have a very high potential for productive agricultural land. Therefore, it is likely that non-agricultural land (*e.g.,* forest) will continue to be converted to agricultural land within this portion of the Assessment Area. It is unlikely that substantial agricultural development will occur within the Pokiok to Longs Creek portion of the Assessment Area.

6.10.4.2.3 Adjacent Land Uses

Other land uses within the Assessment Area (*e.g*., commercial, residential, pits and quarries) may remove some agricultural land area from production, or may use land that could have been converted to agricultural land. It is not possible to forecast what this demand for other land uses will be in the next 5 years. However, there are no indications that residential or commercial land use will increase substantially during that time. There may be some Project-related development of pits and quarries for aggregate required for construction of the proposed highway.

6.10.4.2.4 Planned Development Along Proposed TCH

The Tobique Truck Stop development will result in the loss of 3.6 ha of agricultural land formerly used for potato production. The Grand Falls Irving Big Stop will result in the loss of 5.4 ha of agricultural land also used for potato production. The combined loss of agricultural land area from these projects is 9 ha.

6.10.4.2.5 Other Planned Development

The New Brunswick Potato Museum and Learning Center will result in the loss of 0.8 ha of cleared field that could have been used for agricultural production. The Wakefield Salmon Hatchery will result in the loss of 0.8 ha of agricultural land. The combined loss of agricultural land area from these projects is 1.6 ha.

6.10.4.3 Summary

The Project, in combination with other TCH Projects, will result in a total loss of 263 ha (0.73%) of current agricultural land area within the Assessment Area. In addition, 1,589 ha of non-agricultural land will not be available for agriculture as it will be within the RoW. Some additional agricultural land area, albeit small, may be taken out of production due to inaccessible severances.

Planned development along the proposed TCH will result in an additional 9 ha of lost agricultural land area and other planned development will result in an additional 1.6 ha of lost agricultural land area. This provides a total estimated loss of agricultural land area within the Assessment Area of 273.6 ha, or 0.76% of the total developed agricultural land area within the Assessment Area.

6.10.5 Determination of Significance

The conversion of land to agricultural land area within the Grand Falls to Aroostook and Perth-Andover to Woodstock portions of the Assessment Area was high during the period of 1991 to 2001. Current trends in agricultural practices (*i.e.*, converting forest land to agricultural land) suggest that this will continue or increase in the near future. The selection of the RoW for the Project, and for the Grand Falls to Aroostook Project, minimized the loss of developed agricultural land area. It is not anticipated that the loss of 273.6 ha of agricultural land area within the Assessment Area will compromise the ability of the agriculture industry to meet current market demands. Also, landowners will be compensated for any loss of land through land acquisition, or for severances through provision of alternate access roads. It is therefore concluded that the loss of agricultural land by the development of the Project, in combination with other past, present, and future projects and activities that will be carried out, will not result in a significant cumulative environmental effect. However, it should be noted that this may result in the conversion of an equal amount (273.6 ha) of non-agricultural land to agricultural land to maintain similar production levels in the region, or other measures such as increased use of fertilizer or other productivity-related measures. This future development may take place inside or outside of the Assessment Area.

There is no follow-up monitoring suggested, in addition to that already proposed in Section 5.13.3.8 (Land Use VEC), for the verification of the accuracy of the cumulative environmental effects analysis on agricultural land.

7.0 CONCLUSIONS AND RECOMMENDATIONS

In accordance with the requirements of Sections 16 (1) and (2) of *CEAA* and the Guidelines (Appendix A), this environmental assessment includes:

- A discussion of the alternatives to the Project and the alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means;
- A description of the proposed Project including the purpose and need, the proposed facilities and activities, and the potential malfunctions or accidental events that may occur in connection with the Project;
- A summary of consultation mechanisms and issues raised during consultation (*i.e.*, issues scoping) as well as a description of the methodological approach to the environmental assessment;
- An assessment of the environmental effects of the proposed Project for each of the VECs and the significance of the effects;
- An assessment of the effects of the environment on the Project;
- Recommendations for measures to mitigate any significant adverse environmental effects; and
- Recommendations for a follow-up program.

Based on the results of the environmental assessment, it is concluded that the Project is not likely to cause significant adverse environmental effects.

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Approved by: Transport Canada

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Approved by: Fisheries and Oceans Canada

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Approved by: Infrastructure Canada

8.0 REFERENCES

8.1 Literature Cited

ACCDC. 2003. Provincial Lists and Ranks. Internet Publication: http://www.accdc.com/products/lists/. Last updated: 24/02/2003.

ACCDC (Atlantic Canada Conservation Data Centre). 2002. Species Profile: Canada Clearweed (*Pilea pumila*). Internet Publication: http://www.accdc.com/products/profiles/clearweed.html. Downloaded December 2002.

ACER. 2003. Environmental Background Study for the Proposed Upgrading of the Trans-Canada Highway, River de Chute to Florenceville, NB. Prepared for New Brunswick Department of Transportation.

ACER (ACER Environmental Services Ltd.). 2002. Environmental Screening, Proposed Route 2 Upgrading and Lockhart Mill Road Interchange. Report to NBDOT. September 9, 2002.

Acres. 1977. Regional Flood Frequency Analysis. Canada-New Brunswick Flood Damage Reduction Program.

ADI Limited. 2003. Identification of a Realistic Provincial Standard Noise Threshold Level report prepared by ADI Limited for the New Brunswick Department of Transportation, Report: (55) 0600-454.1, April, 2003.

Agfor Inc. 2003. Assessment of Market Stumpage Values on Private Land. Prepared for the New Brunswick Department of Natural Resources and Energy.

Almkvist, E. (1999) 'Detailed climatic measurements above and beside the road', paper issued from Physical Geography, Department of Earth Sciences, Goteborg, Sweden, 10 pp.

Anderson, P.G., B.R. Taylor and G.C. Balch. 1996. Quantifying the effects of sediment release on fish and their habitats. Canadian Manuscript Report on Fisheries and Aquatic Sciences, No. 2346.

Banner, A., and S. Schaller. 2001. Gulf of Maine Watershed Habitat Analysis. USFWS Gulf of Maine Coastal Program. Internet Publication: http://r5gomp.fws.gov/gom/habitatstudy/Gulf_of_Maine_Watershed_ Habitat_Analysis.htm. March 2001.

Barnes, J.L., M. Stephenson, 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 Aquatic Toxicity Workshop: October 1-4, 2000, St. John's, Newfoundland. Edited by K.C. Penney, K.A. Coady, M.H. Murdoch, W.R. Parker and A.J. Niimi. Canadian Technical Report of Fisheries and Aquatic Sciences 2331, Fisheries and Oceans Canada, p. 20-33.

Betts, M. 1999. Landscape Ecology Mapping Project: A Landscape Approach to Conserving the Appalachian Hardwood Forest. Nature Trust of New Brunswick, Fredericton, N.B.

Betts, M. 2000. A Conservation Network for the Appalachian Hardwood Forest of the Saint John River Valley. Nature Trust of New Brunswick. Downloaded January 12, 2004 from http://www.elements.nb.ca/theme/millenium/matt/betts.htm.

Blomqvist, G. 2001. De-icing salt ad the roadside environment: Air-borne exposure, damage to Norway spruce and system monitoring. Ph.D. Thesis, Department of Civil and Environmental Engineering, Royal Institute of Technology, Stockholm, Sweden. Internet Publication: http://media.lib.kth.se:8080/dissengrefhit.asp?dissnr=3140. Downloaded 09/09/2003.

Bond, W.K., K.W. Cox, T. Heberlein, E.W., Manning, D.R. Witty, and D.A. Young. 1992. Wetland Evaluation Guide. Sustaining Wetlands Issue Paper, No. 1992-1. North American Wetlands Conservation Council (Canada), Ottawa, Ontario.

Bruun-Schmidt, J. 1994. [Traffic killed animals in relation to landscape, topography and type of road]. Upubliceret specialerapport, Odense Universitet, Biologisk Institut.

Canadian Council of Forest Ministers. 1997. Criteria and Indicators of Sustainable Forest Management in Canada. Technical Report. Cat. Fo75-3/6-1997E. ISBN 0-662-25623-9.

CCME. 2000. Canada Wide Standards for Particulate Matter (PM) and Ozone, endorsed by the Council of Ministers of the Environment (CCME), June 5-6, 2000, Quebec City.

CCME. 2002, 'Multi-Pollutant Emission Reduction Analysis Foundation (MERAF) for the Hot-Mix Asphalt Sector', prepared for Environment Canada and The Canadian Council of Ministers of Environment (CCME), prepared by Canadian Ortech Environmental Inc., and John Emery Geotechnical Engineering Limited, September 30, 2002.

CCME (Canadian Council of Ministers of the Environment). 1998. Canada Wide Accord on Environmental Harmonization of the CCME and Canada Wide Environmental Standards Sub-Agreement (optional values).

CCME. 1999. Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Updated 2001, 2002, 2003. Winnipeg. Publication No. 1299, ISBN 1-896997-34-1.

CEAA (Canadian Environmental Assessment Agency). 1994. A Reference Guide for the *Canadian Environmental Assessment Act*, Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects. Prepared by the Federal Environmental Assessment Review Office.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2004. Canadian Species at Risk, November 2003. Committee on the Status of Endangered Wildlife in Canada. 44 pp.

Cowan, J.P. 1994. Handbook of Environmental Acoustics. Van Nostrand Reinhold, New York. 283pp.

CRDC (Carleton Regional Development Commission Inc.). 2001. Carleton Area, New Brunswick, Canada Regional Profile.

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.

Cumberland, R.E. and J.A. Dempsey. 1994. Recent confirmation of a cougar, *Felis concolor*, in New Brunswick. Canadian Field Naturalist 1008:224-226.

CWS (Canadian Wildlife Service). 1987. Wetlands Atlas for New Brunswick. Environment Canada, Canadian Wildlife Service, Sackville, N.B.

Department of Forestry and Rural Development. 1967. Land Capability Classification for Forestry, The Canada Land Inventory Report #4.

Department of Forestry and Rural Development. 1969. Soil Capability Classification for Agriculture, The Canada Land Inventory Report #2.

DFO. 2002. Atlantic Salmon Maritime Provinces Overview for 2001. DFO Stock Status Report D3-14 (2002).

DFO (Fisheries and Oceans Canada). 1986. Policy for the Management of Fish Habitat. Ottawa, Ontario.

DFO. 1995a. Factsheet #2. Blasting – Fish and Fish Habitat Protection. Department of Fisheries and Oceans. St. John's, Newfoundland.

DFO. 1995b. Freshwater Intake End-of-Pipe Fish Screen Guideline. Ottawa, Ontario.

DFO. 1999a. Guidelines for the Protection of Fish and Fish Habitat – Placement and Design of Large Culverts. Fisheries and Oceans Canada, Maritimes Region.

DFO. 1999b. Status of Wild Striped Bass and Interaction Between wild and Cultured Striped Bass in the Maritime Provinces. DFO Science Stock Status Report D3-22.

DFO. 2001. Atlantic Salmon Maritime Provinces Overview for 2000. DFO Stock Status Report D3-14 (2001) (revised).

Dignam and Associates Consulting. 2003. Final Report: Heritage Evaluation for the Proposed Upgrade of Route 2 Between Route 560 at River de Chute and Route 10 at Florenceville. Report on file at Archaeological Services Unit, Province of New Brunswick.

Dillon (Dillon Consulting Limited). 2003. Environmental Studies Route 2 – Florenceville to Woodstock. Prepared for New Brunswick Department of Transportation.

Downes, C.M., B.T. Collins and M. Damus. 2003. Canadian Bird Trends Web site Version 2.1. Migratory Birds Conservation Division, Canadian Wildlife Service, Hull, Quebec. Internet Database: http://www.cws-scf.ec.gc.ca/birds/trends/default_e.cfmDuchesne, S., Bélanger L., Grenier M. and F. Hone. 1999. Guide to conserving forest corridors in an agricultural environment. Environment Canada, Canadian Wildlife Service (Québec Region) and Fondation Les oiseleurs du Québec Inc. http://www.qc.ec.gc.ca/faune/corridors_verts/corridors.html.Dupuis, T.V., Bertram, P., Meyer, J., Smith, M., Kobriger, N., and Kaster, J. 1985. Effects of highway runoff on receiving waters, Volume III: Resource document for environmental assessments: Federal Highway Administration Final Report FHWA/RD-84/064, 153 p."

Environment Canada. 1984. 'The Climate for Agriculture in Atlantic Canada', Atmospheric Service, Bedford, Nova Scotia.

Environment Canada. 1970. The Canada Land Inventory Land Capability Classification for Wildlife. The Canadian Land Inventory Report No. 7. Environment Canada, Lands Directorate, Ottawa, Ontario.

Environment Canada. 1991. The Federal Policy on Wetland Conservation. Environment Canada. Ottawa, Ontario.

Environment Canada. 1993. Canadian Climate Normals 1961-90, vol. 6, Atlantic Provinces, A Publication of the Canadian Climate Program, Minister of Supply and Services Canada, 105 pp.

Environment Canada. 1996. The Federal Policy on Wetland Conservation. Implementation Guide for Federal Land Managers. Environment Canada, Canadian Wildlife Service, Wildlife Conservation Branch. Ottawa, Ontario.

Environment Canada. 1998. National Air Pollution Surveillance (NAPS) Network Annual Summary for 1995. Environmental Protection Series Report EPS 7/AP/28.

Environment Canada. 1999a. National Air Pollution Surveillance (NAPS) Network Annual Summary for 1997. Environmental Protection Series Report EPS 7/AP/30.

Environment Canada. 1999b. National Air Pollution Surveillance (NAPS) Network Annual Summary for 1996. Environmental Protection Series Report EPS 7/AP/29.

Environment Canada. 2000. National Air Pollution Surveillance (NAPS) Network Annual Summary for 1998. Environmental Protection Series Report EPS 7/AP/31.

Environment Canada. 2001a. National Air Pollution Surveillance (NAPS) Network Annual Summary for 2000. Environmental Protection Series Report EPS 7/AP/33.

Environment Canada. 2001b. National Air Pollution Surveillance (NAPS) Network Annual Summary for 1999. Environmental Protection Series Report EPS 7/AP/32.

Environment Canada. 2001c. Priority Substances List Assessment Report: Road Salts. Environment Canada and Health Canada, Ottawa, ON.

Environment Canada. 2002a. Canadian Climate Normals 1971–2000. Internet Publication: http://www.climate.weatheroffice.ec.gc.ca.

Environment Canada. 2002b. National Air Pollution Surveillance (NAPS) Network Annual Summary for 2001. Environmental Protection Series Report EPS 7/AP/34.

Environment Canada. 2003a. Guidelines for Migratory Bird Survey, Trans-Canada Highway, Route 2 Upgrade, Perth-Andover to Woodstock, NB. Letter to Debbie de Grasse, Transport Canada, January 20, 2003. EAS#1998-029E2.

Environment Canada. 2003b. Lightning Activity in Major Cities in Canada – Lightning in Atlantic Canada. Internet Publication: http://www.msc.ec.gc.ca/education/lightning/ .

Environment Canada. Unpublished. Rainfall Intensity-Duration and Frequency Values for Fredericton and St. Leonard, New Brunswick. Atlantic Climate Centre, Fredericton , NB. Data provided January 15, 2004.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young, Jr., K.J. Sernka and R.E. Good. 2001. Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. National Wind Coordinating Committee, Washington, DC.

Erritzoe, J., T.D. Mazgajski, and L. Rejt. 2003. Bird casualties on European roads – a review. Acta Ornithologica 38:77-93.

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS. 270 pp.

Fuellhaas, U., C. Klemp, A. Kordes, H. Ottersber, M. Pirmann, A. Thiessen, C. Tshoetschel, and H. Zucchi. 1989. Untersuchungen zum Strassentod von Vögeln, Säugetieren, Amphibien und Reptilien. Beiträge Naturkunde Niedersachens 42:129-147.

GCSI (Global Change Strategies International Inc.) and MSC (Meteorological Service of Canada). 2000. Water Sector: Vulnerability and Adaptation to Climate Change. Report by Global Change Strategies International Inc and The Meteorological
Service of Canada. Technical background paper presented at Canadian Society of Civil Engineering conference held in Moncton, N.B. on May 11 to 12, 2000. Internet Publication: http://www.gcsi.ca/downloads/ccafwater.pdf

Golet, F.C. 1973. Classification and Evaluation of Freshwater Wetlands as Wildlife Habitat in the Glaciated Northeast. Ph.D. thesis, University of Massachusetts.

Gore, J. A. 1983. The distribution of desmognanthine larvae (Amphibia: Plethodontidae) in coal surface impacted streams of the Cumberland Plateau, USA. Journal of Freshwater Ecology 2:13-23.

Greater Vancouver Regional District . 2001. 2000 Lower Fraser Valley Ambient Air Quality Report, Acceptable Objectives.

Health Canada. 1996. Guidelines for Canadian Drinking Water Quality. 6th Edition.

Health Canada. 2003. Summary of Guidelines for Canadian Drinking Water Quality. Internet Publication: http://www.hc-sc.gc.ca/hecs-sesc/water/pdf/summary.pdf .Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kinsgley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

Heritage Technologies Inc. 2003. Final Report Archaeological Surveying and Subsurface Testing for the Proposed Woodstock to Florenceville Highway Project. Report on file at Archaeological Services Unit, Province of New Brunswick.

Hinds, H.R. 2000. The Flora of New Brunswick. Second Edition. University of New Brunswick, Fredericton, New Brunswick.

Hooper, W.C., L. McCabe and T. Robertson. 1995. A Standardized Fisheries Stream Survey for Atlantic Canada. Department of Natural Resources and Energy, Fish and Wildlife Branch, Fredericton, NB.

Hooper, W.C. 1997. Strategy to Assess and Monitor Lake and Stream Ecosystem Health in New Brunswick. Presented at the Canadian Council on Ecological Areas Annual Meeting. September 15-17, 1997.

ICF Consulting. 1999. Emission factors, global warming potentials, unit conversions, emissions, and related facts.

Jutterblock, J.E. 1990. Variation in larval growth and metamorphosis in the salamander Desmognanthus fuscus. Herpetologica 46:291-303.

JWEL (Jacques Whitford Environment Limited). 1997. Eel River Botanical Survey, Route 2 By-pass, Alignment A and J, Meductic, New Brunswick. Report to the New Brunswick Department of Transportation. Project #9169. November 25, 1997.

JWEL. 1998. Northumberland Strait Crossing Project Terrestrial Environmental Effects Monitoring Program: 1997 Results. Prepared for Northumberland Strait Crossing Inc.

JWEL. 2003a. Environmental Background Study Route 2 (TCH) Bypass Perth-Andover to Route 560 (River de Chute). Final Report to NBDOT – Planning and Land Management.

JWEL. 2003b. Environmental Background Study - Route 2 Bypass, Pokiok/Nackawic Area to Longs Creek. Final Report to NBDOT – Planning and Land Management.

JWEL. 2003c. Addendum to Environmental Background Study - Route 2 Bypass, Pokiok/Nackawic Area to Longs Creek. Letter Report to NBDOT – Planning and Land Management.

JWEL. 2003d. Environmental Assessment Tobique Truck Stop Wolastokwik Negoot-gook (Maliseet Nation at Tobique) Perth-Andover, New Brunswick, Final Report.

JWEL. 2003e. Environmental Screening Report - Route 2 Bypass, Pokiok/Nackawic Area to Longs Creek. Final Report to NBDOT – Planning and Land Management.

JWEL. 2003f. Heritage Resource Impact Assessment Route 2 Four-Lane Highway Perth-Andover to River de Chute, NB, on file at Archaeological Services Unit, Province of New Brunswick.

JWEL. 2004. New Route 2 Trans Canada Highway Project Grand Falls to Aroostook, New Brunswick.

Kamstra, J. 1991. Rediscovery of the northern dusky salamander, Desmognanthus f. fuscus in Ontario. Canadian Field Naturalist 105: 561-563.

Kobriger, N.P., Meinholz, T.L., Gupta, M.K., and Agnew, R.W. 1981. Constituents of highway runoff Volume III, Predictive procedure for determining pollution characteristics in highway runoff: Federal Highway Administration Final Report FHWA/RD-81/044, 205 p

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.

Libby, C. 2000. Eastern Cougar. Internet Publication: http://www.elements.nb.ca/themw/endangeredspecies/cougar/eastern.htm .

MacDougall, A. 1997. Appalachian Hardwood Forest Conservation Stewardship Project: Phase I Summary Report. The Nature Trust of New Brunswick, Fredericton, N.B.

MacDougall, A. and J. Loo. 1998. Natural History of the Saint John River Valley Hardwood Forest of Western New Brunswick and Northeastern Maine. NR Can. Information Report M-X-204E. Canadian Forest Service. Atlantic Forestry Centre.

Maritimes & Northeast Pipeline Management Ltd. 2002. Mainline Expansion Application GH-3-2002 Proceeding; File 3400-M124-14, Environmental Screening Report, National Energy Board.

May, D. N. 1978. Handbook of Noise Assessment. VanNostrand Reinhold Company, Toronto, ON.

Mine Environment Neutral Drainage (MEND) Program. 1991. Acid Rock Prediction Manual.

Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. McGreer and J.S. Mathers. 1986. Development and Evaluation of a Model to Predict Effects of Buried Underwater Blasting Charges on Fish Populations in Shallow Water Areas. Canadian Technical Report of Fisheries and Aquatic Sciences, No. 1418. Department of Fisheries and Oceans, Habitat Management Division, Vancouver, B.C.

NatureServe. 2002. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.6. Arlington, Virginia, USA: NatureServe. http://www.natureserve.org/explorer .

NB Power. 1991. Environmental Protection Plan. July 1991.

NBDAFA (New Brunswick Department of Agriculture, Fisheries and Aquaculture). 2003. Agriculture Environment Management Initiative.

NBDELG (New Brunswick Department of Environment and Local Government). 2003a. New Brunswick air quality monitoring results for the year 2001. Technical Report T-2002-02. Sciences and Reporting Branch, Fredericton, N.B.

NBDELG. 2002a. Guidelines for the Siting and Operation of a Construction and Demolition Debris Disposal Site.

NBDELG. 2002b. Watercourse Alterations Technical Guidelines. Regional Services Branch.

NBDELG. 2003b. New Brunswick's Wellfield Protection Program. Internet Publication: http://www.gnb.ca/0009/0371/0001/0001-e.html. Downloaded 21/08/2003

NBDELG. 2003c. Guideline for the Management of Contaminated Sites. Version 2. November 2003. Available online at: http://www.atlanticrbca.com/eng/nb_guideline_v2.html

NBDNR (New Brunswick Department of Natural Resources). 2003a. General Status of Wildlife in New Brunswick. http://www.gnb.ca/0078/fw/wstatus/index-e.asp

NBDNR. 1979. Geological Map, New Brunswick. Compiled by R.R. Potter, J.B. Hamilton, and J.L. Davies, Map Number NR-1, Second Edition.

NBDNR. 2003b. New Brunswick Big Game Harvest Reports 2002. Fish and Wildlife Branch. http://www.gnb.ca/0078/fw/biggame-e.asp . 35 pp.

NBDNR. unpublished. Assessing the impact of the highway twinning project on Butternut (Comments from NBDNR) and Information on Butternut (*Juglans cinerea*) in New Brunswick (NBDNR unpublished data. Dec. 10, 2003.

NBDNRE (New Brunswick Department of Natural Resources and Energy). 1989. Rapport D'Inventaire (1986) Forestier du Nouveau-Brunswick. Report No. NRE/RNE-89-01-003.

NBDNRE. 1995. Natural Resources and Energy 1994-95 Annual Report.

NBDNRE. 2002a. The General Status of Wildlife in New Brunswick - Draft Report (Vascular Plants).

NBDNRE. 2002b. Natural Resources and Energy 2001—2002 Annual Report. http://www.gnb.ca/0078/2001-02annualreport.pdf

NBDNRE and NBDELG. 2002. New Brunswick Wetlands Conservation Policy. http://www.gnb.ca/0078/reports/wetlands/wetlands.pdf

NBDOE (New Brunswick Department of Environment). 2000. New Brunswick air quality monitoring results for the year 1999. Technical Report T-2000-08.

NBDOE. 1980. Fredericton Planning Region Water Resources Review. Water Resources Branch, Report I-8001.

NBDOE. 1999a. New Brunswick air quality monitoring results for the year 1998. Technical Report T-9904. Environmental Evaluation Section, Fredericton, N.B.

NBDOE. 1999b. New Brunswick air quality monitoring results for the year 1996 and 1997. Technical Report T-9901. Environmental Evaluation Section, Fredericton, N.B.NBDOT. 1989. A Highway Improvement Plan for the Trans-Canada Highway Through New Brunswick *in* Adequate Highways – A Key to Regional Economic Development.

NBDOT. 1992a. Bridge Maintenance Manual.

NBDOT. 1992b. Highway Maintenance Management System Field Manual.

NBDOT. 1993. The White Paper – Highways for the Next Century *in* Adequate Highways – A Key to Regional Economic Development.

NBDOT. 1994. Province of New Brunswick National Highways Improvement Plan.

NBDOT. 1998a. Environmental Protection Plan, Third Edition. http://www.gnb.ca/0113/envpp/dotEnvPp.PDF

NBDOT. 1998b. Summary of Environmental Review Proposed Upgrading Route 2 Bull's Creek to Meductic.

NBDOT. 1998c. Summary of Environmental Review Proposed Upgrading Route 2 Meductic to Pokiok.

NBDOT. 1999. Summary of Environmental Review for the CEAA, Transport Canada, Proposed Bypass Alignment, Route 2, Sainte-Leonard to/a Grand Falls/Grand Sault.

NBDOT. 1999a. Summary of Environmental Review for the CEAA, Transport Canada, Proposed Bypass Alignment, Route 2, Saint-Léonard to/a Grand Falls/Grand Sault. March 1999.

NBDOT. 1999b. Amendment to Summary of Environmental Review for the CEAA, Transport Canada, Proposed Bypass Alignment, Route 2, Saint-Léonard to/a Grand Falls/Grand Sault. March 1999.

NBDOT 2001. Amendment to Summary of Environmental Review for the CEAA, Transport Canada, Proposed Bypass Alignment, Route 2, Saint-Léonard to/a Grand Falls/Grand Sault. April 2001.

NBDOT. 2002. CSIF Prospective Analysis Route 2- Grand Falls to Longs Creek. ADI Limited Report 55 0600-457.1.

NBDOT. 2003. Standard Specifications. http://ftp.dot.gnb.ca/specs/default.html

NBDOT 2004. Moose-Vehicle Collision Information. Internet address: http://www.gnb.ca/0113/moose/alert-e.asp.

New Brunswick Culture and Sport Secretariat, Heritage Branch. 2004. Guide to Heritage Resource Impact Assessment in New Brunswick. New Brunsswwick Manuscripts in Archaeology 35. Edited by Archaeological Services.

New Brunswick Culture and Sport Secretariat, Heritage Branch. 2001. New Brunswick's Designated Provincial Historic Sites. http://www.gov.nb.ca/scripts/culture/heritage/desighist-e.idc . Last updated 05/2001. Downloaded 3/06/2001.

New Brunswick Department of Tourism and Parks. 2001. River Valley Scenic Drive Consumer Profile.

Noss, R. 2003. The Ecological Effects of Road Construction. Downloaded December 18, 2003 from http://www.wildlandscpr.org/resourcelibrary/reports/ecoleffectsroads.html

Peabody, G. 1998. A Unique Hardwood Forest. Nature Trust of New Brunswick. Downloaded January 12, 2004 from http://www.elements.nb.ca/theme/forest/ahf/ahf.htm

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington and London 587 pp.

Pommen, L.W. 1983. The Effect on Water Quality of Explosives Use in Surface Mining. Volume 1: Nitrogen Sources, Water Quality, and Prediction and Management of Impacts. Ministry of Environment Technical Report, Victoria, B.C.

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.

Roland, A. E. 1998. Roland's Flora of Nova Scotia. Second Edition (revised by M. Zinck). Nova Scotia Museum/Nimbus. Halifax, N.S.

Rosenberg, K.V., R.W. Rohrbaugh, Jr., S.E. Barker, J.D. Lowe, R.S. Hames, and A.A. Dhondt. 1999. A land managers guide to improving habitat for Scarlet Tanagers and other forest-interior birds. The Cornell Lab of Ornithology.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Ottawa.

Smiley, A. 2002. Moose Accident Countermeasures: New Brunswick Highway 7. Report by Human Factors North Inc. for NBDOT.

TAC (Transportation Association of Canada). 1999. Geometric Design Guide for Canadian Roads. Transportation Association of Canada

TAC. 1998. Manual of Uniform Traffic Control Devices, Fourth Edition.

Takats, D.L., C.M. Francis, G.L. Holroyd, J.R. Duncan, K,M, Mazur, R.J. Cannings, W. Harris, and D. holt. 2001. Guidelines for Nocturnal Owl Monitoring in North America. Beaverhill Bird Observatory and Bird Studies Canada, Edmonton, Alberta. 32 pp. http://www.bsc-eoc.org/download/Owl.pdf

TEDCO (Tobique Economic Development Corporation). 2003. Traditional Ecological Knowledge Study in Relation to the Twinning of the Highway Project from Pokiok to Longs Creek.

Therrien, J, and G. Bourgeois. 2000. Fish Passage at Small Hydro Sites. Report by Genivar Consulting Group for CANMET Energy Technology Centre, Ottawa, 114 p.

Trow Consulting Engineers Ltd. 1996. Instream Sediment Control Techniques Field Implementation Manual. Ontario Ministry of Natural Resources. Northeast Science & Technology. FG-007. 109p

US EPA. 1996. Indicators of the Environmental Impacts of Transportation – Highway, Rail, Aviation, and Maritime Transport. Policy, Planning, and Evaluation, EPA 230-R-96-009.

US EPA. 2000. AP-42: Compilation of Air Pollutant Emission Factors, Volume 2: Mobile Sources. Office of Mobile Sources, United States Environmental Protection Agency.

US EPA. 2001. Air Quality Criteria for Particulate Matter, Volume I, USEPA, Second External Review Draft, March 2001, EPA 600/P-99/002aB.

US EPA. 2002. Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition. United States Environmental Protection Agency.

Washburn and Gillis Associates Ltd. 1997. Heritage Resources Evaluation Proposed Trans-Canada Highway Corridor Grand Falls to St. Leonard. Report on file at Archaeological Services Unit, Province of New Brunswick.

Washburn and Gillis Associates Ltd. 1998. Environmental Field Guide. Prepared for the New Brunswick Department of Transportation.

Westcoast Energy Inc. 2002. Revised Draft Comprehensive Study Report for the Grizzly Extension Pipeline and Weejay Lateral. Prepared by Jacques Whitford Environment Limited and AXYS Environmental Consulting Ltd.

Wilder, I.W. 1913. The life history of *Desmognathus fusca*. Biological Bulletin 24:251-342.

Wright, D.G, and G.E. Hopky. 1998. Guidelines for the use of Explosives In or Near Canadian Fisheries Waters. Canadian Technical Report of Fisheries and Aquatic Sciences 2107, Department of Fisheries and Oceans, Ottawa, Ontario.

8.2 Personal Communications

Allen, Patricia. Culture and Sports Secretariat. Fredericton, New Brunswick. August 6, 2003.

Antworth, Kevin. Director Carleton County, N.B. Cattle Marketing Agency. 2003.

Antworth, Ross. New Brunswick Federation of Snowmobile Clubs. July 2003.

Arseneau, Emile. Fisheries Officer, DFO, St. Leonard. 2003

Bagnall, Bruce A., Botanist/Bryologist, B&B Botanical, Nauwigewauk, NB. January, 2004.

Banks, Susannah. Executive Director. N.B. Soil and Crop Improvement Association. Fredericton, New Brunswick. 2003.

Barner, Wendy. Dump Closures Section, Remediation Branch, New Brunswick Department of Environment and Local Government. Fredericton, New Brunswick. July 2003.

Bernard, Emery. Registry of Agricultural Land and Farm Land Identification Program, Land Development, DAFA. Fredericton, New Brunswick. 2003.

Blaney, Sean. Botanist, Atlantic Canada Conservation Data Centre, Sackville, New Brunswick, November 2002.

Boucher, Serge. Junior Planner, the Kent District Planning Commission. Bouctouche, New Brunswick. 2003.

Bourque, Gilles. Culture and Sports Secretariat. Fredericton, New Brunswick. August 6, 2002.

Brennan, Joe. Director and President, Agricultural Producer's Association of New Brunswick. 2003.

Brennan, Peter. Land Development Officer, N.B. Department of Agriculture, Fisheries and Aquaculture. Wicklow, New Brunswick. 2003.

Brown, Betty. New Brunswick. Partners in Agriculture 2003.

Busby, Dan. Biologist, Canadian Wildlife Service. Sackville, New Brunswick, 2003.

Cameron, Cecil. Aboriginal Resource Consultants, March 1, 2004.

Crandlemeir, Ed. Dairy Producers Association. 2003.

Crowell, Mike. Botanist, Jacques Whitford Environment Limited, Dartmouth, Nova Scotia, September 16, 2003.

Culberson, Roy. President, Potato Shipper's Association. 2003.

Cunjak, Rick. Fellow, Canadian Rivers Institute. 2003

Currie, Ted. Habitat Assessment Biologist, DFO, Moncton. 2003

Curry, Allen. Fellow, Canadian Rivers Institute. 2003

Daigle, Jean-Louis. Executive Director, Eastern Canada Soil and Water Conservation Centre. Grand Falls, New Brunswick. 2003.

Demarsh, Peter. Director. New Brunswick Federation of Woodlot Owners. 2003.

Dickenson, Kim. Fishery Officer, DFO, Woodstock. 2002.

Duplessis, Brian. Professional Agrologists of New Brunswick. Fredericton, New Brunswick. 2003.

Fairchild, Gordon. Ph.D. Soil Specialist, Eastern Canada Soil and Water Conservation Centre. Grand Falls, New Brunswick. 2003.

Fava, Erica. Environmental Farm Planner Coordinator, APANB. Fredericton, New Brunswick. 2003.

Ferguson, Albert. Culture and Sports Secretariat – archaeological resources, Oct 2002; May 26, 2003.

Fox, Tim. Carleton Victoria Forest Products Marketing Board. 2003.

Green, Oulton. Local Resident. Summerfield, New Brunswick. September and October 2002.

Holyoke, Tim. ADI, Fredericton, New Brunswick. July 2002.

Jones, Ross. Salmonid Research, DFO, Moncton. 2003.

Kee, Robert. Manager, Accounts Receivable Section, Finance. Fredericton, New Brunswick. 2003.

Laforge, Jacques. Director for Victoria and Madawaska Counties, New Brunswick. Dairy Producers Association. Fredericton, New Brunswick. 2003.

Lamoreau, Sterling. Local Resident. Middle Sackville, New Brunswick. Oct 2002.

Landry, Mark. Gérant municipal, La Ville de Bouctouche Inc. Bouctouche, New Brunswick. 2003.

Lavender, Fulton L. Naturalist (Birds), Dartmouth, Nova Scotia. 2003.

Libby, Cade. Biologist, Big Game/Furbearer Section, Fish and Wildlife Branch, NBDNR, Fredericton, New Brunswick. 2003.

MacDonald, Patton. Executive Director, Potato NB. Centreville, New Brunswick. 2003.

MacDonald, Mike. Biologist, Jacques Whitford Environment Limited,

Maicher, George. Agronome Économiste Politiques et Planification, DAFA. Fredericton, New Brunswick. 2003.

Makepeace, Scott. Biologist, Forest Habitat Section, Fish and Wildlife Branch, NBDNR. Fredericton, New Brunswick. 2002.

Melanson, Gary. General Manager, Enterprise Carleton Region. Woodstock, New Brunswick.

Michaud, Benoit. La Ferme Michaud Farm Ltée. Bouctouche Bay, New Brunswick. 2003.

Mitchell, Simon J. Forest Certification Coordinator, Falls Brook Centre. New Brunswick. 2003.

Moore, Lynn M. P. ag. Manager, Resource Development Section, Land Development Branch, DAFA. Fredericton, New Brunswick. 2003.

Nicholls, Katrina. Executive Director, Agricultural Producers Association of New Brunswick. Fredericton, New Brunswick. 2003.

O'Brien, Wayne. Business Consultant, Enterprise Carleton Region. Woodstock, New Brunswick. 2003.

Ouellette, Benoit. Business Development. New Brunswick Potato Statistics Update. 2003.

Pickard, Gerard. Soil and Crop Association of New Brunswick. 2003.

Prentice, Norman. Manager, Regional Biology Unit (Region 4), NBDNR. Edmundston, New Brunswick. 2003.

Prosser, Doug. Project/Forestry Resource Consultant, AGFOR Inc. Fredericton New Brunswick. 2003

Russel, John. Environmental Analyst, Agricultural Products Association of New Brunswick. Fredericton, New Brunswick. 2003.

Seaman, Allan. Geologist, NBDNR. Fredericton, New Brunswick. June 18, 2003.

Seymour, Pamela. Biologist, NBDNR, Fredericton. 2003.

Simpson, Jamie, Nature Trust of New Brunswick, Fredericton, New Brunswick. 2003.

Smith, Jennifer. Local resident. Wicklow, New Brunswick. October 2002.

Swanson, Lee. Biologist, Wetlands and Coastal Habitat Section, NBDNR. Fredericton, New Brunswick. July 21, 2003.

Tepper, Hank. New Brunswick Soil and Crop Association. Drummond, New Brunswick. 2003.

Toner, Maureen. Biologist, Species at Risk Section, Fish and Wildlife Branch, NBDNR. Fredericton, New Brunswick. July 21, 2003, and email dated August 1, 2002.

Vienna Brown (local resident), Wilklow New Brunswick, Sept 2002.

Watson, Alfred. Maple Sugar and Christmas Trees. 2003.

Wilson, Reg. NBDNR. Fredericton, New Brunswick. April 23, 2003.