7.3 Caribou

The proposed TLH - Phase III lies within the range of the MMCH, a 'resident' herd exhibiting characteristics typical of woodland caribou, such as short seasonal movements and low densities. Woodland caribou in Labrador are listed as threatened by COSEWIC (COSEWIC 2002). A review of available information provided an understanding of the effects of development on caribou and contributed to the limited knowledge of the herd's historic range and abundance. Original research was carried out on the distribution, movement patterns, and size of the herd in 2002 and 2003. The results of these studies were presented in a caribou component study (Otto 2002a), a progress report (Otto 2002b), and an addendum to the caribou component study (Otto 2003). These reports provide the most current information available for evaluating the effects of the outfitter route on the MMCH.

7.3.1 Boundaries

Project boundaries for caribou are defined by the spatial and temporal extent of the anticipated physical, visual, and auditory influences of the project in the area surrounding the proposed highway route. This boundary is a 2-km wide corridor centred on the proposed outfitter route. The assessment of project effects on caribou extends to the entire herd and its range (Figure 7.11).

Ecological boundaries for caribou are primarily seasonal, with the most important periods being calving/post-calving and overwintering. Caribou are a wide-ranging group. The MMCH winter range is extensive and fairly consistent over the years. Winter habitat use is heavily dependent on snow cover, with animals making greater use of forested areas during years of less snowfall. Calving locations are dispersed and, although there is often an attraction to a particular section of range for calving, specific sites within that portion of range are not selected consistently from year to year. In summer, individuals are relatively sedentary and aggregated in small groups. Movement is greatest in the fall and once animals are established on their wintering range, there is relatively little movement unless snow conditions change. Prediction of environmental effects will be made for the MMCH.

The Government of Newfoundland and Labrador, through the Inland Fish and Wildlife Division, Department of Tourism, Culture, and Recreation, is responsible for the management of caribou. The MMCH are protected and there is no legal hunting of the herd.

7.3.2 Methods

Recent population estimates for the MMCH are inconsistent, age structure data are not available, and recent seasonal range use is not well defined. However, the herd is fairly well understood in terms of its history and historic distribution (seasonal and overall), thus permitting a general understanding of how caribou may use habitat along the outfitter route, and how that use may be affected by the project. The ongoing telemetry monitoring of radio-collared animals has provided new information on movement and distribution of the herd as it relates to the outfitter route. Data collected include spring, calving, and post-calving distribution from March to November, 2002 (Otto 2002a; 2003b), and winter, spring, calving, and post-calving distribution from January to August, 2003 (Otto 2003). Caribou were captured with a net fired from helicopter, restrained physically (no chemical immobilizing agents were used) and fitted with very high frequency (VHF) transmitter collars. In 2002, four females and two males were collared; in 2003, 11 females were collared.

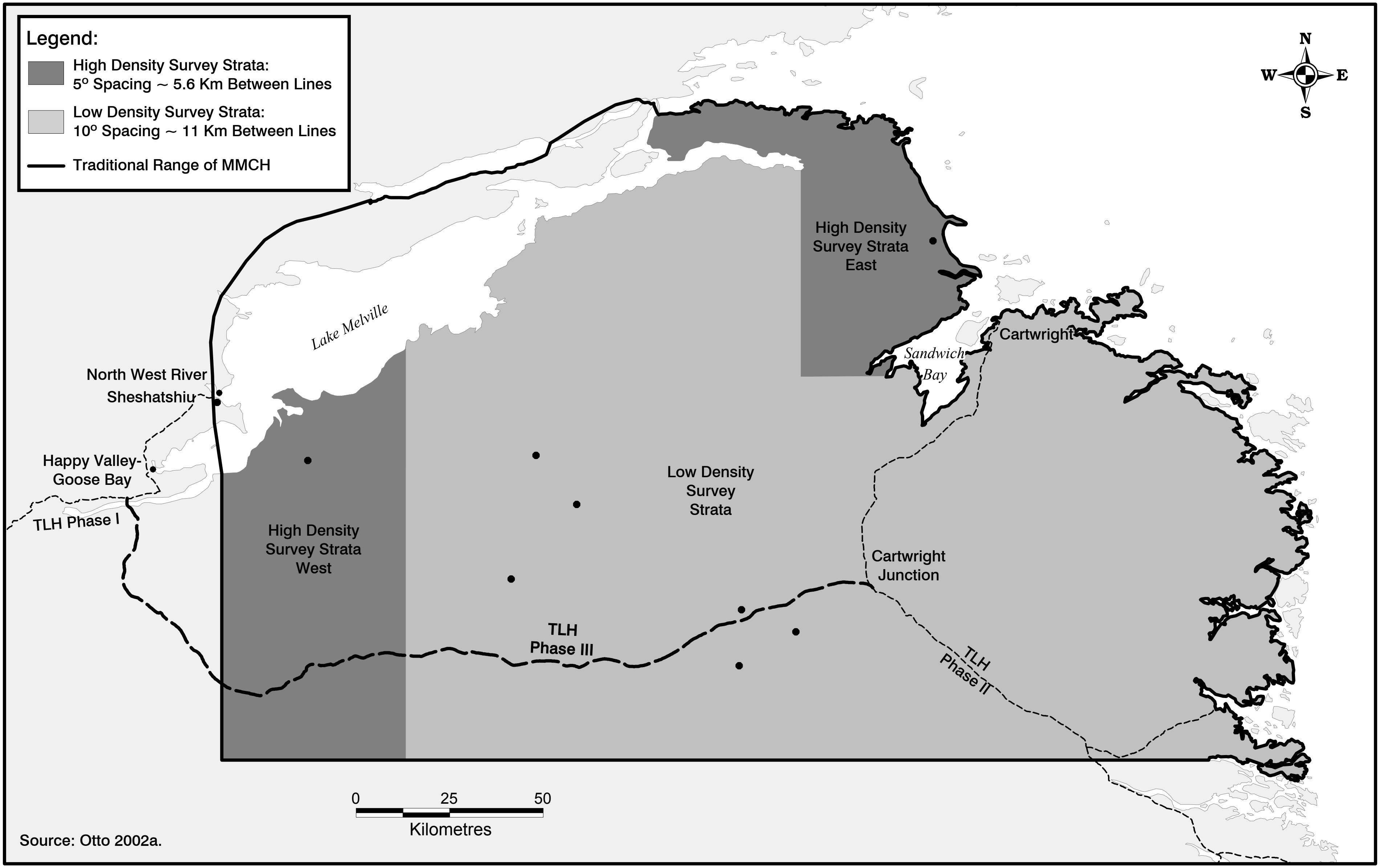

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FIGURE 7.11

Traditional Range of the MMCH and Area Covered During Aerial Surveys

7.3.3 Existing Environment

7.3.3.1 Herd Range

The MMCH is the largest and most accessible (to local residents) caribou herd in southern Labrador, and probably the only population in the project region. The MMCH is scientifically the least well known of the three recognized woodland caribou herds in Labrador (Otto 2002a). However, a number of studies have reported on the history and seasonal range of the herd and on the wide population fluctuations the herd has undergone in the past.

The traditional range of the MMCH extends from Lake Melville and Groswater Bay, south toward the Lower North Shore of Québec and the Labrador Straits, and from the Kenamu River headwaters, east to the Labrador coast. In normal winters, the main concentration of animals is in the Mealy Mountains (Bergerud 1967; Hearn and Luttich 1987). In winters with little snow, caribou make greater use of the forested areas south of the Mealy Mountains. In years of heavy snowfall, animals are more likely to winter on the south shore of Lake Melville (between Carter Basin and Etagaulet Bay), where they may occasionally cross to the north side of the lake to areas of less snowfall (Bergerud 1967). In most years, some groups may winter along the coastal areas of Groswater (Porcupine Strand area) and Sandwich Bays, and on the Kenamu River marshlands (Bergerud 1967; Hearn and Luttich 1990). In late spring, females move from wintering areas to dispersed calving locations on the extensive bog/forest stand complexes present in the area, particularly around the headwaters of the Eagle, English, North and White Bear rivers (Hearn and Luttich 1987). The post-calving period is spent near the calving locations, sometimes within the forest stands in the area. The summer range includes the bog/forest complexes in the general calving area, and extends toward the coast, north of Sandwich Bay. The caribou are relatively sedentary and widely dispersed. In fall, movement increases somewhat (probably because of rutting activities) and the animals move to wintering areas in late fall to early winter.

Refer to Section 6.3.3.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion on herd range.

7.3.3.2 Herd Abundance

The MMCH has experienced four or five cycles of abundance and scarcity since the early 1900s. The more recent declines have been attributed to overhunting (Bergerud 1967). Caribou were common in the region around 1900, were reported to be scarce by 1916, and were increasing again by 1945 (Bergerud 1967). Population estimates of the MMCH have ranged from 2,600 in 1960 (Bergerud 1963) to a low of 200 in 1975 (Hearn and Luttich 1990) and 534 in 1997 (Schaefer 1997).

During the spring aerial surveys of 2002, a total of 276 caribou were observed in a characteristic late winter clumped distribution within the survey area (the survey area generally coincided with the traditional range of the herd). The largest number of caribou occurred in five discrete groups within an area of approximately 2,500 km^2 centred around Park Lake (Figure 7.12). Two smaller groups were recorded at the coast; one in the vicinity of Porcupine Strand north of Cartwright, the other south of Cartwright in the general vicinity of Hawke Bay (Figure 7.12).

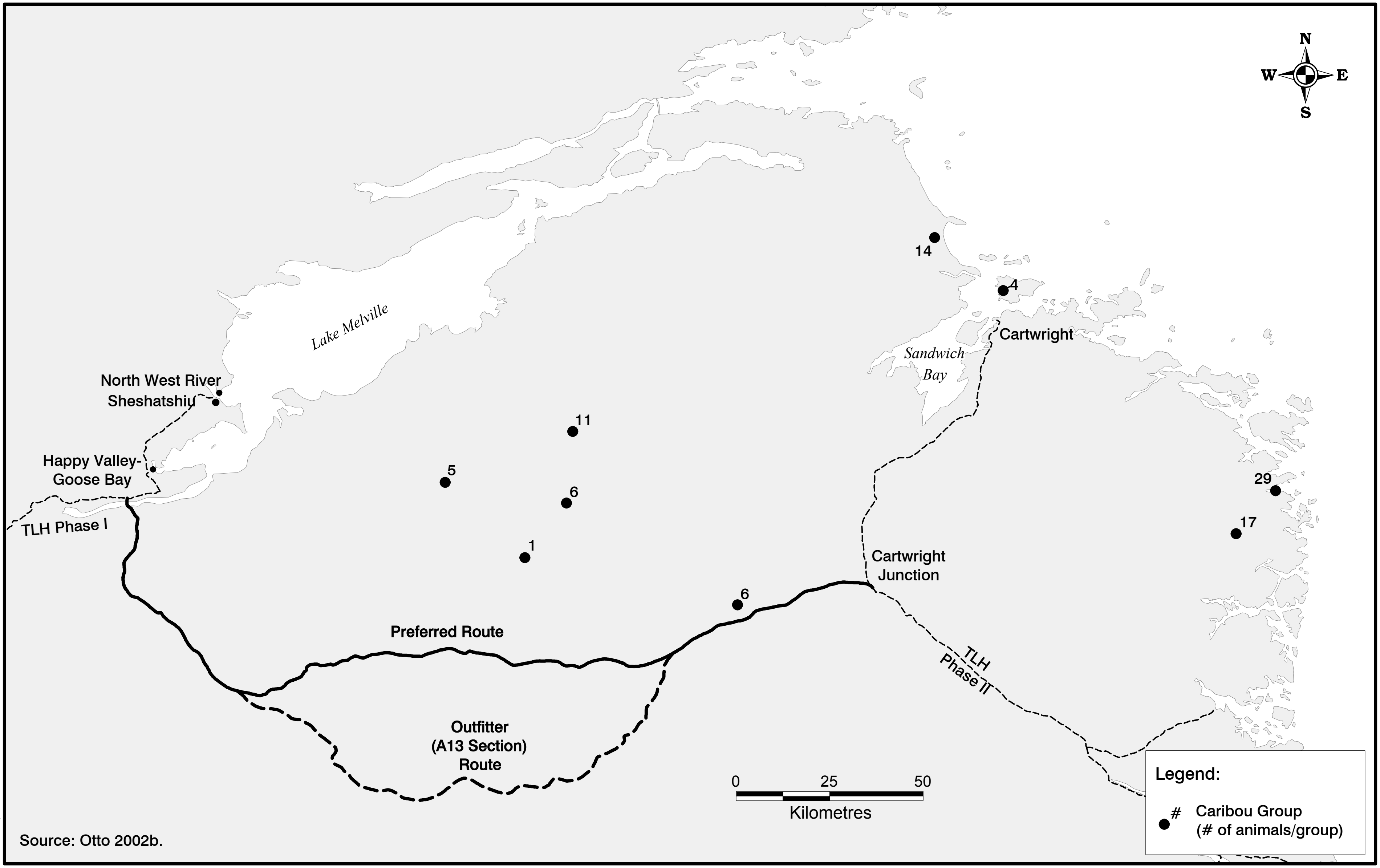

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FIGURE 7.12

Locations of Caribou Groups from Aerial Surveys,
March 29 to April 7, 2002

From surveys conducted in 2002, caribou densities in the survey area were estimated to range from 0.048 to 0.182 animals/km^2. Based on the 2002 surveys, the population of the MMCH was estimated to be 2,585 animals (+/- 1,596) (Otto 2002a). The 2002 classification results indicate that recruitment rates are high. The male:female sex ratio of 1:2 suggests that survival rates are also high. If these rates were maintained over a five-year period, there would be a large increase in herd size. However, certain data such as population age structure are missing and must be obtained before conclusions can be made that a large increase in the MMCH population has occurred over the last five years (Otto 2002a). The uncertainty surrounding the latest census results and the lack of data on population age structure make it difficult to determine the current status of the population.

In 2003, block surveys of caribou numbers within 10 km of either side of the preferred route and outfitter route provided some information on density in these areas (Otto 2003). Caribou densities were 0.0205 animals/km^2 in the central part of the preferred route, 0.00654 animals/km^2 in the outfitter (A13 section) route, 0.00871 animals/km^2 in the common eastern part of the route, and no caribou were observed in the common western section of the route.

Although little historical classification data are available for the herd, some more recent results are known. The results of classifications carried out in the last 20 years are presented in Table 7.5.

Table 7.5 Classification Results for the Mealy Mountains Caribou Herd, 1981 to 1994

Year	Season	Stags	Does	Calves	Stags/100 does	Calves/100 does	% Calves
1981	Winter	118	227	86	52	37.9	20
1985	Spring	227	359	172	63.2	47.9	22.7
1985	Fall	46	118	37	39	31.4	18.4
1987	Winter	431	698	242	61.7	34.7	17.7
1989	Spring	218	420	89	51.9	21.2	12.2
1990	Spring	398	725	125	54.9	17.2	10
1992	Spring	98	291	35	33.7	12	8.3
1994	Spring	119	290	62	41	21.4	13.2
Source: Otto 2003.							

Refer to Section 6.3.3.2 of the TLH - Phase III EIS (JW/IELP 2003a) for further discussion on herd abundance.

7.3.3.3 Migration Patterns

The 2002 spring, calving, and post-calving distributions of collared animals are shown in Figure 7.13. The locations of caribou observed during aerial block surveys during the calving period in 2003 are provided in Figure 7.14. The distribution of collared animals during the 2003 post-calving season telemetry survey is shown in Figure 7.15.

No consistent pattern of movement or range use emerged from the monitoring of radio-collared caribou in 2002 and 2003. However, it does appear that areas dominated by bog are preferred for calving, and forested areas are preferred during the post-calving period (Otto 2003) (Figure 7.15). In 2002, three of the six collared animals exhibited the relatively sedentary pattern typical of woodland caribou, and three others moved up to 100 km during the April to September monitoring period (Otto 2002b) (Figure 7.13). The 2003 movement data reported by Otto (2003) focus on the calving and post-calving periods (June to August). Mean maximum movement by collared females during this time was 13.3 km, although one movement of greater than 50 km was recorded. The amount of movement depends on the sex of the animal and the presence or absence of a calf (Otto 2003). Generally, males and females without calves travel farther than females with a calf.

All caribou locations in 2002 and 2003 fall within the traditional range of the herd, and indicate that members of the herd are present in the area of the preferred route and outfitter route. However, during the calving period block survey, 12 (50.0 percent) of the 24 caribou observed, were in the central section of the preferred route and five (20.8 percent) were in the outfitter (A13 section) route (Figure 7.14).

Schaefer et al. (2000) evaluated consecutive-year site fidelity (the proportion of animals returning to a specific site or range) of satellite-tracked woodland caribou from the Red Wine Caribou Herd. The most intense fidelity occurred during post-calving when, on average, female caribou returned to as near as 6.7 km of locations occupied the previous year. At the seasonal range scale, woodland caribou still displayed fidelity from calving to breeding, although not during winter. The mean distance between consecutive-year locations of individuals during winter was approximately 50 km.

Refer to Section 6.3.3.3 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for additional information on 2002 movement patterns and habitat selection of the MMCH.

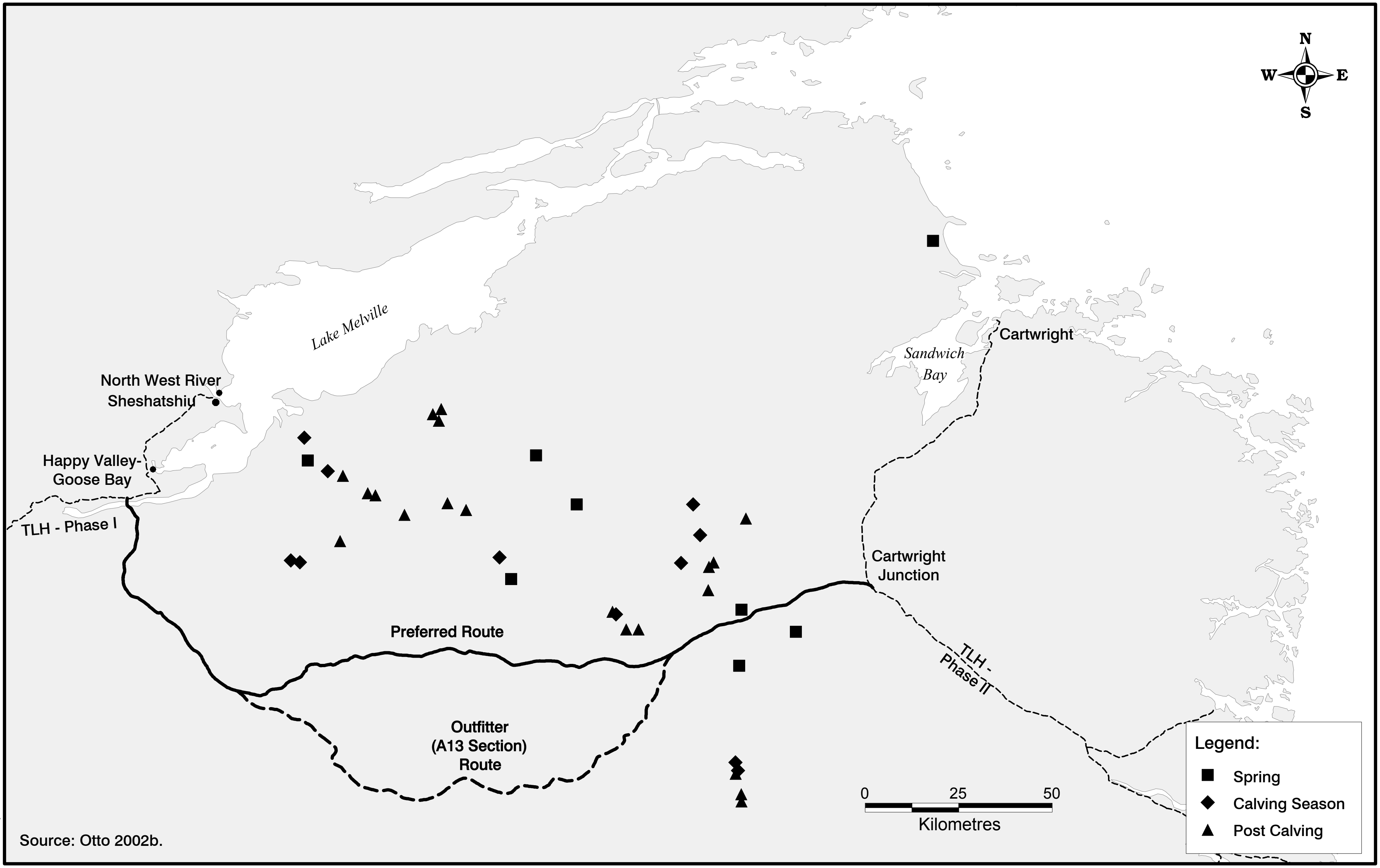

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FIGURE 7.13

Distribution of Collared Caribou, 2002

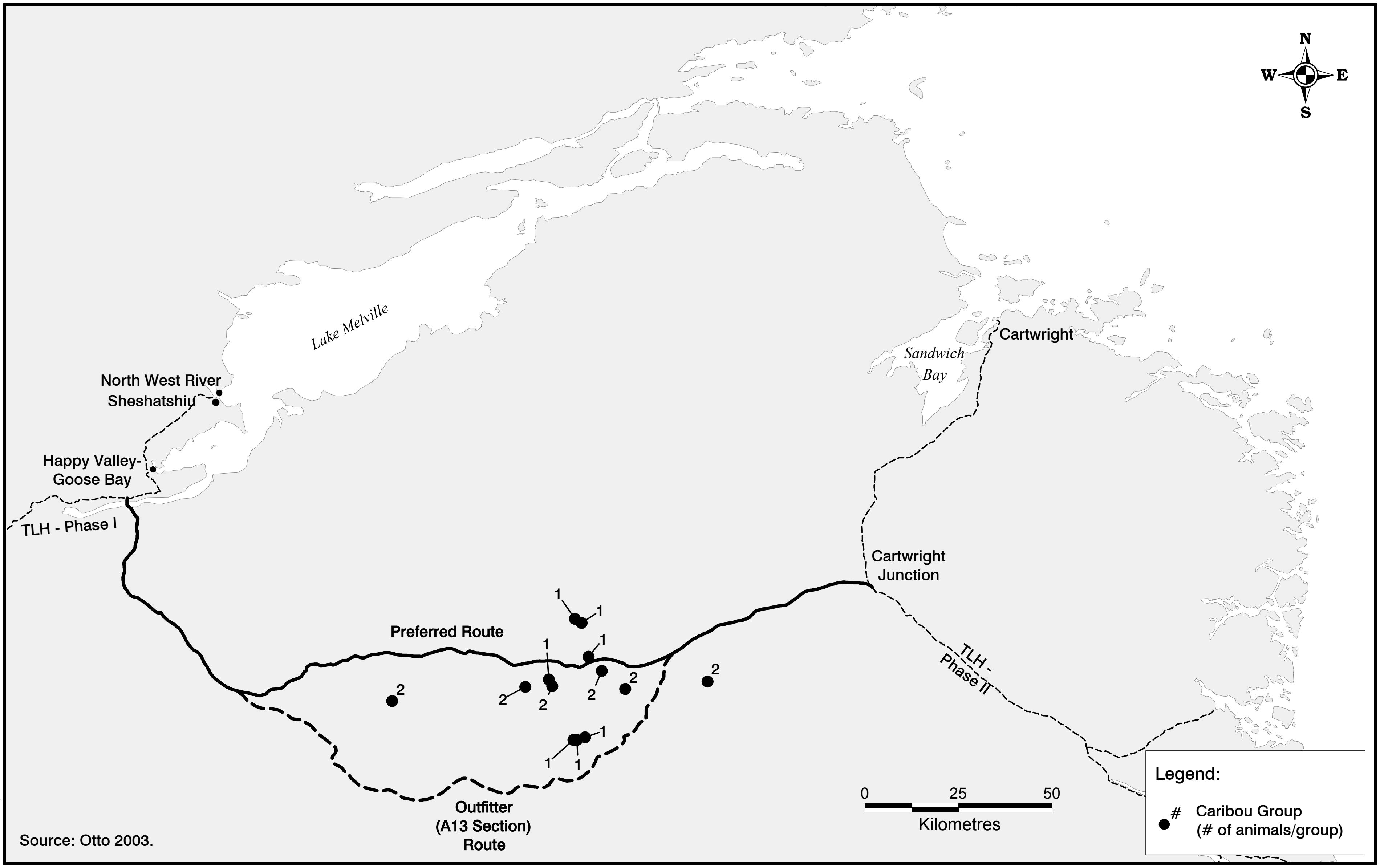

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FIGURE 7.14

Caribou Observed During Aerial Block Surveys
During the Calving Period, June 2003

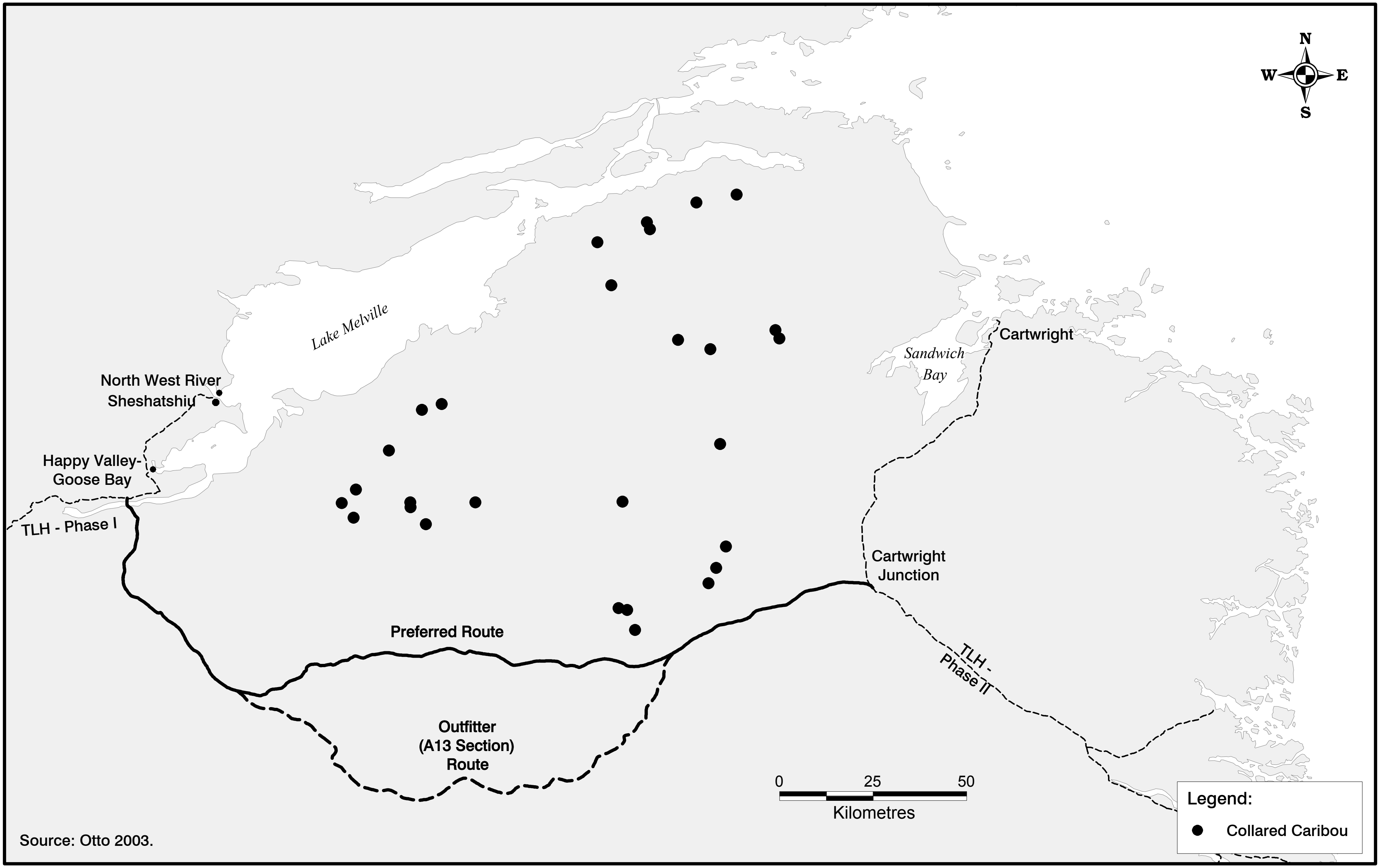

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FIGURE 7.15

Locations of Caribou from Telemetry Surveys
During the Post-Calving Period, July and August 2003

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7.3.4 Potential Interactions

Activities associated with construction (i.e., use of heavy equipment, blasting, and human presence) may affect caribou, causing animals to temporarily avoid habitat where noise and activity levels are high. The construction camps that will be established along the route during the seven-year construction period are shifting centres of human presence, which may be avoided by caribou. Right-of-way clearing and grubbing will result in habitat alteration or loss.

During operation, the physical presence of the highway may interfere with caribou movement through the area. This avoidance is particularly likely to occur when traffic volumes are high. Increased illegal harvesting of caribou could result from improved access.

Caribou/vehicle collisions may also occur. Accidental events such as a forest fire or fuel/hazardous materials spill could also cause habitat alteration or contaminate food sources.

7.3.5 Issues and Concerns

Issues and concerns relating to caribou include:

- disturbance of caribou, including interference with seasonal movements, during the seven-year construction period and during operation;
- displacement of caribou from critical range (i.e., calving or wintering areas) due to habitat alteration or loss during construction, which may lead to lower productivity;
- direct mortality of caribou due to increased hunting made possible by improved access;
- caribou/vehicle accidents; and
- accidental events such as fuel/hazardous materials spills or fires, which could result in habitat alteration or contamination of food sources.

7.3.6 Existing Knowledge

There is extensive literature reporting on the potential effects of linear developments on caribou. These studies identify three major aspects of highway development that may affect caribou: habitat alteration; disturbance caused by the visual presence of the highway, noise and human presence; and increased harvesting as a result of improved access.

Caribou have a number of seasonal habitat requirements, including availability of adequate forage at all seasons, habitats offering insect relief during summer, and calving areas that are relatively predator-free (VBNC 1997). The distribution and seasonal movements of a caribou herd result from an attempt to meet these requirements and to improve reproduction and survival of herd members. Disturbances that alter or destroy habitat, or change the pattern of habitat use, may displace caribou to less suitable habitats or cause the animals to over-graze remaining range. The effects of habitat alteration or loss, or displacement of animals from preferred habitat, are likely to be more important for woodland caribou herds that occupy fairly discrete home ranges than it is for nomadic barren-ground caribou populations that use extensive areas on a seasonal basis (Jakimchuk 1980).

Caribou tend to avoid linear structures such as highways, but avoidance is due primarily to the presence of people and/or traffic and not because of the presence of the highway itself (Klein 1980; Shidler 1986; Cameron et al. 1992). Northcott (1985) noted that caribou in the vicinity of the Upper Salmon hydroelectric development in Newfoundland were hindered from crossing main access highways by dust associated with fast-moving vehicles.

There are many examples of caribou habituating to an operating highway. The Avalon herd in Newfoundland has habituated to the presence of fast-moving traffic (Bergerud et al. 1984). Some animals in that herd could be approached to within 100 m, and as the herd increased in size, its range expanded to include the highway. The caribou in that herd had no previous experience with highways, nor a previous tradition of crossing the highway. Another Newfoundland herd wintered within 2 km of the operating railway and within 4 km of the Trans Canada Highway (Bergerud 1974).

In many recent papers which discuss caribou/development interactions, the developments being assessed for their effects on caribou are generally characterized by complex infrastructure, broad disturbance footprints, and intensive activity. This contrasts with the single linear character of the TLH - Phase III project.

Mahoney and Schaefer (2002) investigated the effects of hydroelectric development on the movements and space-use of animals from the Buchans Plateau Caribou Herd (BPCH) in west-central Newfoundland. The Star Lake project was constructed directly in the herd's migratory pathway, between its calving/summer range in the north and its winter range in the south. Patterns of range use, site fidelity, and migration timing of radio-collared caribou were compared before, during, and after project construction. Relative timing of migration to, and departure from, the calving and summer grounds before the project was individual-specific and was predictable. This predictability was less certain during development. The year-to-year consistency of fall and spring migration among individuals was apparent before and after construction, but was not as consistent during construction.

Prior to construction, more than 50 percent of the collared caribou were found within 3 km of the site each year. During construction, less than 25 percent of the collared animals were located within 3 km of the site. This situation persisted until two years after construction. The variation in calving site fidelity observed during the study was attributed to year-to-year differences in snowfall. Mahoney and Schaefer (2002) concluded that the development caused a temporary disruption of migration timing during the construction period, and may cause longer-term diminished use of the range immediately surrounding the project site. The behaviour by the BPCH after construction is consistent with previous studies in that caribou appeared to be more sensitive to the human activities associated with construction, traffic, and noise than to the infrastructure itself. However, it was hypothesized that disruption of movement might be harmful with respect to herd demographics, where human activities are protracted in either time or space (Mahoney and Schaefer 2002).

Dyer et al. (2001) evaluated the response of woodland caribou to petroleum development in northern Alberta. Infrastructure associated with such development included a dense network of roads and seismic lines, as well as numerous wellsites. The level of avoidance of infrastructure appeared to be related to the level of human activity present. The maximum avoidance distances recorded for wellsites were 1,000 m and for roads and seismic lines, 250 m. Avoidance of roads was highest during late winter (the period of highest traffic levels with 600 to 800 vehicles per day) and lowest during summer (less than 100 vehicles per day). Road avoidance distances were also near the maximum during the calving period. However, in all time periods and in all habitat types, the use by caribou of habitat within 250 m of roads was not measurably different from use of habitat 3,000 m from the road.

Smith et al. (2000) examined the responses of radio-collared migratory woodland caribou to winter timber harvesting on the herd's range in west-central Alberta. The size of the winter range changed very little throughout the 15-year study period, although individual home range size was reduced. However, the distribution of caribou relative to progressive timber harvesting did change. Animals moved away from active cut blocks, followed by a partial return to the pre-logging distribution after six years of logging. Daily winter movement rates were reduced as logging progressed, primarily because the landscape was becoming increasing fragmented by roads and cut blocks. Although there was no avoidance of fragmented areas during the early stages of logging activity, there was considerable avoidance of such areas after 12 years of harvesting. By this time cut blocks made up 3.6 percent of the study area, and 11 percent of the winter range was fragmented. While it was acknowledged that snow depths and wolf predation may also have influenced movement rates, the highly fragmented winter habitat was considered to be a major factor in reducing both home range size and movement rates, and may have compromised the "spacing out" anti-predator strategy of caribou.

Duchesne et al. (2000) assessed the effect of ecotourist visits during winter on the behavioural time budgets of woodland caribou in the Charlevoix World Natural Heritage Biosphere Reserve, Québec. Skiing or snowshoe tour groups of 5 to19 people visited the caribou once a week for 11 weeks (January to March), with each tour lasting an average of 39.3 minutes. The group viewed caribou from a distance of 10 to15 m. Caribou did not leave the wintering area because of human presence, although they did abandon the range twice in response to the presence of wolves. During the early part of the study, particularly with the larger tour groups, the animals spent less time foraging and more time in a state of alertness. After three weeks, the caribou were spending less time in a state of alertness and more time foraging when the tour groups were present. Duchesne et al. (2000) suggested that, although the number of visits was low, the caribou appeared to habituate to human presence.

James et al. (2000) examined the hypothsis that linear corridors would increase human harvest and predation pressure on woodland caribou in northeastern Alberta. Generally, the trend within the caribou population studied was to avoid the large number of linear structures in the region. However, there was no evidence that habitat was a limiting factor for caribou in the study area. In terms of increased pressure on caribou, it was found that caribou occupying habitat near linear corridors were at higher risk of predation by wolves than were caribou farther from the corridor. Mortalities caused by humans were not considerably greater closer to corridors.

Nellemann and Cameron (2000) investigated the changes in distribution and range use of calving barren-ground caribou faced with an increasing density of roads in an oilfield development area in Prudhoe Bay, Alaska. The greatest effects of oilfield development on caribou are attributed to initial construction of the road complex and related facilities. Caribou density declined by 63 percent at road densities of 0.0 to 0.3 km road/km^2 and by 86 percent at road densities of 0.6 to 0.9 km road/ km^2. At the latter road density, cow-calf pairs were virtually excluded. The avoidance response detected in the study may be due to the preponderance of females and calves in the populations surveyed. Males and yearlings did not display such avoidance of these areas.

The rugged terrain in the Prudhoe Bay study area was strongly preferred for calving. As availability of such terrain declined, caribou did not abandon these portions of the range. Rather, they intensified their use of the preferred patches. However, as opportunities for optimal forging continued to diminish, there was a redistribution of some calving activity from the oilfield development site to areas of undisturbed rugged terrain farther inland. While this redistribution could favor foraging, it might result in higher rates of predation (Nellemann and Cameron 2000).

Refer to Section 6.3.6 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion on existing knowledge of the effects of highways on caribou.

7.3.7 Mitigation

Environmental management planning incorporates a number of mitigation measures aimed at reducing the potential effects of the project on caribou and their environment. Specific mitigative measure include the following:

- limiting areas of vegetation clearing and grubbing to 30 m within the right-of-way;
- blasting to comply with government laws and regulations, and instantaneous peak noise levels minimized by time delay blasting cycles;
- scheduling of high disturbance activities such as blasting to occur outside of sensitive periods such as calving, when caribou are present in the area of construction;
- walls of decommissioned borrow pits graded to slopes less than 2:1;
- slopes of the highway graded for ease of passage at potential crossing points for caribou;
- vehicles operate at appropriate speeds and yield to wildlife;
- project personnel will not chase, harass, or feed wildlife.
- construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes; and
- design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.

7.3.8 Environmental Effects Assessment

7.3.8.1 Construction

Some habitat used by the MMCH is expected to be altered or lost as a result of right-of-way clearing, grubbing, and other construction activities regardless of the route selected. It is anticipated that caribou will avoid the immediate area of the highway during construction activities because of noise and human disturbance. The calving and post-calving habitat located on the string bogs in the headwaters of the Eagle and Paradise rivers and the calving locations adjacent to the central portions of the preferred and outfitter routes are the areas most likely for this interaction to occur.

Avoidance of habitat because of noise and human activity would probably last one construction season in any particular area. Caribou live in a highly variable environment and tend to habituate quickly to disturbance (Roby 1978; Klein 1980). Caribou prevented by construction activity from using a particular calving area in the headwaters of the Eagle and Paradise rivers or elsewhere will likely select an alternate undisturbed site. No reduction in herd productivity is anticipated.

Although some fragmentation of range may result from this project, the major portion of spring and summer habitat for the MMCH remains north of the preferred and outfitter routes. Displaying the considerable flexibility that caribou appear to have in their habitat requirements (Davis et al. 1985), the MMCH will likely select alternate habitat during construction. That flexibility is perhaps most important in the selection of calving locations. Habitat that may be avoided during construction will most likely be used again following construction, as experience in other developments has shown (Hill 1985; Mahoney et al. 1989).

Although some summer habitat will possibly be lost through construction, caribou are widely dispersed over a summer range that extends from the calving areas to the coast, north of Sandwich Bay (Hearn and Luttich 1987). Little MMCH wintering habitat appears to be threatened by construction activities. Most of the traditional winter range (Mealy Mountains, Porcupine Strand, south shore of Lake Melville) is well removed from the preferred and the outfitter routes. However, in years of light snowfall, caribou often move into forested areas south of the mountains. It is here where they may interact with the preferred and outfitter routes, but this interaction is not expected to be adverse since construction will not be occurring during the winter.

Refer to Section 6.3.8.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for additional discussion on the effects of construction on caribou.

7.3.8.2 Operation

The environmental effects of highway operation on caribou will be similar for both the preferred and outfitter routes. In either case, the route will be generally on the periphery of the herd's range. However, the outfitter route will be farther toward the southern periphery of the range. Some habitat adjacent to either route may be avoided due to the presence of traffic. However, as noted above, caribou are know to habituate to vehicular traffic, and traffic levels on the TLH - Phase III will be low. Animals would be expected to habituate to either route, and to cross when conditions (i.e., low traffic volumes) are acceptable. Herd integrity is not likely to be threatened.

Refer to Section 6.3.8.2 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion on the environmental effects of highway operation on caribou.

7.3.8.3 Accidental and/or Unplanned Events

The effects of accidental and/or unplanned event will be similar for both the preferred and outfitter routes. The major effect of fire on caribou would be destruction of the food supply. Lichens, a major forage group for caribou throughout the year (and especially critical in winter), are particularly susceptible to wildfires in summer and require many decades to recover (Klein 1982). Summer forage plants are also at risk from fire, but can recover more quickly, as they have more advanced root systems or can re-grow from seed sources (Henry and Gunn 1991). However, boreal species such as caribou are adapted to a fire-driven ecosystem and the amount of habitat affected within the range of the MMCH as a result of a fire originating near the highway would be relatively small.

Some mortality may result from collisions with vehicles; however, with the low traffic volume expected on the highway and the generally low densities of caribou in the region, the number of vehicle collisions is expected to be low.

7.3.9 Environmental Effects Evaluation

The following definitions are used to rate the significance of the predicted residual environmental effects of the project on caribou:

A **major (significant) environmental effect** is one affecting a caribou population in such a way as to cause a change in abundance and/or distribution beyond which natural recruitment (reproduction and in migration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its former level within several generations. The effect is not reversible.

A **moderate (significant) environmental effect** is one affecting a portion of caribou population in such a way as to cause a change in the abundance and/or distribution of that portion of the population or any populations or species dependent upon it over one or more generations, but does not change the integrity of any population as a whole. The effect may not be reversible.

A **minor (not significant) environmental effect** is one affecting a specific group of individuals of a caribou population in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less), but not affecting other tropic levels or the integrity of the population itself. The effect is reversible.

A **negligible (not significant) environmental effect** is one affecting a specific group of individuals of a caribou population in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less) in a manner similar to small random changes in the population due to natural irregularities, but having no measurable effect on the population as a whole. The effect is reversible.

The most likely caribou-project interactions are expected to occur during the calving and post-calving periods. Woodland caribou are known to calve singly or in small groups and readily use alternate sites (i.e., do not necessarily have fidelity to any one site). An increase in illegal harvesting is anticipated and caribou-vehicle collisions (a new phenomenon for this herd) can be expected when the highway becomes operational. However, the highway (regardless of which route is selected) will be located near the southern periphery of the herd's range and caribou are known to habituate to highways. As well, the density of animals in any given area at any given time will be low, thus limiting opportunities for poaching the highway. Based on the preceding discussion and proposed mitigations, the residual environmental effects of construction, operation, and accidental events on caribou during these periods are predicted to be minor (not significant) (Table 7.6) and will be limited to a specific group of individuals in a localized area.

Table 7.6 Environmental Effects Summary - Caribou

	Construction	**Operation**	**Accidental/Unplanned Events**
Mitigation: • limiting areas of vegetation clearing and grubbing to 30 m within the right-of-way; • blasting to comply with government laws and regulations, and instantaneous peak noise levels minimized by time delay blasting cycles; • scheduling of high disturbance activities such as blasting to occur outside of sensitive periods such as calving when caribou are present in the area of construction; • blasting areas will be surveyed for caribou and other wildlife species, if any wildlife are observed in the immediate area, blasting activities will be postponed; • guidelines for mitigating effects of blasting activities on wildlife will be developed in consultation with Inland Fish and Wildlife Division; • uncontrolled blasting caused by failed discharges or otherwise will be reported immediately to the appropriate authority; and • where uncontrolled blasting results in degradation to terrestrial habitats, mitigative measures as recommended by the regulatory agency responsible will be implemented; • walls of decommissioned borrow pits graded to slopes less than 2:1; • slopes of the highway graded for ease of passage at potential crossing points for caribou; • vehicles operate at appropriate speeds and yield to wildlife; • project personnel will not chase, harass, or feed wildlife. • construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes, avoiding wetland areas wherever possible; and • design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.			
Environmental Effects Criteria Ratings			
Magnitude	Low	Low	Unknown
Geographic Extent	<1 km^2	1 to 10 km^2	100 km^2
Frequency	Continuous	Continuous	<10
Duration	>72	>72	>72
Reversibility	Irreversible	Irreversible	Unknown
Ecological/Socio-economic Context	Low		
Environmental Effects Evaluation			
Significance	Not Significant (Minor)	Not Significant (Minor)	Not Significant (Minor)
Level of Confidence	High	High	High
Likelihood[1]	n/a	n/a	n/a
Sustainable Use of Renewable Resource[1]	n/a	n/a	n/a
[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).			
Environmental Monitoring and Follow-up: • Construction areas will be monitored for caribou and construction activities will be curtailed as appropriate. • No blasting will occur if caribou are present in the construction area. • WST will liaise closely with Science Division representatives in Happy Valley-Goose Bay regarding appropriate actions to be taken. • All project personnel will be briefed on caribou issues during the environmental awareness session.			

	Construction	Operation	Accidental/Unplanned Events
Key:			
Magnitude:	High, Medium, Low, Nil or Unknown		
Geographic Extent (km^2):	<1, 1-10, 1-100, 101-1,000, 1,001-10,000, >10,000 or Unknown		
Frequency (events/year):	<10, 11-50, 51-100, 101-200, >200, Continuous or Unknown		
Duration (months):	<1, 1-12, 13-36, 36-72, 72 or Unknown		
Reversibility:	Reversible, Irreversible or Unknown		
Context:	Existing Disturbance (High, Medium, Low, Nil or Unknown)		
Significance:	Significant, Not Significant, Positive or Unknown		
Level of Confidence:	High, Medium, Low		
Likelihood:	High, Medium, Low or Unknown		
Sustainable Use of Renewable Resources:	High, Medium, Low or Unknown		

7.3.10 Cumulative Environmental Effects

The effects of existing (hunting, trapping, angling, gathering, camping) and possible future (commercial forestry, mining, cabin development) activities will be the same whether the preferred route or the outfitter route is chosen.

Woodland caribou are endangered throughout their range in Canada (with the exception of the Island of Newfoundland). Activities such as poaching and unregulated timber harvesting could have adverse effects on the MMCH. The magnitude of the effect would depend on the extent of timber harvesting and level of unregulated hunting.

If large scale industrial forest harvesting occurs without any consideration of habitat requirements for caribou, access from the highway by ATV and along resource extraction roads (from forest harvesting) is uncontrolled, and no enforcement of regulations prohibiting hunting occurs, a major (significant) cumulative effect (i.e., one affecting a caribou population in such a way as to cause a change in abundance and/or distribution beyond which natural recruitment (reproduction and in migration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its former level within several generations) may result from these unregulated activities.

The various resource management agencies should consider a cooperative management or regional land use planning approach to managing the land and resources along the highway and surrounding area. In addition, the departments and agencies responsible for managing wildlife resources may need to review existing management policies and programs to ensure that they are appropriate. There may also be a need for agencies to increase their enforcement staff levels.

Refer to Section 6.3.10 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for a more complete discussion of cumulative effects on caribou.

7.3.11 Environmental Monitoring and Follow-up

Construction areas will be monitored for the presence of caribou and construction activities, including blasting, will be curtailed as appropriate. WST will liase closely with the Science Division representatives in Happy Valley-Goose Bay regarding appropriate action to be taken should caribou be observed in a construction area. As well, all project personnel will be briefed on caribou issues during the environmental awareness session.

7.4 Furbearers

Within the context of this assessment, furbearers represent a diverse group of species that occupy a variety of terrestrial and aquatic habitats in the study area. This group represents not only several species with important ecological niches (e.g., as predators or prey) but also those that may dramatically influence habitat for other species (e.g., beaver). Furbearers also have important implications for the Labrador economy. Although waning in recent years, trapping effort for furbearers represents one of the most important and traditional land use activities by residents.

7.4.1 Boundaries

Project boundaries for furbearers are defined by the spatial and temporal extent of project activities and zones of influence in the project area. These project boundaries will extend throughout the project construction and operation phases.

In terms of ecological boundaries, related to this VEC, some species in this group represent those that are wide ranging (home ranges extending several square kilometres) (e.g., mink, otter, fox, wolf, marten), while other species may be resident in or near a specific waterbody (e.g., beaver, muskrat) or have smaller home ranges (e.g., red squirrel, northern flying squirrel). Black bear and porcupine have been included in the furbearer VEC because of their importance to Aboriginal people and the potential sensitivity of these species to highway development. Ecological boundaries related to this VEC are defined by the distribution of furbearer populations which use the project area.

Furbearers are managed under the Newfoundland and Labrador *Wildlife Act*.

7.4.2 Methods

Specific information on furbearer densities, distribution and productivity in the study area or even Labrador in general does not exist. Some harvest information from trapping statistics can infer relative abundance and trends, although these data are influenced by effort. Although surveys for this assessment were not designed specifically for furbearers, opportunistic observations of otter and beaver activity were recorded during surveys for waterfowl and raptors along the outfitter (A13 section) route in 2003 (JW/MLP 2003a; 2003b). Scientific names of furbearers discussed in this chapter are provided in Appendix B.

7.4.3 Existing Environment

Species expected to be found in the project area include aquatic furbearers such as otter, mink, muskrat and beaver, as well as more terrestrial species such as red fox, grey wolf, Canada lynx, short-tailed weasel, red squirrel, northern flying squirrel and American marten. For further discussion on the existing environment with respect to furbearers, black bear and porcupine in Labrador, refer to Section 6.4.3 of the TLH - Phase III EIS/CSR (JW/IELP 2003a). A summary of the characteristics of furbearers in the project area is provided in Table 7.7.

Table 7.7 Characteristics of Furbearers in the Project Area

Species	Probable Habitat in the Study Area	Behaviour	Reproduction	Food Habits
Marten	mature coniferous and mixed forest, >20 percent canopy cover	diurnal/nocturnal, solitary, arboreal and terrestrial	one litter/yr, 1 to 5 young, average 3	small mammals, hares, birds, carrion, fish, insects, berries
Mink	riparian zones, wetlands	solitary and nocturnal, terrestrial	one litter/yr 2 to 10 young, average 4-5	small mammals, muskrat, amphibians, fish, birds, hares, invertebrates
River Otter	permanent waterbodies, riparian zones	nocturnal/ crepuscular, family units, aquatic and terrestrial	1 litter/yr 1to 6 young, average 2-3	fish, invertebrates, reptiles, amphibians, birds, small mammals
Least Weasel	open areas, mixed forest	nocturnal, solitary, terrestrial	2+ litter/yr 1 to 10 young	small mammals, insects
Ermine	tundra, forest	nocturnal, solitary, arboreal and terrestrial	1 litter/yr 4 to 10 young	small mammals, small birds, fish, amphibians, invertebrates
Red Fox	semi-open habitats, forest edges and clearings	diurnall/nocturnal, family units in spring/summer, solitary in fall/winter, terrestrial	1 litter/yr 1 to 10 young	small mammals, birds, berries, carrion, hares
Lynx	mature and successional forest, riparian zones in river valleys	nocturnal/ crepuscular, solitary, populations cycle with snowshoe hare, terrestrial	1 litter/yr 2 to 5 young	snowshoe hare, small mammals, birds, caribou and moose calves
Wolf	varied, depends on habitat or prey location	nocturnal/ crepuscular, gregarious in family units and packs, terrestrial	1 litter/yr 1 to 11 young, average 6 to 7	caribou, moose, beaver, birds, small mammals
Red Squirrel	mature coniferous or mixed forest	diurnal, solitary, arboreal	1 to 2 litter/yr 1 to 8 young	conifer cones, berries, fungus, eggs, mice
Northern Flying Squirrel	boreal forest	nocturnal, somewhat gregarious, arboreal	1 litter/yr 2 to 4 young	lichens, leaves, seeds, carrion, bird eggs
Beaver	slow streams, lakes and ponds in or near forested areas	nocturnal/ crepuscular, gregarious, aquatic and terrestrial	1 litter/yr 3 to 4 young	aquatic vegetation, bark, leaves, buds and stems of deciduous species
Muskrat	permanent water that does not freeze to bottom, with herbaceous and aquatic vegetation	nocturnal/ crepuscular, solitary or family units, aquatic and terrestrial	2 to 3 litters/yr 3 to 9 young	aquatic vegetation, fish, clams, mussels
Black Bear	mosiac of forested and non-forest habitats	diurnal, solitary, terrestrial	1 to 4 young every 2 years	omnivorous, mainly vegetation, insects, fish, carrion, caribou calves

Species	Probable Habitat in the Study Area	Behaviour	Reproduction	Food Habits
Porcupine	deciduous/coniferous forest	nocturnal/ crepuscular, solitary, arboreal and terrestrial	1 litter/yr one young	leaves, seedlings, grass, cambium layer and inner bark of trees (aspen, birch, spruce, balsam fir, tamarack)
Wolverine	forest, Arctic and alpine tundra	nocturnal, solitary, terrestrial	1 litter/yr 2 to 3 young	birds, small mammals, hares, carrion
Source: adapted from DND 1994c.				

Wolverine are currently listed as endangered by COSEWIC; however, there have been no confirmed records of wolverine in Labrador since the 1950s. Knox (1994) summarized recent (since 1935) sightings of animals or tracks. No observations have been made in the vicinity of the outfitter (A13 section) route.

Observations of beaver lodges and dams, otter tracks, and any encountered furbearers were recorded during aerial surveys conducted for raptors and waterfowl along the outfitter (A13 section) route from May through August 2003. Beaver activity was concentrated in two general areas, east of Salmon River and south of Otter Brook (Figure 7.16). A total of 86 lodges were recorded along the outfitter route. Lodges were usually observed in smaller waterbodies and streams with hardwood (i.e., aspen or birch). Where otter tracks were seen in early spring surveys, it was generally where openings in the ice allowed access to the water. One observation of otter was made southwest of Otter Brook during a survey for waterfowl (Figure 7.17).

One set of marten tracks was observed south of Crooks Lake (Figure 7.17). This single observation would not be representative of marten activity in the region, as tracks of this species are difficult to see in forested areas where marten are generally found. Two observations were made of a muskrat swimming, both south of Otter Brook (Figure 7.17). As the observations were quite close together and seen on different surveys, it is possible that the two observations were of the same animal. Several observations of porcupine were made, some on open wetland or bog areas during the spring surveys (Figure 7.17), apparently feeding on new growth in these areas. Two black bear observations were made, both approximately 5 km north of the outfitter route (Figure 7.17) and observations of individual blacks bears were also made, several in the Paradise River area (Figure 7.17).

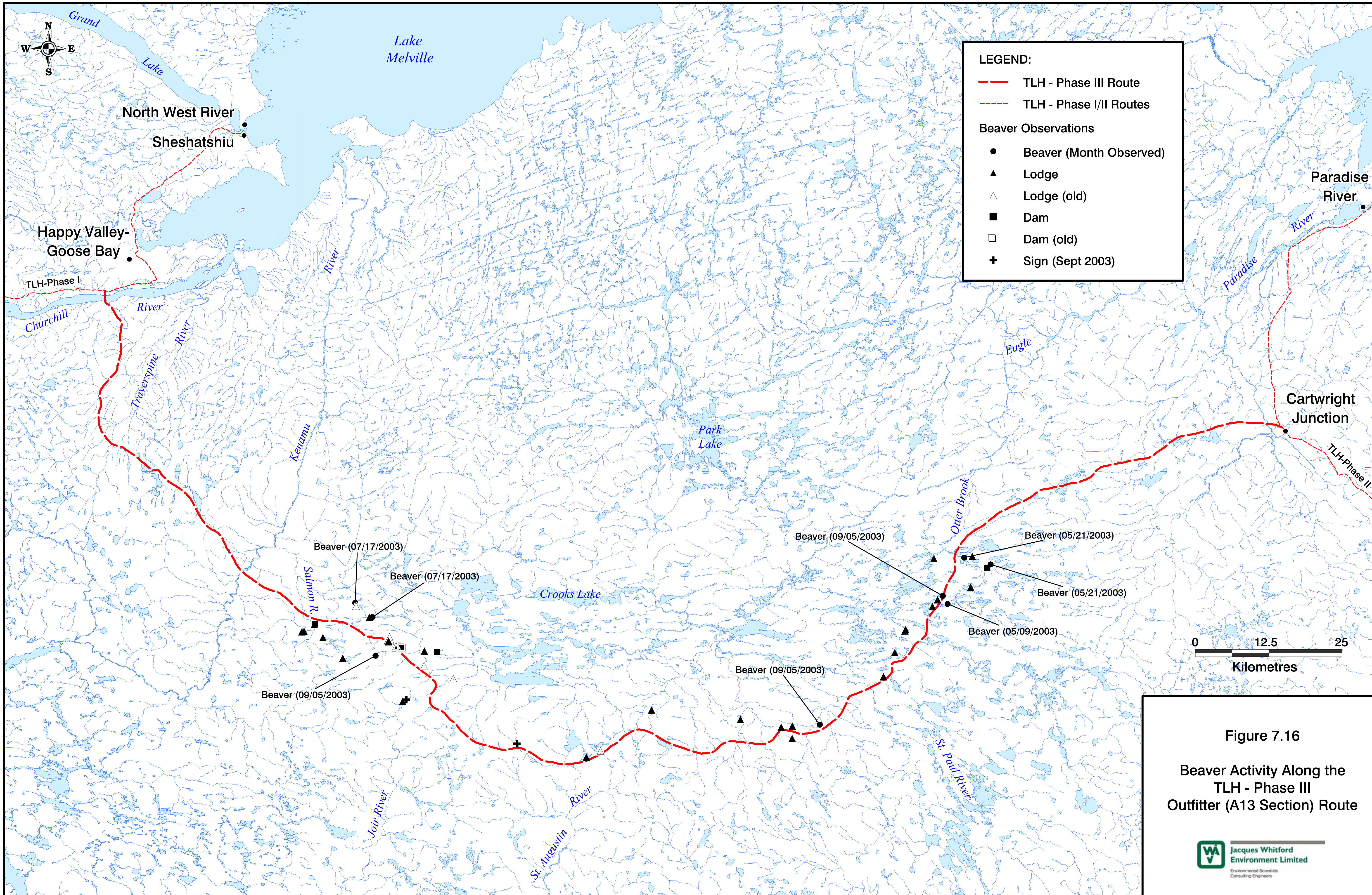

Figure 7.16

Beaver Activity Along the TLH - Phase III Outfitter (A13 Section) Route

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Figure 7.17

Activity of Furbearers, Black Bear and Porcupine Along the TLH - Phase III

7.4.4 Potential Interactions

With such a variety of species within the furbearer group, there are a number of sensitivities and reactions that may potentially occur as a result of the proposed project. In some cases, species within this group may be attracted to, for example, a clearing, whereas others would be displaced.

Construction activities (noise, equipment use and human presence) may cause furbearers to temporarily avoid some areas. In addition to disturbance from noise and human presence, construction may also alter or remove habitat for furbearers, particularly if it occurs in the riparian zone along watercourses and standing waterbodies or in forested areas.

During operation, noise and regular vehicular activity may also cause disturbance, resulting in avoidance of habitat in the vicinity of the highway. Increased harvesting of furbearers may occur as a result of improved access.

An accidental event such as a forest fire could cause furbearers to avoid areas previously inhabited or result in lost foraging opportunities. Spills of fuel or other hazardous materials could result in the contamination of waterbodies, leading to reduced foraging opportunities for species such as otter and mink. Collisions with vehicles may result in mortality for a variety of furbearers.

7.4.5 Issues and Concerns

Issues and concerns related to furbearers include:

- habitat loss through removal of vegetation during construction;
- habitat avoidance of human disturbance and noise during construction and operation;
- increased harvesting of furbearers as result of improved access;
- loss of habitat as a result of an accidental event such as a forest fire; and
- mortality as a result of collisions with vehicles or accidental spills of fuel or other hazardous materials.

7.4.6 Existing Knowledge

In general, the effects of development and human disturbance on furbearers are difficult to study due to low or fluctuating population numbers and wide-ranging movements of species in this group (Sopuck et al. 1979). Studies have shown that furbearers such as otter will exhibit a negative response to disturbance but will become habituated to that disturbance. Similarly, marten are known to be attracted to areas of human activity. Other furbearers may be attracted to roads because of the availability of prey; however, the benefits realized by ease of travel and increased prey may be offset by the increased risk of direct mortality through road kills or indirect mortality through harvesting in areas more easily accessible to humans. In contrast, some species of furbearers such as wolves and lynx tend to be more sensitive to human disturbance.

Removal of habitat may affect furbearers if the removal occurs in the core area of a home range (Bissonnette et al. 1988), such as for marten, or if the species has a small home range, such as red squirrel. Most sources of indirect mortality for furbearers are related to increased human access. Populations subjected to hunting or trapping will likely sustain increased mortalities as a result improved access (Peterson et al. 1984; Melquist and Hornocker 1986; Weaver et al. 1996).

Refer to Section 6.4.6 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for a detailed discussion on existing knowledge related to the environmental effects of highways on furbearers.

7.4.7 Mitigation

WST has attempted to reduce the project's potential effects on furbearers through project design and planning. Specific mitigative measures include the following:

- minimization of vegetation removal to 30 m within the right-of-way;
- pre-construction surveys for active beaver ponds and maintenance of a 30-m buffer zone around active beaver ponds, where possible;
- reduction or avoidance of in-stream activity;
- erosion control measures;
- drainage to and through wetlands will be maintained to prevent loss of water supply to downslope areas;
- no harassment or feeding of furbearers by project personnel during construction;
- all construction personnel will be required to follow all applicable legislation for hunting and trapping, and using and storing firearms;
- proper storage and disposal of construction camp garbage and refuse to avoid attracting wildlife;
- all vehicles yield to wildlife; and
- design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.

7.4.8 Environmental Effects Assessment

7.4.8.1 Construction

The environmental effects of construction of the proposed highway on furbearer populations will be similar for both the preferred route and the outfitter route. These effects include disturbance from human activity and noise and loss of habitat from vegetation clearing. The amount of forest vegetation that will be removed as a result of highway construction along the outfitter (A13 section) route is approximately 274 ha (includes spruce/fir forest, spruce/lichen forest and hardwood scrub).

Refer to Section 6.4.8.1 in the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion of the environmental effects of highway construction on furbearers.

7.4.8.2 Operation

The environmental effects of highway operation on furbearer populations will be similar for both the preferred route and the outfitter route. Similar to construction, noise disturbance from traffic may cause furbearers to avoid habitat adjacent to the highway. The most likely operational effect on furbearers in the area will be increased trapping as a result of improved access from the highway. While harvesting levels are not likely to reach that seen in past decades, there will probably be more trapping in the area following the opening of the highway, followed by a leveling off of effort. However, the trapping activity will still be greater than if the highway was not present. A total of 86 beaver lodges were identified in the region surrounding the outfitter route. In comparison, 105 lodges were recorded along the preferred route. These totals include lodges in good repair as well as those that are old and not apparently active.

Refer to Section 6.4.8.2 in the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion of the environmental effects of highway operation on furbearers.

7.4.8.3 Accidental and/or Unplanned Events

The environmental effects of accidental or unplanned events on furbearer populations will be similar for both the preferred route and the outfitter route. Some mortality may result from collisions with vehicles; however, with the low traffic volume expected on the highway and the generally low densities of furbearers in the area, the number of vehicle collisions is expected to be low and will have no measurable effect on furbearer populations in the area.

Forest fire would destroy forested habitat, initially representing an adverse event for furbearers such as marten, lynx and red squirrel. However, once successional vegetation becomes established, foraging opportunities for marten, lynx, fox and wolf would increase as the area becomes colonized by small mammals.

Refer to Section 6.4.8.3 in the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion of the environmental effects of accidental events on furbearers.

7.4.9 Environmental Effects Evaluation

The key potential interactions between project activities and furbearers include direct disturbance, habitat loss and increased trapping. The following definitions are used to rate the significance of the predicted residual environmental effects of the project on furbearers.

A **major (significant) environmental effect** to furbearers is one affecting a population of a species of furbearer in such a way as to cause a change in abundance and/or distribution beyond which natural recruitment (reproduction and in migration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its former level within several generations. The effect is not reversible.

A **moderate (significant) environmental effect** to furbearers is one affecting a portion of a population of a species of furbearer in such a way as to cause a change in the abundance and/or distribution of that portion of the population or any populations of species dependent upon it over one or more generations, but does not change the integrity of any population as a whole. The effect may not be reversible.

A **minor (not significant) environmental effect** to furbearers is one affecting a specific group of individuals of a species of furbearer in such a way as to cause a change in abundance and/or distribution in a localised area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself. The effect is reversible.

A **negligible (not significant) environmental effect** to furbearers is one affecting a specific group of individuals of a species of furbearers in such a way as to cause a change in abundance and/or distribution in a localised area and/or over a short period (one generation or less) in a manner similar to small random changes in the population due to natural irregularities, but having no measurable effect on the population as a whole. The effect is reversible.

The proposed highway is a linear development that will have relatively low volumes of traffic. For furbearers, the environmental effects of greatest consequence will be removal of habitat in the immediate highway corridor and the indirect effect of improved access to areas along the highway. Based on the preceding discussion and proposed mitigations, the residual effects of the project on furbearers are assessed as minor (not significant) for construction due to the availability of alternative habitat that will not be disturbed by highway construction and the low density of these species. The residual effects of highway operation are assessed as moderate (significant) due to the potential for increased trapping pressure in localized areas and the potential for induced activities such as forest harvesting to remove large areas of forested habitat in the vicinity of the proposed highway (Table 7.8). An accidental forest fire may remove large areas of habitat for forest-dependent furbearers such as marten and lynx. Therefore, the residual effects of an accidental event on furbearers is considered moderate (significant) (Table 7.8). Overall, the project is not likely to result in significant adverse environmental effects on furbearer populations as a whole.

7.4.10 Cumulative Environmental Effects

The cumulative effects related to the interaction of existing activities and potential future activities with the proposed highway will be the same regardless of whether the highway follows the preferred route or the outfitter route. However, if the highway follows the outfitter (A13 section) routing, it is unlikely that the road will be within the boundaries of the proposed Mealy Mountain National Park. Therefore, resources that may have fallen within the boundary of the National Park will not be protected from future development or exploitation.

If resource management agencies do not have the resources to effectively manage trapping activities (including enforcement of trapping regulations and research to understand population dynamics of various species), the cumulative effects on furbearer populations from increased access would be minor (not significant) as long as trapping and other induced activities are limited to areas near the road. If there is uncontrolled accessibility from the highway by ATV and snowmobile and along resource extraction roads (from forest harvesting), depletions of furbearers populations may occur. Similarly, if inadequate planning or management of activities such as forest harvesting occurs, populations of terrestrial furbearers such as fox, marten, lynx, and red squirrel may decline if large areas of forested habitat are removed without any consideration of habitat requirements for furbearer species. If there is uncontrolled access and trapping, a moderate (significant) cumulative effect resulting from this activity (i.e., one affecting a portion of a population in such a way as to cause a change in the abundance and/or distribution of that portion of the population or any populations or species dependent upon it over one or more generations, but does not change the integrity of any population as a whole) may result. Resident species such as beaver or those particularly vulnerable to trapping, such as marten, may be particularly affected. It should be kept in mind that levels of trapping activity would tend to be influenced more by prices and abundance of furbearers, than purely by improved access.

Table 7.8 Environmental Effects Summary - Furbearers

	Construction	Operation	Accidental/Unplanned Events
Mitigation: • minimization of vegetation removal to 30 m within the right-of-way; • pre-construction surveys for active beaver ponds and maintenance of a 30-m buffer zone around active beaver ponds, where possible; • reduction or avoidance of in-stream activity; • erosion control measures; • drainage to and through wetlands will be maintained to prevent loss of water supply to downslope areas; • no harassment or feeding of furbearers by project personnel during construction; • all construction personnel will be required to follow all applicable legislation for hunting and trapping, and using and storing firearms; • proper storage and disposal of construction camp garbage and refuse to avoid attracting wildlife; • all vehicles yield to wildlife; and • design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.			
Environmental Effects Criteria Ratings			
Magnitude	Low	Low	Unknown
Geographic Extent	<1 km^2	1 to 10 km^2	100 km^2
Frequency	Continuous	Continuous	<10
Duration	72	>72	>72
Reversibility	Reversible	Reversible	Unknown
Ecological/Socio-economic Context	Nil/May be affected by resource use and users.		
Environmental Effects Evaluation			
Significance	Not Significant (Minor)	Significant (Moderate)	Significant (Moderate)
Level of Confidence	High	High	High
Likelihood[1]	n/a	n/a	Low
Sustainable Use of Resources[1]	n/a	n/a	n/a
[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).			
Environmental Monitoring and Follow-up: • Identification of active beaver ponds within 100 m of construction site where topography allows, a 30-m buffer of vegetation will be maintained around such ponds. • Monitor area for furbearers and curtail construction activities appropriate (e.g., blasting). • Environmental awareness sessions will make them ore aware of furbearers and what can be done to minimizing effect. • Will consult with Inland Fish and Wildlife staff as appropriate.			
Key: Magnitude: High, Medium, Low, Nil or Unknown Geographic Extent (km^2): <1, 1-10, 11-100, 101-1,000, 1,001-10,000, >10,000 or Unknown Frequency (events/year): <10, 11-50, 51-100, 101-200, >200, Continuous or Unknown Duration (months): <1, 1-12, 13-36, 37-72, >72 or Unknown Reversibility: Reversible, Irreversible or Unknown Context: Existing Disturbance (High, Medium, Low, Nil or Unknown) Significance: Significant, Not Significant, Positive or Unknown Level of Confidence: High, Medium, Low Likelihood: High, Medium, Low or Unknown Sustainable Use of Resources: High, Medium, Low or Unknown			

The various resource management agencies should consider a cooperative management or regional land use planning approach to managing the land and resources along the highway and surrounding area. In addition, the departments and agencies responsible for managing wildlife resources may need to review existing management policies and programs to ensure that they are appropriate. There may also be a need for agencies to increase their enforcement staff levels.

For a detailed discussion on cumulative environmental effects, refer to Section 6.4.10 of the TLH - Phase III EIS/CSR (JW/IELP 2003a).

7.4.11 Environmental Monitoring and Follow-up

During annual pre-construction surveys for active raptor nests, WST will also identify any active beaver ponds (defined by the presence of a beaver lodge in good repair with recent cuttings) that may be affected by vegetation removal as a result of highway construction. Where topography allows, a 30-m buffer of vegetation will be maintained around such ponds.

Construction areas will also be monitored for the presence of furbearers and construction activities such as blasting will be curtailed as appropriate. WST will consult with Inland Fish and Wildlife Division staff as appropriate and all project personnel will be briefed during environmental awareness sessions on minimizing construction effects to furbearers.

7.5 Fish and Fish Habitat

As many as 20 species of fish are present in the numerous lakes, ponds, rivers and streams of the region; however, only half that many, or less, are common. These waterbodies comprise fish habitat, which for the purpose of this assessment includes the water quality, sediment quality and all of the aquatic flora and fauna that are present in the region's fish-bearing waters. Fish and fish habitat form complex food webs that sustain themselves and interconnect with other ecological components, including predators, prey and grazers. Freshwater fish have played an important role in the subsistence, recreation and economy of Labrador.

7.5.1 Boundaries

The outfitter route alternative for TLH - Phase III will cross through six major watersheds in Southern Labrador, and touch one other. Boundaries for freshwater fish and fish habitat are discussed in terms of project boundaries, ecological boundaries, and administrative boundaries.

The project boundary is the 40 m wide right-of-way at the proposed stream crossing locations (Figure 7.18). Temporal project boundaries are seasonal for construction and year-round for operation.

The ecological boundaries for the freshwater fish and fish habitat consider spatial and temporal boundaries. The highway will cross six large watersheds in Southern Labrador, which have diverse fish communities. The highway (i.e., footprint) crosses a very small portion of each watershed. None of the fish species in the region are known to be restricted to a small area either inside or outside of the survey area, so these are Population Type 3 (i.e., species that have a widespread distribution pattern and very small proportion of their population confined at any one time within a given zone of influence). The population of all species extends well beyond the study area as the ecological boundary. Temporal boundaries are year-round for brook trout, other resident species, and pre-smolt stages of anadromous species (Atlantic salmon, Arctic charr and sea-run brook trout). Otherwise, the adults of anadromous species are seasonally present in the study area.

The regulatory boundaries fall under provincial and federal jurisdictions. As in other areas of Newfoundland and Labrador, freshwater aquatic resources are regulated by several provincial and federal departments. The *Fisheries Act* is the primary federal legislation governing protection and management of fish and fish habitat in both marine and freshwater environments. DFO has jurisdiction for fisheries and fish habitat protection in the province. DFO recreational and commercial regulations are in effect. There are two scheduled salmon rivers along the length of the outfitter route, the Eagle River and Paradise River. Specific regulations pertain to these rivers. Environment Canada has responsibility for Section 36 of the *Fisheries Act*, which regulates the release of deleterious substances (DFO is responsible for sedimentation issues). The NWPA is enforced by the Canadian Coast Guard of DFO. The creation of a federal park in the Mealy Mountains area will bring some of that area under the jurisdiction of Parks Canada, which may then place recreational fishing under the control of Parks Canada. Finally, settlement of land claims with Innu Nation may place portions of the study area under some form of aboriginal regulatory authority.

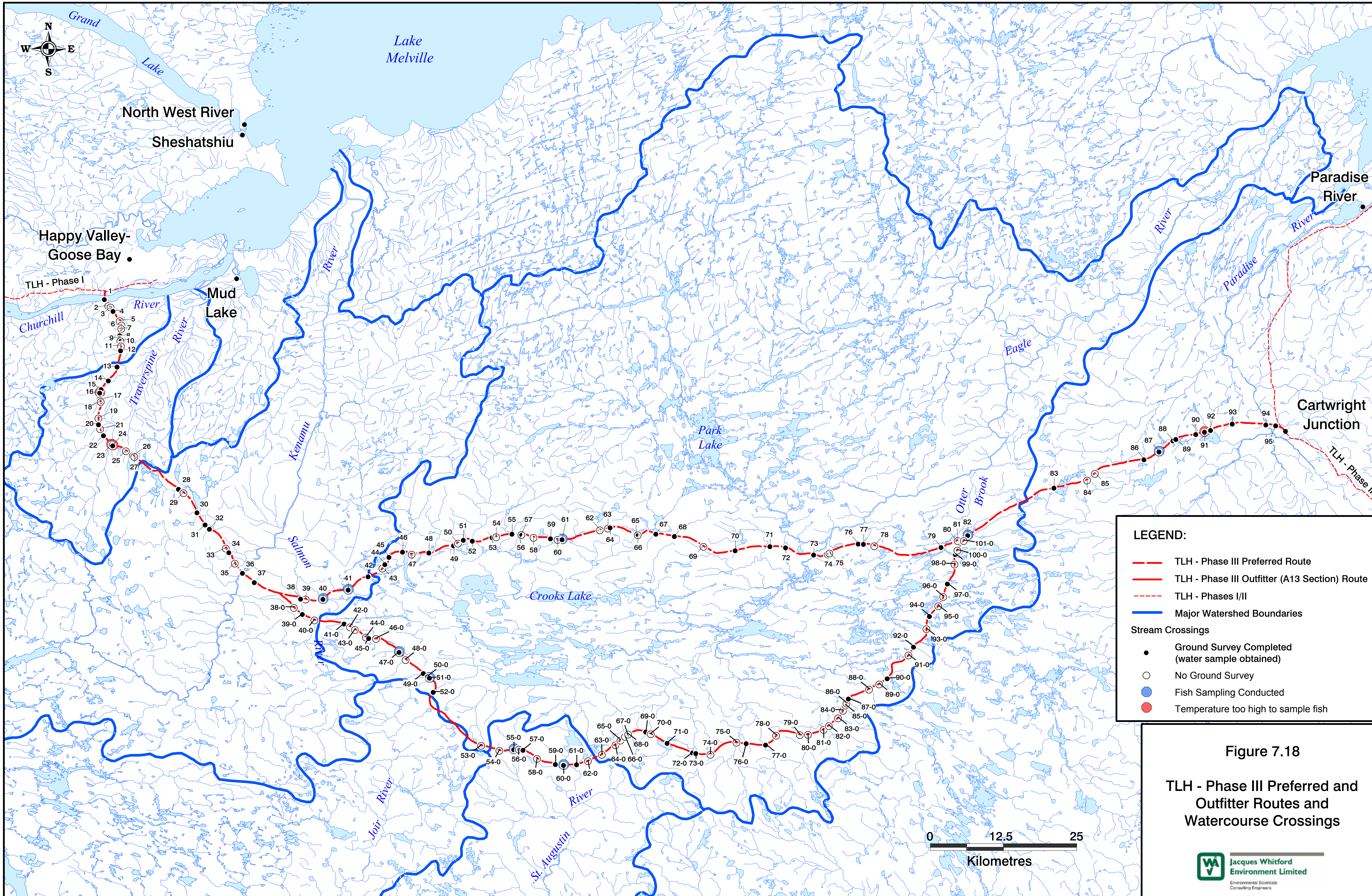

Figure 7.18

TLH - Phase III Preferred and Outfitter Routes and Watercourse Crossings

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The Water Resources Division of the DOE has jurisdiction over water quality and water quantity in the watersheds pursuant to the *Waters Resources Act* (2002), which regulates development within 15 m of a waterbody and which has provisions to regulate development within wetlands and flood plains. Regulations under the *Water Resources Act* include the *Environment Control Water and Sewage Regulation*, which regulate discharges to a body of water. Further discussion on the effects of the proposed highway on water resources is provided in Section 7.8.

7.5.2 Methods

A preliminary review of the existing literature included Scott and Crossman (1973), Anderson (1985), Black et al. (1986), Scruton et al. (1997), and Harrington (1998), along with reports generated by DFO (e.g., DFO 1997; 2002; Reddin et al. 2000; 2001). Other information included 1:50,000 topographical maps, aerial photographs and information provided by WST from their route selection and preliminary design phases. Based on the information provided by WST, 64 watercourse crossings were identified for habitat assessment (Figure 7.18).

The scope of the fish and fish habitat section is based on the EIS guidelines (Appendix A) and the comments provided in the deficiency statement provided to WST April 2003. Fish habitat surveys were conducted at all of the watercourse crossing locations along the A13 section of the outfitter route in 2003; the remainder of the route was surveyed in 2002 for the original EIS/CSR (JW/IELP 2003a). On-ground investigations conducted on the A13 section in 2003 are described in the Fish Habitat Component Study Addendum (JW/MLP 2003c); ground surveys in 2002 are described in the previous Fish Habitat Component Study (JW/IELP 2003b). The combined information is summarized in this section.

A Fish and Fish Habitat Component Study Addendum (JW/MLP 2003c) was conducted in July 2003 to gather fish habitat, fish and water quality information on the proposed stream crossing locations of the A13 section of the outfitter route. However, because actual engineering surveys have not been completed, detailed design information is not available and precise watercourse crossings sites have not been confirmed. WST provided information on water conveyance structures, which are the minimum required, based on hydrologic modelling of the upstream basins. These structures are listed in the project description (Chapter 3.0). Final design will only be completed when the route is surveyed.

Electrofishing surveys were conducted at selected stream crossings within the Paradise River, Eagle River, St. Augustin River, Kenamu River, and Traverspine River watersheds. These surveys were conducted using the index electrofishing methods described by Sooley et al. (1998). All electrofishing was conducted in accordance with conditions set out in an experimental licence issued by DFO specifically for this study.

The surveys were completed on selected representative secondary and tertiary streams in each watershed. Surveyed areas were located within 250 m upstream and 250 m downstream of the proposed stream crossing as outlined in the fish habitat survey section. Sampling was conducted for 500 seconds of electrofishing effort or over an area of approximately two units (200 m^2). As a condition of the Experimental Licence, electrofishing could only be conducted if water temperatures were below 18°C. On many occasions, the water temperatures were above this limit and electrofishing was not conducted (Figure 7.18).

Other information and effects assessments related to fish habitat and fish will be found in the following sections:

- geomorphology is described in Section 7.7;
- wetlands are discussed in Section 7.9;
- riparian vegetation is described in Section 7.10; and
- recreational and subsistence fish harvesting are described in Section 7.12.

7.5.3 Existing Environment

There is limited historical information and habitat surveys available on watersheds in Southern Labrador. The outfitter route for the highway is remote from any communities, except at the Happy Valley-Goose Bay end, and is remote from the coastlines and the shore of Hamilton Inlet/Lake Melville.

The outfitter route will cross watercourses ranging from small, possibly intermittent, brooks to large rivers, including the Paradise River and Churchill River (Figure 7.18). Watersheds in this area are described in Table 7.9 with regard to barriers to fish migration and the fish species present.

Table 7.9 General Information on Watersheds Crossed by the Outfitter Route

Watershed	Barriers to Fish Migration	Fish Species Present
Main Route		
Churchill River	Muskrat Falls is a complete barrier under most conditions (40 km).	Atlantic salmon, brook trout, threespine stickleback, burbot, lake trout, Arctic charr, lake whitefish, round whitefish, white sucker, longnose sucker, rainbow smelt, Atlantic sturgeon, American eel, ninespine stickleback, northern pike, lake chub, mottled sculpin, slimy sculpin, pearl dace, longnose dace.
Traverspine River	Approximately 20 percent of watershed area is unaccessible. Partial obstructions have been identified at several locations.	Atlantic salmon, brook trout, burbot, rainbow smelt.
Kenamu River	All of the river is generally accessible.	Atlantic salmon, brook trout, threespine stickleback, lake whitefish, round whitefish, white sucker, rainbow smelt, longnose sucker.
Eagle River	Two relatively small tributary areas are not accessible due to barriers.	Atlantic salmon, brook trout, white sucker, longnose sucker, northern pike.
St. Augustin River	Several barriers present in lower reaches.	Atlantic salmon, brook trout, longnose sucker, white sucker, northern pike.
Paradise River	Two partial barriers on tributaries that connect 20 km and 40 km from mouth.	Atlantic salmon, brook trout, threespine stickleback, white sucker, American eel, ninespine stickleback, American smelt.

Note: Only complete barriers to fish migration are included and are reported as the distance in kilometres from the mouth of the river or tributary in question. For information on the extent and location of partial barriers to migrating fish, refer to Anderson (1985).
Source: Anderson 1985; Black et al. 1986; Dubois 1996; Lockerbie 1987; G. Bird (pers. comm.)

Twenty species of freshwater fish have been listed as present in the combined watersheds that would be crossed by the outfitter route. Most of these are found in the Churchill River system, while the other watersheds have half that many or less. Harrington (1998) reported 15 species in the Mealy Mountains region, of which only 10 are relatively common. The recreational fishery is focussed mainly on Atlantic salmon and brook trout. Reference has been made in the deficiency statement to long-lived, slow growing trophy brook trout, but these are more likely fast-growing brook trout that have achieved larger size as a result of feeding ecology.

Atlantic salmon have anadromous runs in all of the rivers in the study area, but their range may not extend to the watercourse crossing locations. Sea-run salmon do make it to some of the proposed crossings of the Churchill River, Kenamu River, Eagle River and Paradise River. Anadromous salmon in St. Augustin River range only approximately 80 km from the mouth (Dubois 1996), whereas the crossing locations are more than twice that far from the Gulf of St. Lawrence. Much of the road route is located in the upper headwaters of the Traverspine, Kenamu and Eagle rivers, and brook trout are more numerous than salmon in these areas (Harrington 1998).

Besides anadromous Atlantic salmon and brook trout, the Churchill River also has anadromous Arctic charr in the lower reaches. These species all use stream habitat for spawning and rearing, and stream migration is an important aspect in the lifestyle of anadromous species (Scruton et al. 2000). Lake whitefish, round whitefish and lake trout are predominantly lake-dwelling salmonids that occur in some of the watersheds. The habitat preferences of these species are summarized by Bradbury et al. (1999).

Non-salmonid species found in some of the watersheds include northern pike, longnose sucker, white sucker, burbot, rainbow smelt, forage fish such as threespine and ninespine stickleback and the catadromous American eel.

Paradise River and Eagle River are scheduled salmon rivers crossed by the outfitter route and catch statistics for Eagle River are summarized in Section 7.12.

7.5.3.1 Fish Habitat

The field surveys were identical to those conducted for the preferred route of the TLH - Phase III in 2002 (i.e., aerial surveys by helicopter followed by ground surveys at selected sites) (JW/IELP 2003b).

An aerial survey of the watercourse crossings on the outfitter route (A13 section) was conducted from July 13 to 15, 2003, followed by ground surveys from July 16-21. The survey collected field information at three levels of detail:

- assembling the compiled information provided by WST and any other desk-top sources such as topographic mapping;
- videotaping and photographic recording of the stream for 250 m each upstream and downstream of proposed crossing location; and
- detailing aerial and (in many cases) on-ground surveys of the stream section at the crossing location.

Habitat characterization was completed at each watercourse crossing site, using methods described by Sooley et al. (1998), using methods that were modified from Sooley et al. (1998), and methods modified from the assessment of TLH - Phase II, including:

- depth (estimated as 0 to 1 m, 1 to 2 m, greater than 2 m or unknown);

- channel width (i.e., wetted width estimated as 0 to 2 m, 2 to 5 m, 5 to 20 m, or greater than 20 m);
- flow type (steady, riffle, rapids, pools - see Table 7.10);
- substrate composition (fines/gravel, cobble, boulder or bedrock - see Table 7.11);
- bank material (fines/gravel, cobble, boulder or bedrock - see Table 7.11);
- backslope (shallow, medium or deep gully, forest stream, flood plain, bog/fen - see Table 7.12);
- Beak salmonid habitat type (see Table 7.13);
- bank vegetation (bog, grasses, shrubs, or trees);
- cover (instream, overhang, canopy);
- presence/absence of potential obstructions (falls, rapids, chute and cascade); and
- gradient (estimated as (0 to 1 percent, 1 to 3 percent, 3 to 5 percent or 7 percent)).

Table 7.10 General Stream Flow (Habitat) Types

Stream Flow	Definition
Run	Swiftly flowing water with some surface agitation but no major flow obstructions, coarser substrate (gravel, cobble, and boulders).
Riffle[1]	Shallower section with swiftly flowing, turbulent water with some partially exposed substrate (usually cobble or gravel-dominated).
Pocketwater	Turbulence increased greatly by numerous emergent boulders, which create eddies or scour holes (pockets) behind the obstructions.
Flat (or steady)[1]	Water surface is smooth and substrate is made up of organic matter, sand, mud, and fine gravel. This habitat differs from a pool due to the length, associated with low gradient. This habitat type generally has a flat bottom.
Pool [1]	Deeper area comprising full or partial width of stream, due to the depth or width flow velocity is reduced. Pool has rounded surface on bottom.
Cascade (rapids)[1]	Areas of steeper gradient with irregular and rapid flows, often with turbulent white water. Rapids are primarily associated with larger stream sections and rivers. In larger rivers, it is recommended that the survey crew not attempt to conduct cross sections in these types of habitat.
Glide	Wide, shallow pool flowing smoothly and gently, with low to moderate velocities and little or no surface turbulence. Substrate usually consists of cobble, gravel and sand.

[1] Flows characterized during the aerial survey were described by these four types.
Source: Sooley et al. 1998.

Table 7.11 Classification of Substrate

Substrate	Description
Bedrock (Br)	Continuous solid rock exposed by the scouring forces of the river/stream.
Boulder (Bo)	Boulder sized rocks from 25 cm to greater than 1 m in diameter.
Small Boulder	Boulder sized rocks from 25 cm to 1 m diameter.
Rubble (R)	Large rocks from 14 to 25 cm in diameter.
Cobble (C)	Moderate to small sized rocks from 3 to 13 cm in diameter.
Gravel(G)	Small stones from 2 mm to 3 cm in diameter.
Fines (F)	Sand and smaller sized material on margins of streams or between rocks and stones, up to 2 mm in diameter.

Source: Bradbury et al. 2001.

Table 7.12 Riparian Backslope

Backslope	Description
Shallow Gully	Up to 1 m deep. Gullies are typically well-defined, steep-sided channels which contain sporadic flooding but may suffer bank erosion depending on bank material.
Medium Gully	2 to 3 m deep.
Deep Gully	3 to 4 m deep.
Forest Stream	Has low to medium gradient and a well-defined channel with some spilling over the banks - erosion may occur due to reduced stability of forest soils.
Flood Plain	Is a wide, shallow course with narrow channel(s) in middle - flooding occurs onto grasses with little lasting effect.
Bog/Fen	With few permanent narrow cut channels and auxiliary intermittent channels - periodic flooding causes no lasting effect.
Source: Bradbury et al. 2001.	

Table 7.13 Beak Salmonid Habitat Classification Types

Type	Definition
I	Good salmonid spawning and rearing habitat; often with some feeding pools for larger age classes: **flows:** moderate riffles; **current:** 0.1 to 0.3 m/s; **depth:** relatively shallow, 0.3 to 1 m; **substrate:** gravel to small cobble size rock, some larger rocks or boulders; and **general habitat types:** primarily riffle, pool.
II	Good salmonid rearing habitat with limited spawning, usually only in isolated gravel pockets, good feeding and holding areas for larger fish in deeper pools, pockets or backwater eddies: **flows:** heavier riffles to light rapids; **current:** 0.3 to 1 m/s; **depth:** variable from 0.3 to 1.5 m; **substrate:** larger cobble/rubble size rock to boulders and bedrock, some gravel pockets between larger rocks; and **general habitat types:** run, riffle, pocketwater, pool.
III	Poor rearing habitat with no spawning capabilities, used for migratory purposes: **flows:** very fast, turbulent, heavy rapids, chutes, small waterfalls, **current:** 1 m/s or greater; **depth:** variable, 0.3 to 1.5 m; **substrate:** large rock and boulders, bedrock; and **general habitat types:** run, pocketwater, cascades.
IV	Poor juvenile salmonid rearing habitat with no spawning capability, provides shelter and feeding habitat for larger, older salmonid (especially brook trout): **flows:** sluggish; **current:** 0.15 m/s; **depth:** variable but often 1 m; **substrate:** soft sediment or sand, occasionally large boulders or bedrock, aquatic macrophytes present in many locations; and **general habitat types:** flat, pool, glide.
Source: Sooley et al. 1998.	

All data were recorded on standardized field data sheets. Photographs were taken to augment the videotape record and ground surveys. A detailed aerial assessment was not possible on all watercourse crossings due to the small size of some streams and visual obstruction created by thick tree canopy.

The scope of work for the field study included on-ground surveys for selected crossing locations. The selected locations included all crossings that could safely be accessed and which had an upstream basin area greater than 2 km^2, and Beak Type I and II habitat.

The ground surveys included detailed measurements of the section where the crossing is proposed and other sampling that included a sample for water quality determination, stream flow velocity, stream gradient and any observations of fish. This information, along with details of the stream habitat and riparian habitat, were all recorded on the field data sheets. Fish sampling was also conducted during these ground surveys.

7.5.3.2 Description of Watersheds

The results of the aerial and ground surveys of watercourse crossings conducted by JW in each watershed are described in the following sections. The stream crossings of the outfitter route were surveyed in 2002 and 2003 (the A13 section in 2003). Information is tabled by river basin, listing the crossing number, stream order, upstream basin drainage area, ponds and lakes upstream and downstream of the crossing site, and a notation on whether a ground survey was required or completed.

Churchill River

The Churchill River is the largest river in Labrador; its 93,415 km^2 watershed extends from the far western border of Labrador to Lake Melville. However, the proposed highway crosses the river 23 km from the mouth; therefore, direct effects on fish habitat are limited to the river sections within this distance from the mouth. Potential effects to fish would include disruption of migrations; however, migrations on the river are limited to the areas below Muskrat Falls, located 40 km from the mouth. Very little of the watershed falls under the potential influence of the project. There are several minor tributaries that are crossed by the route progressing south of the main stem of the river. Seven of eleven watercourse crossings have limited upstream basins (less than 2 km^2), and they are all small streams in width. Six of eleven watercourse crossings are in potentially productive (Type II) habitat (Table 7.14). The Churchill River crossing site was conservatively classed as Type II habitat by JW/IELP (2003b), but on review, and with additional information, it has been revised to Type IV habitat. No ground survey was conducted in 2002, but since then, geotechnical investigations have been completed at the crossing site, which confirm the Type IV characterization.

Table 7.14 Summary Information of Crossings on the Churchill River and Minor Tributaries

			Upstream		Downstream		
Stream Crossing	Stream Order	Watershed Area (km²)	Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	Comment
1	3+	90,000+					Churchill River no ground survey (Type IV)
2	1	0.5	N	-	M	1	no ground survey (<2 km²)
3	1	1	N	-	M	1.5	no ground survey (<2 km²)
4	2	2.6	N	-	M	4.5	not safely accessible
5	1	0.6	N	-	M	5	no ground survey (<2 km²)
6	1	0.5	N	-	M	7	no ground survey (<2 km²)
7	1	0.6	N	-	M	8	no ground survey (<2 km²)
8	2	4	H	2.3	M	15	ground survey completed
9	3	3.7	H	4	M	15	ground survey completed
10	2	1.8	N	-	M	15	no ground survey (<2 km²)
11	1	0.7	N	-	M	15	no ground survey (<2 km²)
12	2	4.7	N	-	M	15	not safely accessible

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (L), or none (N).
Downstream of crossings have lake (L), steady (S), large tributary (T), or the main stem of the river (M).

At many of the small tributary crossing sites, heavy forest presents a canopy that obscures most of the stream crossing locations, thus limiting the ability to closely characterize the stream sections and associated habitat. Two of four ground surveys were completed, while forest cover prevented access by helicopter to the other two sites.

Traverspine River

The Traverspine River is a tributary to Churchill River, extending 50 km to the south. The proposed route roughly bisects the Traverspine watershed in a southeasterly orientation. Fifteen watercourse crossings in this basin are mostly small streams of less than 5 m width and less than 2 km² upstream areas (Table 7.15).

Table 7.15 Summary Information of Crossings on the Traverspine River and Tributaries

Stream Crossing	Stream Order	Watershed Area (km²)	Upstream		Downstream		
			Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	Comment
13	1	2.4	N	-	M	3	ground survey completed
14	1	3.1	N	-	M	4.5	not safely accessible
15	3	26.5	L	3	M	6	not safely accessible
16	3	56.8	L	6.5	M	6.5	ground survey completed
17	1	1.15	N	-	M	7.5	no ground survey (<2 km²)
18	1	0.5	N	-	M	7.8	no ground survey (<2 km²)
19	2	1.7	N	-	M	3	no ground survey (<2 km²)
20	2	2.1	N	-	M	2.5	not safely accessible
21	1	0.7	N	-	M	2.5	no ground survey (<2 km²)

Stream Crossing	Stream Order	Watershed Area (km^2)	Upstream		Downstream		Comment
			Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	
22	3+	77	L	10	M	2.5	ground survey completed
23	3+	191	-	-	-	-	Traverspine River ground survey completed
24	3	29	L	4	M	0.4	ground survey completed
25	1	0.4	N	-	M	3	no ground survey (<2 km^2)
26	1	0.15	N	-	L	3.5	no ground survey (<2 km^2)
27	1	0.25	N	-	L	3.5	no ground survey (<2 km^2)

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (L), or none (N).
Downstream of crossings have lake (L), steady (S), large tributary (T), or the main stem of the river (M).

Of the eight crossing locations that were to be surveyed on the ground, five were accessible by helicopter. Three of these are Type II habitat and two are Type III (cascades) habitat. Field data on all of the watercourse crossings are reported in the Fish and Fish Habitat Component Study (JW/IELP 2003b).

Kenamu River

The two route sections (preferred and outfitter routes) roughly bisect the Kenamu River watershed, in an east-west orientation. In part, the outfitter route crosses slightly to the south of the preferred route. Thirteen watercourse crossings were identified for investigation, 10 were surveyed in 2002 and the remaining three in 2003 (Table 7.16).

Table 7.16 Summary Information of Crossings on the Kenamu River and Tributaries

			Upstream		Downstream		
Stream Crossing	Stream Order	Watershed Area (km^2)	Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	Comment
28	3+	72.3	L	1.5	L	3	ground survey completed
29	1	0.78	N	-	L	3	no ground survey (<2 km^2)
30	2	11.9	L	2	L	0.5	no ground survey (Type IV)
31	1	2.7	N	-	T	1	landing not possible (osprey)
32	2	6.3	N	-	T	0.5	not safely accessible
33	1	1.5	N	-	M	5	no ground survey (<2 km^2)
34	1	6.95	N	-	M	4	not safely accessible
35	1	1	N	-	M	3	no ground survey (<2 km^2)
36	3+	2, 026	-	-	-	-	Kenamu River ground survey completed
37	1	4.75	N	-	M	3.5	ground survey completed
38-O	1	0.9	H	0.25	Salmon R.	1	no ground survey (<2 km^2)
39-O	3+	38.4	L	5+	Kenamu R.	15 +	Salmon River ground survey completed
40-O	1	3.4	L	1.2	Salmon R.	1.5	no ground survey (Type IV)

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (L), STEADY (s) or none (N).
Downstream of crossings have lake (L), steady (S), large tributary (T), or the main stem of the river (M).

Most of the watercourse crossings are less than 5 m in width. The Kenamu River is over 20 m in width at the crossing location. Six watercourse crossings did not require ground surveys, two could not be safely accessed, and one crossing could not be accessed because osprey threatened to charge the helicopter on three separate occasions. Four watercourse crossings were surveyed on the ground.

Eagle River

The outfitter (A13 section) route transects the upper half of the Eagle River watershed and 52 crossing locations were identified for investigation while one was surveyed in 2002. All 52 were overflown and surveyed from the air. Eighteen watercourse crossings did not require ground surveys based on the upstream basin area and 15 did not require ground surveys because they had Type IV habitat (Table 7.17). The remaining 19 crossings were ground surveyed and the one crossing surveyed in 2002 was also ground surveyed.

Table 7.17 Summary Information of Crossings on the Eagle River and Tributaries

Eagle River Tributaries			Upstream		Downstream		
Stream Crossing	**Stream Order**	**Watershed Area (km^2)**	**Pond or Lake**	**Distance to Crossing (km)**	**Lake or Main Stem**	**Distance to crossing (km)**	**Comment**
41-O	2 to 3	44.3	Lake	0.3	Lake	6	ground survey completed
42-O	1	0.9	None	-	Lake	6	no ground survey (<2 km^2)
43-O	1	1.2	None	-	Lake	6.5	no ground survey (<2 km^2)
44-O	1	1.1	None	-	Lake	10 ±	no ground survey (<2 km^2)
45-O	2	7.6	Lake	1	Lake	10 ±	ground survey completed
46-O	1	3.4	H	2	Lake	10 ±	no ground survey (Type IV)
47-O	3	26.1	Lake	5+	Lake	20 ±	ground survey completed
48-O	2	14.9	None	-	Lake	20 ±	no ground survey (Type IV)
49-O	1	3.4	None	-	Lake	12 ±	ground survey completed
50-O	1	2.7	None	-	Lake	12 ±	ground survey completed
51-O	2	5.5	None	-	Lake	15 ±	ground survey completed
52-O	1	3.2	None	-	Lake	15 ±	ground survey completed
53-O	1	6.7	Lake	0.3	Lake	1.5	no ground survey (Type IV)
63-O	2	4.6	H	2	Lake	0.6	no ground survey (Type IV)
64-O	1	0.9	None	-	Lake	1.6	no ground survey (<2 km^2)
65-O	1	0.9	None	-	Lake 1	20 ±	no ground survey (<2 km^2)
66-O	1	0.2	None	-	Lake 1	20 ±	no ground survey (<2 km^2)
67-O	1	0.6	None	-	Lake 1	20 ±	no ground survey (<2 km^2)
68-O	1	1	None	-	Lake 1	20 ±	no ground survey (<2 km^2)
69-O	2	7.9	Lake	2.2	Major Trib	12 ±	ground survey completed
70-O	1	1.1	None	-	Major Trib	12 ±	no ground survey (<2 km^2)
71-O	2 to 3	50.7	Lake	0.2	Lake	0.4	ground survey completed
72-O	1	6.9	None	-	Major Trib	0.6	ground survey completed
73-O	2	29.4	None	-	Major Trib	1.4	ground survey completed
74-O	1	1.4	None	-	Major Trib	8 ±	no ground survey (<2 km^2)
75-O	3+	98	H	10 ±	Major Trib	16 ±	no ground survey (Type IV)
76-O	1	4.1	None	-	Major Trib	2.5	ground survey completed

Eagle River Tributaries			Upstream		Downstream		
Stream Crossing	Stream Order	Watershed Area (km^2)	Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	Comment
77-O	2 to 3	40.9	None	-	Major Trib	7 ±	ground survey completed
78-O	1	4.1	None	-	Major Trib	7 ±	no ground survey (Type IV)
79-O	1	0.4	None	-	Lake	2	no ground survey (<2 km^2)
80-O	3+	61.5	Lake	6 ±	Major Trib	2.5 ±	no ground survey (Type IV)
81-O	1	1.98	None	-	Lake	1	no ground survey (<2 km^2)
82-O	3	36.7	None	-	Major Trib	22 ±	no ground survey (Type IV)
83-O	2	13.6	None	-	Major Trib	22 ±	no ground survey (Type IV)
84-O	3	8.4	None	-	Major Trib	22 ±	no ground survey (Type IV)
85-O	1	1.5	None	-	Major Trib	23 ±	no ground survey (<2 km^2)
86-O	1	0.2	None	-	Major Trib	23 ±	no ground survey (<2 km^2)
87-O	1	2.3	None	-	Major Trib	12 ±	ground survey completed
88-O	2	4.9	H	1.8	Major Trib	8 ±	no ground survey (Type IV)
89-O	1	4.7	Lake	2	Lake	0.6	no ground survey (Type IV)
90-O	2	18	Lake	0.5	Lake	1.5	ground survey completed
91-O	1	3.6	None	-	Lake	1	no ground survey (Type IV)
92-O	1	4.3	Lake	2	Lake	1	ground survey completed
93-O	1	1.2	None	-	Lake	0.5	no ground survey (<2 km^2)
94-O	3	16.1	Lake	0.2	Lake	0.2	ground survey completed
95-O	2 to 3	41.1	Lake	0.1	Lake	0.2	no ground survey (Type IV)
96-O	2	1.5	Lake	0.1	Lake	0.2	no ground survey (<2 km^2)
97-O	1	4.4	Lake	0.4	Lake	2	ground survey completed
98-O	1	1.3	None	-	Lake	1	no ground survey (<2 km^2)
99-O	3+	122.9	Lake	0.1	Lake	0.1	ground survey completed
100-O	1	2	Lake	0.4	Lake	0.6	no ground survey (Type IV)
101-O	1	0.3	None	-	Major Trib	2	no ground survey (<2 km^2)
82	3	25	Lake	3	Major Trib	1.5	ground survey completed

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (Lake), or none (No).
Downstream of crossings have lake (Lake), large tributary (Major Trib), or the main stem of the river (Name).
Lake 1 is approximately 12 km south-west of Crooks Lake.

Joir River

The Joir River, which is a tributary of the Little Mecatina River, drains two small areas that are crossed by the outfitter route (Figure 7.18). There are no watercourse crossings within the Joir River basin, so no habitat surveys, fish surveys, or water sampling was conducted in relation to this basin.

St. Augustin River

The outfitter route makes an excursion into the St. Augustin River watershed that includes nine watercourse crossings in the headwater area (Table 7.18). Only three crossings did not require ground surveys based on the presence of Type IV habitat. One crossing could not safely be accessed due to tree cover and the remaining five crossing sites were ground surveyed.

Table 7.18 Summary Information of Crossings on the St. Augustin River Tributaries

St. Augustin River Tributaries			Upstream		Downstream		
Stream Crossing	**Stream Order**	**Watershed Area (km^2)**	**Pond or Lake**	**Distance to Crossing (km)**	**Lake or Main Stem**	**Distance to crossing (km)**	**Comment**
54-O	2	2.1	None	-	Lake	4	no ground survey (Type IV)
55-O	2	6	None	-	Lake	2	ground survey completed
56-O	3	32.5	Lake	0.5	Lake	2	no ground survey (Type IV)
57-O	2	3.8	None	-	Lake	1.5	ground survey completed
58-O	1	2.9	None	-	Lake	0.5	site not safely accessible
59-O	1	3.1	None	-	Main Stem	0.4	ground survey completed
60-O	3	46	St Aug L	2	Main Stem	0.5	ground survey completed
61-O	2	8.6	Lake	1.5	Main Stem	0.7	ground survey completed
62-O	1	2.6	None	-	Lake	0.6	no ground survey (Type IV)

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (Lake), or none (No).
Downstream of crossings have lake (Lake), large tributary (Major Trib), or the main stem of the river (Name).
St. Aug L is St. Augustin Lake.

Paradise River

Phase II of the TLH runs along the lower half of Paradise River en route to the communities of Paradise River and Cartwright. The course of the TLH - Phase III outfitter route/preferred route intersects approximately midway along Paradise River (Cartwright Junction) and then bears west across the watershed. Thirteen watercourse crossings have been identified (Table 7.19) including Paradise River itself. The terrain has a numerous wetland areas and low relief and, hence, seven of the crossings are Type IV habitat (steadies). In one case, there was no visible channel or flow and in another, the stream increasingly diminished in visible flow until it disappeared, as subsurface flow through the substrate. The remaining stream crossing locations were surveyed on the ground.

Table 7.19 Summary Information of Crossings on the Paradise River and Tributaries

			Upstream		Downstream		Comment
Stream Crossing	Stream Order	Watershed Area (km^2)	Pond or Lake	Distance to Crossing (km)	Lake or Main Stem	Distance to crossing (km)	
83	2	11.4	L	0.6	L	0.5	no ground survey (Type IV)
84	1	1.9	N	-	l	0.5	no ground survey (<2 km^2)
85	1	0.8	N	-	T	7	no ground survey (<2 km^2)
86	3	78	L	1.2	T	9	no ground survey (Type IV)
87	3	24	L	5	L	1	ground survey completed
88	3+	35	S	0.1	L	0.15	ground survey completed
89	1	6.55	S	0.3	L	0.1	ground survey completed
90	1	2.55	H	1.5	L	2	ground survey completed
91	2	16.6	L	2	L	1.2	ground survey completed
92	1	2.5	H	1.4	L	0.4	no ground survey (intermittent)
93	1	2.74	H	0.7	L	3	no ground survey (Type IV)
94	3+	3, 339	-	-	-	-	Paradise River ground survey completed
95	1	6.8	N	-	M	1.5	ground survey completed

Notes:
Upstream of crossings have headwater pond (H), a lake(s) with tributaries (L), or none (N).
Downstream of crossings have lake (L), steady (S), large tributary (T), or the main stem of the river (M).

The information collected during the ground surveys of watercourse crossing suites is summarized for each watershed in for the Churchill River, Traverspine River, and Kenamu River basins (Table 7.20); for the Eagle River Basin (Table 7.21); and for the St. Augustin River and Paradise River Basins (Table 7.22). The crossings with “O” following the number are on the A13 section of the outfitter route and were surveyed in 2003. The other crossings are the outfitter route crossings that were surveyed in 2002.

The tables, again arranged by river basin, identify by number the crossing sites that were ground surveyed and show the depth, width, habitat type, flow type, surface velocity, substrate and bank material, backslope, riparian vegetation, percent cover, stream gradient, and potential obstructions for fish or navigation. The terms and codes are explained in the legend at the bottom of the tables.

The information in Tables 20 to 22 was collected during the ground surveys. For the sake of completeness, much of the same information was collected, or estimated, from the aerial surveys of the crossing sites that were not ground surveyed. This information is summarized from the first page of the field data for those sites (the second page being largely blank). The information is segregated from the previous tables as, although the terminology is the same, the detail and precision is different between the aerial and ground surveys.

The aerial survey information for stream crossings not ground surveyed is compiled for Churchill River (Table 7.23), Traverspine River (Table 7.24), Kenamu and St. Augustin rivers (Table 7.25), and the Eagle and Paradise rivers (Table 7.26). For each river basin the crossings are numbered in order followed by the estimated water depth, stream width, habitat type, flow type, substrate and bank material, apparent backslope, bank vegetation, cover, and potential obstructions to fish migration and navigation.

Table 7.20 Ground Survey Information of Watercourse Crossings - Churchill River, Traverspine River and Kenamu River Watersheds

#	Depth (m)	Width (m)	Habitat Type	Flow	Surface Velocity (m/s)	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Gradient (%)	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
CHURCHILL RIVER WATERSHED													
8	0.30 to 0.37	2.2	II	R	0.11	F	F	FS	S/T/G	100	1	U	T (SS/OH)
9	0.10 to 0.13	1.5	IV	R	0.07	F	F	FS	T/S/G	100	<1	U	T (SS/SW)
TRAVERSPINE RIVER WATERSHED													
13	0.20 to 0.30	4	II	R	0.49	C/R/Bo/G		FS	T/S	80	4	U	T (SW/OH)
16	0.38 to >1.0	18	II	R/P	0.51	Bo/R/G/F	Bo/F/R/C/	SG	T/S/G	15	2	P (CA)	P (SW/C)
22	0.50 to 1.0	10	III	RA	0.33	Bo/Br/R	Bo/Br/C/R	MG	T/S/G	5	2.5	P (F/RA/C)	P (C/CA)
23	0.58	15	II	R	0.44	Bo/C/R/G	Bo/C/R/Br/G	MG	T/S/G	10	1.5	T (F/RA)	T (F)
24	0.46	5	III	RA	0.28	Bo/R/C/G	Bo/R/C/G	MG	T/S	20	4	T (F)	T (F)
KENAMU RIVER WATERSHED													
28	0.70 to 1.0	<20	II	R	0.49	Bo/R/C/G	C/R/Bo/F	SG	T/S/G	15	1	U	P (SW)
36	0.4	~100	II	R	0.24	C/R/Bo/F/G	C/R/Bo/F/G	DG	S/G/T	5	1	U	U
37	0.30 to 0.60	1.5	IV	S	0.14	F	F	FS	S/T/G	100	<1	U	T (SS/OH)
39-O	0.35 to 0.80	8.0 to 8.5	II	R	0.41	Bo/C/R/F	Bo/F/C/R	FS	T/S/G	20	2	U	P (SW)

Legend:

#	Stream crossing number.
Depth	Maximum depth in m.
Width	Average or range in m.
Habitat type	Beak habitat Type I, II, III, IV (see Table 7.13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) (see Table 7.10).
Surface velocity	Current velocity in m/s.
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG).
Bank vegetation	Shrubs (S), trees (T), grass (G).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Gradient	Stream gradient expressed as %.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

Table 7.21 Ground Survey Information of Watercourse Crossings - Eagle River Watershed

#	Depth (m)	Width (m)	Habitat Type	Flow	Surface Velocity (m/s)	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Gradient (%)	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
EAGLE RIVER WATERSHED													
41-O	0.2 to 0.53	8 to 8.5	II	R	0.31	C/R/Bo/G/F	C/R/F/Bo/G	FS	T/S	20	1	U	P (SW)
45-O	0.32	4.5	II	R	0.47	Bo/Br/R/C	Bo/Br/R/C/F	FS	T/S	20	3	P (C/CA)	T (C/CA)
47-O	0.35 to 0.60	7.7	II	P/R	0.2	Bo/C/R	Bo/F/C/R	FS	T/S	20	1	U	P (SW)
49-O	0.25 to 0.46	1.7	II	R	0.26	Bo/F/R/C	Bo/F/R/C	FS	S/T	100	1	U	T (SS/OH)
50-O	0.15 to 0.20	0.3 to 1.4	IV	S	0.19	F	F	FS	S/T	100	<1	U	T (SS/OH)
51-O	0.17 to 0.37	1.8	II	R	0.47	F/Bo	F/Bo	FS	T/S/G	85	1	U	T (SS/OH)
52-O	0.20 to 0.50	3	II	R	0.37	F/B/R/C	F/B/R/C	FS	T/S	95	1	U	T (SS/OH)
69-O	0.20 to 0.34	4 to 5	II	R	0.36	Bo/R/C/G/F	Bo/F/R/C/G	FS	T/S	40	1	P (C)	P (SW)
71-O	0.20 to 0.28	A:10.0 B: 8.0	II	R	0.49	Bo/R/C	Bo/R/C/F	SG	T/S	10	0.5	U	P (SW)
72-O	0.24 to 0.60	2.3	II	R	0.25	F	F	FS	T/S	80	1	U	T (SS/OH)
73-O	0.20 to 0.67	8	II	R	0.45	R/C/Bo/G/F	R/C/Bo/G/F	FS	T/S/G	25	0.5	U	P (SW)
76-O	0.30 to 0.35	1.4	II	R	0.28	F/Bo/C/R	F/Bo/C/R	FS	T/S	98	<1	U	T (SS/OH)
77-O	0.45	6 to 15	II	R	0.24	F/Bo/R/C/G	F/Bo/R/C/G	SG	T/S/G	10	1	U	P (SW)
87-O	0.10 to 0.14	1.4	II	R	0.19	F/Bo	F/Bo	FS	T/S	100	<1	T (I)	T (SS/I)
90-O	0.18 to 0.50	21	II	R	0.32	Bo/R/C/F/G	Bo/R/C/F/G	FS	T/S/G	10	1	U	P (SW)
92-O	0.18	3	II	R	0.34	Bo/R/C	Bo/R/C/F	FS	T/S	60	<1	U	T (SS/WD)
94-O	0.3	11 to 19	II	R	0.38	Bo/R/C/G	Bo/F/R/C	FS	T/S/G	15	1	U	P (SS)
97-O	0.1	2 to 5	II	R	0.26	Bo/R/C/F	Bo/F/R/C	FS	S/T	70	0.5	U	T (SS/WD)
99-O	0.12 to 0.80	5 to 20	II	R/P	0.33	Bo/R/C/F	Bo/F/R/C	SG	T/S/G	5	1	U	P (SS)
82	0.28 to 1.0	5 to 8	II	R	0.21	Bo/R/C	C/R/Bo/F	MG	S/T/G		2	U	P (SW)

Legend: See previous or following tables.

Table 7.22 Ground Survey Information of Watercourse Crossings - St. Augustin River and Paradise River Watersheds

#	Depth (m)	Width (m)	Habitat Type	Flow	Surface Velocity (m/s)	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Gradient (%)	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
ST. AUGUSTIN RIVER WATERSHED													
55-O	0.34	3.5	II	R	0.42	C/R/Bo/Br	C/R/Bo/F/Br	FS	S/T	70	1	U	T (SS/SW)
57-O	0.18 to 0.23	2.6	II	R	0.19	Bo/F/R/C	F/Bo/C/R	FS	S/T/G	95	1.5	U	T (SW/OH)
59-O	0.10 to 0.15	0.5	II	R	0.25	F/Bo/R/C	F/Bo/R/C	FS	S/T	98	<1	U	T (SS/OH)
60-O	0.45 to 0.70	7 to 8	II	P/R	0.18	F/Bo/R/C	F/Bo/R/C	SG	S/T/G	10	<1	U	P (SW)
61-O	0.23 to 0.80	5 to 9.5	II	P/R	0.43	F/Bo/R/C	F/Bo/R/C	SG	S/T/G		0.5	U	P (SW)
PARADISE RIVER WATERSHED													
87	0.12 to 0.55	2	II	R	0.4	Bo/G/R/C/F	Bo/F/C/R/G	SG	S/T/G	60	4	U	P (SS)
88	< 1	> 5	IV	S		F	F/Bo	SG	S/B/T/G			U	P (SW)
89	0.12 to 0.35	2.4	II	R	0.34	Bo/R/C	C/R/Bo/Br/F	SG	S/G/T	20	2	U	T (SW)
90	0.10 to 0.40	2	IV	S	0.12	Bo/F/R/C/G	F/Bo	FS	T/S	100	0.5	P (I)	T (SS/OH)
91	0.35 to 1.0	7	IV	S	0.16	F/Bo/R/C	F/C/R/Bo	SG	S/G/T	20	1	U	P (SW)
94	>2.0	~50	II	R	0.36	Bo/Br/C/R/G	Bo/Br/C/R/G	DG	T/S	5	1	U	U
95	23	1	II	R	0.29	F/G	F/G	FS	T/S/G	80	0.5	U	T (SS/OH)

Legend:

#	Stream crossing number.
Depth	Maximum depth in m.
Width	Average or range in m.
Habitat type	Beak habitat Type I, II, III, IV (see Table 7.13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) (see Table 7.10).
Surface velocity	Current velocity in m/s.
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG).
Bank vegetation	Bog (B), Shrubs (S), trees (T), grass (G).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Gradient	Stream gradient expressed as %.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

Table 7.23 Aerial Survey Information of Watercourse Crossings - Churchill River Basin

Stream Crossing	Depth (m)	Width (m)	Habitat Type	Flow	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
CHURCHILL RIVER WATERSHED											
1	4	>20	IV	R	F	F	MG	T/S/G	<1	U	U
2	U	<2	II	R	F/C/R/G	F/C/R/G	FS	T/SG	97	U	T (SS/OH)
3	U	<2	U	U	U	U	FS	T/S	100	U	T (SS/OH)
4	<1	<2	II	R	F	F	FS	T/S	98	U	T (SS/OH)
5	U	U	U	U	U	U	FS	T/S	100	N/A	T (SS/OH)
6	<1	<2	II	R	U	U	FS	T/S	99	N/A	T (SS/OH)
7	<1	<2	II	R	U	U	FS	T/S	95	N/A	T (SS/OH)
10	U	<2	U	U	U	U	FS	T/S/B	100	N/A	T (SS/OH)
11	<1	<2	U	U	U	U	FS	T/S	100	N/A	T (SS/OH)
12	U	<2	U	U	U	U	FS	T/S	100	N/A	T (SS/OH)

Legend:

#	Stream crossing number.
Depth	Estimated depth in m.
Width	Estimated width in m.
Habitat type	Beak habitat Type I, II, III, IV or unknown (U) (see Table 7.13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) or unknown (U) (see Table 7.10).
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) or unknown (U) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG), medium gully (MG), deep gully (DG), bog/fen (BF) or flood plain (FP)
Bank vegetation	Shrubs (S), trees (T), grass (G) or bog (B).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

Table 7.24 Aerial Survey Information of Watercourse Crossings - Traverspine River Basin

Stream Crossing	Depth (m)	Width (m)	Habitat Type	Flow	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
TRAVERSPINE RIVER WATERSHED											
14	<1	2 to 5	II	R	B/C/R/G/F	U	SG	S/T/G	40	U	T (SW/OH)
15	<1	5 to 20	II	R	B/C/R/G	B/C/R	MG	T/S	20	P (Ca)	P (SW)
17	U	<2	U	U	U	U	FS	T/S	99	N/A	T (SS/OH)
18	U	<2	U	U	U	U	FS	T/S	100	N/A	T (SS/OH)
19	U	<2	U	U	U	U	FS	T/S/G	99	N/A	T (SS/OH)
20	<1	2 to 5	II	R	F	U	FS	T/S/G	90	U	T (SS/OH)
21	U	<2	U	U	U	U	FS	T/S/G	99	N/A	T (SS/OH)
25	U	<2	U	U	U	U	FS	T/S/B/G	98	N/A	T (SS/OH)
26	U	<2	U	U	U	U	FS	T/S	100	N/A	T (SS/OH)
27	U	<2	U	U	U	U	FS	S/T/G	100	N/A	T (SS/OH)

Legend:

#	Stream crossing number.
Depth	Estimated depth in m.
Width	Estimated width in m.
Habitat type	Beak habitat Type I, II, III, IV or unknown (U) (see Table 7.13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) or unknown (U) (see Table 7.10).
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) or unknown (U) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG), medium gully (MG), deep gully (DG), bog/fen (BF) or flood plain (FP)
Bank vegetation	Shrubs (S), trees (T), grass (G) or bog (B).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

Table 7.25 Aerial Survey Information of Watercourse Crossings - Kenamu River and St. Augustin River Basins

Stream Crossing	Depth (m)	Width (m)	Habitat Type	Flow	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
KENAMU RIVER WATERSHED											
29	U	5 to 20	II	R	U	U	FS	T/S	100	N/A	T (SS/OH)
30	<1	5 to 20	IV	S	F/B	F/B	BF	T/B/G	5	U	U
31	U	<2	U	U	U	U	FS	T/S	90	N/A	T (SS/OH)
32	U	<2	II	R	U	U	FS	T/S	100	N/A	T (SS/OH)
33	U	<2	II	R	U	U	FS	S/T	100	N/A	T (SS/OH)
34	<1	<2	II	R	F/G/C/R	U	SG	S/T/G	98	U	T (SS/OH)
35	No stream										
38-O	<1	0 to 2	IV	S	F	F	FS	S/T/B	80	U	T (SS/OH)
40-O	<1	2 to 5	IV	S	F	F	BF	G/B/S/T	20	U	P (SS/SW)
ST. AUGUSTIN RIVER WATERSHED											
54-O	<1	2 to 5	IV	S	F/C/R/G	U	FP	S/T/G		U	P (SW/OH)
56-O	<1	5 to 20	IV	S	F/B	F/B	FP	S/T/G	10	U	P (SW)
58-O	<1	<2	II	R	F/B	F/B	FS	S/T/G	80	U	T (SS/OH)
62-O	<1	<2	IV	S	F	F	FS	T/S/B	90	P (I)	T (SS/OH/I)

Legend:

#	Stream crossing number.
Depth	Estimated depth in m.
Width	Estimated width in m.
Habitat type	Beak habitat Type I, II, III, IV or unknown (U) (see Table 7.13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) or unknown (U) (see Table 7.10).
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) or unknown (U) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG), medium gully (MG), deep gully (DG), bog/fen (BF) or flood plain (FP)
Bank vegetation	Shrubs (S), trees (T), grass (G) or bog (B).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

Table 7.26 Aerial Survey Information of Watercourse Crossings - Eagle River and Paradise River Basins

Stream Crossing	Depth (m)	Width (m)	Habitat Type	Flow	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
EAGLE RIVER WATERSHED											
42-O	<1	0 to 2	IV	S	F/C/R	F	FS	T/S/G/B	80	U	T (SS/OH)
43-O	<1	0 to 2	II	R	F/B	U	FS	T/S	90	U	T (SS/OH)
44-O	<1	0 to 2	II	R	F/B/C/R	F/B/C/R	FS	T/S	70	U	T (SS/OH)
46-O	<1	2 to 5	IV	S	F/B	F/B	FS	B/T/S/G	40	U	P (SS/OH)
48-O	<1	2 to 5	IV	S	F/B	F/B	FP	G/S/T	20	U	P (SS/SW)
49-O	<1	0 to 2	II	R	U	U	FS	S/T	95	U	T (SS/OH)
53-O	<1	2 to 5	IV	S	F/B	U	BF	S/B/T	25	U	P (SS/SW)
63-O	<1	0 to 2	IV	S	F	F	FS	S/T/G	50	U	T (SS/OH/WD)
64-O	<1	0 to 2	IV	S	F	F	FS	S/T	60	U	T (SS/OH/WD
65-O	<1	0 to 2	IV	S	F	F	FS	T/S	70	P (I)	T (I/SS/OH)
66-O	<1	0 to 2	II	R	F/C/R/B	F/C/R/B	FS	T/S	90	U	T (SS/OH)
67-O	<1	0 to 2	IV	S	F/B/C/R	F/B/C/R	FS	T/S/G	80	U	P (SS/OH/SW)
68-O	<1	0 to 2	IV	S	F/C/R/B	F/C/R/B	FS	S/T/G	70	U	P (SS/OH)
70-O	<1	2 to 5	II	R	U	U	FS	T/S	99	P (I)	T (I/SS/OH)
74-O	<1	0 to 2	IV	S	F	F	FS	T/S/B	80	P (I)	T (I/SS/OH)
75-O	1 to 2	>20	IV	S	F/B	F/B	SG	T/S	5	U	U
78-O	<1	0 to 2	IV	S	F/B	F/B	FS	T/S/G	60	U	T (SS/OH)
79-O	<1	0 to 2	IV	S	F	F	BF	B/G/S/T	10	U	P (SS/SW)
80-O	<1	5 to 20	IV	S	F/B/C/R	F/B/C/R	FS	T/S/G/B	10	U	P (SW)
81-O	<1	0 to 2	IV	S	F/C/R/B	F	FS	S/T/B/G	20	U	T (SS/OH)
82-O	1 to 2	2 to 5	IV	S	F	F	BF	S/B/G/T	10	U	P (WD)
83-O	1 to 2	2 to 5	IV	S	F	F	BF	B/G/S/T	20	U	P (WD/SW)
84-O	<1	2 to 5	IV	S	F/B	F/B	BF	B/G/S/T	20	U	P (SW/WD)
85-O	<1	0 to 2	IV	S	F/B	U	FS	T/B/S/G	5	P (I)	T (I/SS/OH/WD
86-O	No stream										
88-O	<1	2 to 5	IV	S	F	F	BF	B/S/T/G	20	U	P (WD)
89-O	<1	2 to 5	IV	S	F/B/C/R	F/B/C/R	FS	T/S/G/B	20	U	P (SW/WD)
91-O	<1	2 to 5	IV	S	F/C/R/B	F/C/R/B	FS	T/S/G/B	40	U	P (SW/WD)
93-O	<1	0 to 2	IV	S	U	U	FS	T/S	99	P (I)	T (SS/OH/I)
95-O	1 to 2	>20	IV	S	C/R/F/Bo/Br	C/R/F/Bo/Br	SG	T/S/G	10	U	P (SW)

Stream Crossing	Depth (m)	Width (m)	Habitat Type	Flow	Substrate	Bank Material	Backslope	Bank Vegetation	Cover %	Potential Obstructions to Fish Migration	Potential Obstructions to Navigation
96-O	<1	5 to 20	IV	S	F/B/C/R	F/B/C/R	SG	B/T/S/G	10	U	P (SW)
98-O	<1	0 to 2	IV	S	F	F	FS	T/S/G	95	P (I)	T (I/SS/OH/WD)
100-O	<1	2 to 5	IV	S	F/B/C/R	F/B/C/R	FS	T/S/G	80	U	T (SS/OH)
101-O	No stream										
PARADISE RIVER WATERSHED											
83	<1	2 to 5	IV	S	F/B/C/R	F/B/C/R	FS	B/T/S	30	U	U
84	<1	2 to 5	IV	S	F/B/C/R	F	BF	B/T	40	U	T (SS)
85	No stream										
86	<1	5 to 20	IV	S	F/B/C/R	F/C/R	SG	T/S/B/G	20	U	P (SS)
92	<1	<2	Interm.	Nil	F/C/R/B	F/C/R				T (I)	T (SS/I)
93	<1	2 to 5	IV	S	F/B/C/R	F/C/R	SG	S/T/G	40	U	P (SS)

Legend:

#	Stream crossing number.
Depth	Estimated depth in m.
Width	Estimated width in m.
Habitat type	Beak habitat Type I, II, III, IV or unknown (U) (see Table 13).
Flow	Riffle/Run (R), steady (S), pool (P), rapids (Ra) or unknown (U) (see Table 7.10).
Substrate/Bank material	Bedrock (Br), boulder (Bo), rubble (R), cobble (C), gravel (G), fines (F) or unknown (U) (see Table 7.11).
Backslope	Forest stream (FS), shallow gully (SG), medium gully (MG), deep gully (DG), bog/fen (BF) or flood plain (FP)
Bank vegetation	Shrubs (S), trees (T), grass (G) or bog (B).
Percent cover	Percentage of stream cover. Refer to data sheet for type of cover present.
Obstructions (fish migration)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Intermittent (I), Chutes (C), Cascades (Ca), Rapids (Ra), Falls (F).
Obstructions (navigation)	Unobstructed (U), partially obstructed (P), totally obstructed (T), due to: Shallow water (SW), small size (SS), overhanging vegetation (OH), Intermittent (I) woody debris (WD).

7.5.3.3 Fish Surveys

The identification and characterization of 'potential' fish habitat has been done without reference to verifying fish presence and use of the habitat. Conservatively, WST have committed to approaching all watercourse crossings as being fish habitat unless there are counter-indications. Several crossings were selected for fish sampling with the objective of sampling one second order and one third order watercourse in each watershed (i.e., two in each of the Traverspine, Kenamu, St. Augustin river basins and two on each of the routes in the Eagle River basin). Where suitable crossings could not be found, substitutes were used (i.e., a three+ order watercourse was sampled). The sites sampled are shown on Figure 7.18 and the results are summarized in Table 7.27. Full details are contained in the Fish and Fish Habitat Component Study Addendum (JW/MLP 2003c).

Table 7.27 Summary of Fish Sampling Results in Four Watersheds

Watershed and Crossing #	Species	N	CPUE (#/min)	Fork Lengths (mm)		
				Minimum	Maximum	Mean
Eagle River						
47-O	Brook Trout	11	1.29	62	121	85
51-O	Brook Trout	4	0.48	59	120	78.5
61	Brook Trout	14	1.42	35	260	92
82	Brook Trout	5	0.49	72	124	103
	Longnose Sucker	4	0.39	97	175	132
	White Sucker	3	0.29	85	119	98
St. Augustin River						
55-O	Brook Trout	15	1.74	35	129	85
60-O	Brook Trout	9	0.97	30	157	104
	Longnose Sucker	1	0.11	142		
	White Sucker	1	0.11	Specimen lost		
Kenamu River						
40	Brook Trout	4	0.38	30	110	69
41	Brook Trout	16	1.9	22	141	66.5
Paradise River						
87	Brook Trout	3	0.29	70	73	72
	Northern Pike	2	0.19	145		
	White Sucker	2	0.19	95	100	97.5

Note: Attempts were made to sample crossings 16, 23, 24 (Traverspine watershed), 48, 51 (Eagle watershed), and 91 (Paradise watershed). Electrofishing at these sites could not be conducted since water temperatures exceeded 18°C.

Crossing numbers in the table followed by an "O" are on the outfitter (A13 section) route and those without an "O" are on crossings that were surveyed in 2002 - but sampled for fish in 2003. The watershed, stream crossing number, species caught, number of fish, catch-per-unit-effort (CPUE) and the size range of the fish taken are shown in Table 7.27. Note that some sites could not be sampled as DFO require that sampling only be conducted if water temperatures were 18°C or cooler.

WST has committed to approaching all watercourse crossings as being fish habitat, where suitable productive habitat is present and, thus, consideration will be given to preserving water quality, fish, fish spawning and rearing habitat and potential fish migration, as was done for TLH - Phase II. These measures will address fish and fish habitat issues for the purpose of environmental protection.

WST has committed to fish population studies to be completed during the construction phase, when time and access will be more favourable for conducting comprehensive surveys. The protocols to be used have been developed by the Inland Fish and Wildlife Division, who will take the lead in the survey. This will provide extensive baseline information on fish in the area.

7.5.3.4 Fish Species

Although many species are present in the streams and lakes along the highway route, the two that are most likely to be affected by the project are Atlantic salmon and brook trout, by their wide distribution and presence in stream sections and the importance of streams as nursery habitat for both anadromous and resident forms. The importance of these two species is also attributable to the interest afforded them by outfitters and recreational anglers. The following summaries for Atlantic salmon and brook trout are taken largely from Scruton et al. (1997). The information presented for salmon, brook trout, and other species is of a general nature and represents life history strategies from a number of studies across the geographic distribution of the species (Scott and Crossman 1973). The potential for local life history variation within the study area should be recognized.

Atlantic Salmon

Atlantic salmon are the dominant salmonid species in southern Labrador. They occur in the anadromous form that live at sea and return to freshwater to spawn and the resident form that spend their life in freshwater. The Labrador stock status is poorly known but optimistic indicators were reported in 1998 for improved spawning escapements (DFO 1998). Large salmon returns and escapements have been consistently low in Labrador and exploitation of large salmon is a continuing concern. Additional discussion on the recreational angling returns for Labrador is provided in Section 6.12.3.6 of the EIS/CSR (JW/IELP 2003a).

The habitat preferences of salmon in freshwater are summarized in Table 7.28. Adults spawn the fall from mid-September to mid-November. They prefer well-aerated gravel substrate, often located in tributaries to the major rivers. Following spawning, the spent salmon (kelts) return to the sea, or overwinter in freshwater pools or lakes and then return to sea.

Table 7.28 Habitat Preferences of Atlantic Salmon

Habitat Attribute	Atlantic Salmon Life Stage	
	Spawning	Rearing
Location	tail of pools in streams	variable
Water Depth (cm)	20 to 70	fry : 15 to 20 parr : 15 to 25
Water Velocity (cm/s)	0 to 80 (may not spawn in <10)	fry : <40 (5 to 32) small parr : 10 to 50 large parr : 5 to 100
Substrate Class	40 to 50 percent gravel or larger (7.8 to 12.5 cm grade)	fry : pebble/cobble small parr : pebble large parr : cobble/boulder
Other factors Timing Temperature (ºC) pH	Fall 3 to 11 (usually below 7) >5.0	8 to 24

Notes:
- fry (<40 mm long); small parr (40 to 70 mm); large parr (>70 mm).
- Information derived predominantly from Scruton et al. (2002).

Salmon eggs remain in the gravel overwinter and hatch from mid-April to mid-June. Alevins remain in the gravel for four to five weeks while they absorb their yolk sac. They then emerge as fry and commence feeding. Young salmon remain in streams as parr until they are three to six years old, at which time they will migrate to sea as smolt. Parr prefer coarse substrate (rubble, boulder and to a lesser extent cobble) and as they grow, they prefer faster water (riffle and rapids). Cover is not as important to salmon parr as it is for brook trout.

Smolt move to sea from mid-May to mid-June in Labrador, when water temperatures are from 5 to 10˚C. Following a brief acclimation in estuarine conditions, the smolt may go inshore or offshore to feed. After one to three years at sea, the salmon return to their natal streams. Those that return in one year are smaller and are called grilse, as opposed to larger multi-sea winter salmon.

Brook Trout

Brook trout are widely distributed throughout Labrador, including both sea-run and landlocked (resident) forms. They tend to be smaller than salmon and their habitat preferences are correspondingly shifted (Table 7.29).

Table 7.29 Habitat Preferences of Brook Trout

Habitat Attribute	Brook Trout Life Stage	
	Spawning	Rearing
Location	Streams and ponds Often in upwelling areas	Streams, rivers, ponds and lakes
Water Depth (cm)	-	6 to 90 18 to 40 optimum
Water Velocity (cm/s)	-	0 to 45 6 to 21 optimum
Substrate Class	Gravel - Fines reduce success Broadcast spawn over coarse substrate	Various
Other factors Timing Temperature (°C) pH	Fall 4 to 10 >5.0	0 to 24 11 to 16 optimum

Notes:
- \- Indicates not specified in recent literature.
- Information derived predominantly from Scruton et al. (1997) and Scruton et al. (2002).

Brook trout move into stream sections from mid-August and spawn during the month of September, and often extending into October. Spawning is conducted in headwater streams where gravels are well aerated by flow or upwelling. Some spawning occurs in lake habitat, where substrate is suitable and again where upwelling occurs.

The eggs hatch from mid-May to mid-June and the larvae emerge from the gravel as fry when their yolk is depleted. The fry prefer quiet edge water in streams or the margins of ponds. As they grow larger, the juveniles will tolerate faster water and deeper pools. Juvenile trout and salmon often cohabit within streams and feed at the same trophic level.

Adults will occupy a variety of habitats in response to available food, cover, competitors and predators. Preferred habitat includes riffles and pools with deeper water, abundant cover (instream or overhang), suitably cool water temperature and fairly good water quality.

The population status of brook trout is also poorly known, particularly in the remote areas such as the study area for the outfitter route.

Arctic Charr

Arctic Charr has the most northerly distribution of any freshwater fish. Charr can be found in inshore marine waters, lakes and rivers. Arctic charr do not usually range far inland except in large rivers. In Arctic waters, charr spawn in autumn, usually in September or October. Farther south, charr may spawn as late as November or December.

Charr spawn over gravel or rocky shoals in lakes or in quiet pools in rivers, at depths of 1 to 4.5 m. Spawning takes place in the day at temperatures approximately 4 °C. The eggs develop, buried in the gravel over winter. Hatching is thought to occur around April 1, but emergence from the gravel probably does not occur until break-up of the ice. At that time fry are approximately 25 mm in length. Arctic charr may either be anadromous, moving downstream to sea in the spring and returning in autumn, or they may remain permanently in fresh water as landlocked or resident forms. Young anadromous charr move out of the rivers and downstream to sea when 152 to 203 mm in length. Growth rates vary greatly among different populations but, in general, growth is slow. On average, full size is attained at 20 years of age, and although some have lived as long as 40 years they did not become much larger than 20-year-old fish. The average weight of sea run charr is approximately 0.9 to 4.5 kg. Arctic charr are carnivorous and have an exceedingly varied diet, they seem able to exploit any smaller creature that appears in their habitat.

Lake Whitefish

The rate of growth of lake whitefish varies from lake to lake but, in general, is quite rapid. Whitefish have been known to live in excess of 20 years and attain weights in excess of 9 kg in the Great Lakes. Lake whitefish usually spawn in the fall in November and December, but date of spawning varies from year to year, even in the same lake. Spawning usually occurs in shallow water at depths of less than 7.6 m, but spawning in deeper water has been reported. Spawning often takes place over hard or stony bottom, but sometimes over sand, with eggs and sperm being deposited more or less randomly over the spawning grounds. The lake whitefish is a cool water species that move from deep to shoal waters in early spring and back to deeper water as warming occurs. Adult fish are mainly bottom feeders consuming a wide variety of bottom-living invertebrates and small fishes. Food varies from region to region but aquatic insect larvae, molluscs and amphipods are primary foods.

Northern Pike

Northern pike is primarily a freshwater fish but has been known to enter weak brackish water. The northern pike is a spring spawner and spawning takes place immediately after ice out when water temperatures are 4.4 to 11.1 °C. Spawning takes place in daylight hours on heavily vegetated floodplains of rivers, marshes and bays of larger lakes. Eggs are scattered at random and remain attached to the vegetation of the area. Eggs typically hatch in 12 to 14 days and the young often remain attached to the vegetation and feed on the stored yolk for another 6 to 10 days. After the yolk is absorbed, young pike feed heavily on larger zooplankton and immature aquatic insects for 7 to 10 days. At that time pike begin eating fish and by the time the young pike reaches 50 mm in length, fish become the predominant food item.

Lake Trout

Lake trout are relatively fast growing and long lived and are typically found in deep water lakes. Spawning occurs mainly in October, but may occur as early as September in the north and as late as November in the south. Spawning occurs mostly in lakes over rocky shallows, but in rare instances may occur in rivers. Eggs and sperm are extruded over rocky bottom and the fertilized eggs fall into the crevices between rocks. Usually from four to five months are required for incubation and hatching usually occurs in March or April. The young usually seek deeper water within a month or so of hatching (after the yolk sac is absorbed). After spawning, lake trout disperse throughout the lake at various depths and remain dispersed throughout the winter months. In spring, they often inhabit the surface waters immediately after break up of ice. As the surface waters warm, lake trout move to cooler, deeper waters. Lake trout are predaceous and feed upon a broad range of organisms including freshwater sponges, crustaceans, aquatic and terrestrial insects, many species of fish and even small mammals.

Smelt

The smelt is an anadromous species that ascend freshwater streams in spring to spawn. Spawning may last up to three weeks, but the peak seldom lasts more than a week. Spawning can occur in streams or on gravel shoals in lakes. The eggs become adhesive shortly after extrusion and attach to bottom gravel. Eggs typically hatch in two to three weeks, depending on temperature. The young are approximately 5 mm long at hatching and may be 50 mm long by August, where they can be found close to shore along sand and gravel beaches. Sexual maturity can be reached as early as two years of age and the life span is approximately six years. A maximum length of approximately 356 mm is attained in maritime coastal waters, but landlocked fish may only attain a size of 102 mm. Adult smelt are essentially schooling, pelagic fishes inhabiting mid waters of lakes or inshore coastal waters. Smelt are carnivorous and feed on crustaceans, (amphipods, ostracods), aquatic insect larvae, aquatic worms and other small fish.

7.5.4 Potential Interactions

Nearly all aspects of the outfitter route regarding fish and fish habitat are fundamentally the same as those of the preferred route that was previously assessed by JW/EILP (2003b), although the outfitter route has watercourse crossings in an additional river basin. The potential interactions, existing knowledge, and details of mitigation for the outfitter route are largely taken from the assessment of the preferred route submitted earlier this year (JW/IELP 2003a).

Construction activities conducted instream or adjacent to stream banks have the potential to alter fish habitat, leading to displacement and/or reduced productivity or mortality in the population. Initial surveying of the route and clearing the right-of-way will require watercourse crossings by fording, boat, or helicopter. Fording streams at areas of sensitive habitat may destroy eggs or fry in gravel substrate.

At the start of construction, grubbing and debris disposal will take place in close proximity to watercourses. Excavation (cuts and fills) will be completed along the route and borrow pits will be operated where necessary. There may be a requirement for blasting near waterbodies to construct bridge abutments, to level the highway foundation or to establish the right-of-way. Blasting has the potential to cause direct damage to fish (i.e., injury to air bladders and mortality from toxic blast residues) and effects to fish habitat from shotrock and sediment introduction. Culverts and bridges will be placed at watercourse crossings, requiring in stream construction and potential disturbance of fish and fish habitat.

Altering habitat may also occur as a result of changes in water quality through an increase in suspended solids or accidental release of contaminants (waste, fuel, lubricants) into the water body. Increased suspended sediment in watercourses may be caused by fording, right-of-way clearing, grubbing, excavation, borrow pit operation, culvert and bridge installation, subgrade construction, concrete and aggregate production and rehabilitation of areas used during construction. Increased suspended sediment may adversely affect fish habitat by smothering habitat (i.e., feeding, spawning and rearing habitat) and affecting fish health (physical harm, physiological effects, behavioural effects such as an inability to detect predators and prey).

Concrete batch manufacturing will occur at some watercourse crossings. Concrete batch plants and aggregate washing have the potential to introduce silty material into watercourses. Liquid concrete products and truck washing residues have a high pH and can be toxic to plants, invertebrates and fish.

Temporary construction camps will be established to house work crews. If not properly handled and disposed of, domestic sewage and waste from these camps could end up in watercourses. The main concern with domestic sewage is the potential to increase nutrient loading in a watershed.

The installation of culverts or narrow bridge abutments will potentially cause restrictions in flow or increased gradients that may inhibit fish passage, particularly those that migrate into streams prior to spawning. Increased flow velocities or stretches of sustained flow, such as through a culvert, may be too much for some fish to overcome, or may unduly weaken fish that do manage to complete passage through the obstruction. Another barrier to fish passage could be created when water flows primarily under the culvert during low flow conditions.

There is the potential for any instream structures (culverts, bridge abutments or pilings) to affect productive fish habitat.

As sections of the highway are constructed, access to angling areas will be facilitated. This may lead to increased angling activity (and the potential for poaching), and may indirectly affect fish populations.

Many interactions that may occur during construction (sedimentation, contamination) also apply during operation, albeit to different levels of intensity, timing, and/or spatial distribution. During operation, suspended sediment may be introduced into fish-bearing water. Sediment could be introduced from runoff from the highway surface, shoulder grading, ditch cleaning, sand application (ice control), and through airborne dust.

Salt is not used for ice control in Labrador as it is ineffective at the normal cold temperatures and excessive salt leads to destruction of the roadbed (through irregular freezing and thawing). A very small amount of salt (less than 5 percent) is mixed with sand to prevent freezing prior to application for improved traction under icy conditions.

Service depots that are planned for the project may store and handle various hazardous materials, such as fuels, lubricants, solvents and antifreeze. As well, each depot will have waste handling/holding facilities. Improper waste disposal could result in the introduction of hazardous materials to watercourses.

Culverts or bridges that are installed without provision for fish passage may impede or prevent fish migration if the water velocities are excessive. Faulty installations or developing problems with the installations can lead to fish passage problems if the situations are not inspected and rectified.

The highway will provide new access to watercourses and again, the increased human use of watercourses may indirectly affect fish and fish habitat (e.g., resource and subsistence harvesting, recreational activities and poaching).

Acid-generating rock, as described in Section 3.4.2.4, may be encountered along the highway route.

Hazardous materials that will be used during the construction and operation of the outfitter route include fuels, lubricants, solvents, preservatives and antifreeze; these could be accidentally introduced into fish habitat through a spill of these materials. Also, hazardous materials will be transported on the route during normal highway operation. Many of these substances are acutely toxic to fish, plants and invertebrates. Other materials may cause chronic or acute degradation of water quality and fish habitat.

Fire can occur as a result of construction activities, temporary camp operation and highway maintenance activities, accidents relating to the operation and use of the outfitter route, or accidents unrelated to the highway (i.e., lightening strikes). Fire and subsequent burning of forests can lead to a degradation in water quality for fish due to slope destabilization and erosion and may result in pH changes, an increase in suspended sediment or the mobilization of metals from sediments.

Highway crossing failure such as a collapse, washout or flooding can occur during seasonal high flow periods. This could be as a result of exceptionally high flows or due to a failure in local drainage due to poor design or obstruction by ice or debris. Washout of a gravel highway will result in the release of sediment and silt that may enter watercourses. It could also lead to dangerous conditions where the risk of vehicular accidents is increased (i.e., increasing the risk of hazardous materials spills).

7.5.5 Issues and Concerns

Issues and concerns with respect to fish and fish habitat have been raised and discussed at the public consultation meetings and through regulator consultation for the assessment of the preferred route (JW/IELP 2003a). The same issues and concerns, plus those raised in the review of the previous EIS/CRS, apply to the outfitter route.

Most concerns relate to effects of highway construction and/or operation on fish and fish habitat, and the effect of improved access to watercourses, specifically access to key angling areas. There is concern that some of the watercourse crossings may affect fish migration, especially during construction. A concern for the introduction of dust from highway operation was also repeatedly raised during stakeholder consultations. The public, aboriginal groups, and regulators were concerned that appropriate studies be conducted to identify existing fish and fish habitat and measures be taken to protect these during construction and operation. WST supported fish surveys by Inland Fish and Wildlife Division in 2003 (Section 7.5.11).

Culverts or bridges that were installed without provision for fish passage may disrupt fish spawning migrations and subsequent recruitment and habitat use. Excessive water flow or insufficient water depth or flow could be a barrier to fish passage.

Any disturbance or removal of fish habitat by the placement of instream structures could have an adverse effect on the local populations and would not conform to DFO’s no net loss guiding principle for fish habitat management.

Much of the public concern with respect to fish and fish habitat is related to improved access and the potential for increased angling activity, in particular on Eagle River. There is concern that an increase in angling pressure will lead to subsequent declines in fish stocks. Many stakeholders (including outfitters and aboriginal groups) are concerned that improved access would affect their ability to fish in area rivers and the amount of fish that they could take.

There is concern about the effect of construction activities, such as grubbing, blasting, right-of-way clearing, vegetation burning, bridge and culvert installation, other in stream work, quarrying and borrowing activity, and concrete and aggregate production, on fish and fish habitat, fish migration and water quality. Concern was raised about possible siltation resulting from maintenance activities, such as grading and ice control, and the effect that it might have on spawning and rearing habitat. The accidental release of contaminants into waterbodies during transport, storage, use and/or disposal of wastes, fuels, lubricants, solvents and other deleterious substances is a concern. Some stakeholders feel that fish migration will be affected by culvert installations, even when baffles, natural substrates, and other mitigation methods are employed. There may also be concern about the loss of riparian vegetation (tree canopy cover) through vegetation clearing, increased timber harvesting or forest fires.

Acid generating rock has been raised as a concern, which is discussed in Section 3.4.2.4. Drainage from acid-generating rock sources to fish habitat may have a detrimental effect on fish or their food sources.

7.5.6 Existing Knowledge

Sedimentation (increased sediment load and deposition) is perhaps the most recognized environmental effect on aquatic systems during project construction, which has the potential to affect all trophic levels. Sediment deposition can result from a variety of activities, including fording, blasting, vegetation clearing, highway construction, and bridge and culvert installation. Suspended sediment also occurs naturally in watercourses along the route, as witnessed following a heavy rain during the field survey in September to October 2002. The environmental effects of sediment are well studied and understood. Anderson et al. (1996) reviewed the effects of sediment release on fish and their habitats. Anderson et al. (1996) and Trow Consulting Engineers Ltd. (1996) summarized the effects of sedimentation and siltation on fish habitat as follows:

- degradation of water quality (i.e., oxygen levels, light penetration, water temperature, water chemistry such as organic content and metals) leading to changes in primary production and food availability;
- changes in stream morphology and stream bed porosity leading to degradation of spawning substrates, holding pools, instream cover and overwintering habitat;
- reducing the diversity and abundance of bottom dwelling fish food organisms; and
- the destruction of aquatic vegetation that are buried by sediments.

The direct effects on fish include:

- behavioural responses - these are first level responses, usually temporary and not resulting in a change in health;
- minor physiological influences - where the fish may avoid the exposure but there may be effects to health due to exposure or reduction in food supply;
- physiological changes - due to long term exposure affecting life stages or feeding; and
- effects on eggs and larvae which cannot avoid areas of exposure - larvae are most sensitive, eggs are marginally more tolerant.

Sedimentation alters habitat by changing the physical characteristics, distribution and relative abundance of existing substrate types. These changes may result in changes in the carrying capacity of the population. Sedimentation may fill rearing pools, cover coarse substrates and alter channel flow, thereby reducing the suitability of habitat for existing communities of fish and aquatic invertebrates.

Sediment may clog interstitial spaces in gravel, preventing the flow of oxygenated water and removal of waste products from developing eggs deposited in the gravel (Rogerson 1986). This often lowers the dissolved oxygen content in the water, which can lead to suffocation and egg mortalities and may prevent further use of spawning areas (Beschta and Jackson 1979; Chapman 1988). Pore space size determines the percolation rate of water through substrate and also influences movement of emerging alevins through gravel (Lotspeich and Everest 1981). The elimination of sheltered areas between boulders and gravel particles will also affect juvenile fish distribution (Scrivener and Brownlee 1989). The benthic macroinvertebrate populations are also affected by changes to the physical habitat structure, causing changes in relative species abundance and community structure.

Acute lethal effects to fish from suspended solids are unlikely to occur unless the concentrations are high and exposure is chronic (Alabaster and Lloyd 1982). Trow Consulting Engineers Ltd. (1996) notes that impaired water quality can adversely affect fish by:

- clogging gills;
- damaging (abrading) gill membranes;
- reducing fish ability to feed by sight (reduced visibility);
- altering fish behaviour; and
- making fish susceptible to disease due to the added stress of a turbid environment.

These effects are species-dependent, as some fish are better adapted to higher suspended solid levels than others. The seasonal susceptibility of fish depends on life stages and migrations for some species, as outlined in Table 7.30. The information in the table is general and localized variations in timing may be encountered in areas of Labrador.

Table 7.30 Critical Periods for Fish in Labrador

Species	Life Stage or Activity				
	Spawning Migration	Spawning	Incubation	Hatching	Downstream Migration
Anadromous Species (sea-run)					
Brook Trout	Jun 20 - Sep 1	Sep 1 - Sep 30	Sep 1 - Jun 15	May 15 - Jun 15	Jun 15 - Jul 15
Atlantic Salmon	Jul 1 - Aug 31	Oct 1 - Nov 15	Oct 1 - Jun 15	Apr 15 - Jun 15	May 15 - Jun 15
Smelt	May 1 - Jun 15	May 1 - Jun 15	May 1 - Jul 15	Jun 1 - Jul 15	Jun 1 - Jul 15
Arctic Charr	Jul 1 - Sep 30	Oct 1 - Nov 15	Oct 1 - Jun 15	Apr 15 - Jun 15	May 15 - Jun 30
Resident Species (non sea run)					
Brook Trout	Aug 15 - Sep 30	Sep 1 - Sep 30	Sep 1 - Jun 15	May 15 - Jun 15	n/a
Landlocked salmon	Aug 1- Oct 31	Sep 15 - Oct 31	Sep 15 - Jun 15	May 15 - Jun 15	n/a
Lake Whitefish	Sep 1 - Oct 15	Sep 20 - Oct 30	Sep 20 - Jun 15	May 15 - Jun 15	n/a
Northern Pike	Apr 1 - Apr 15	Apr 15 - May 15	12-14 days	May 1 - May 30	n/a
Lake Trout	localized in lakes	Sep 1 - Oct 30	Oct 1 - Mar 15	Mar 15 - Apr 30	n/a
Source: Scruton et al. 1997.					

Sedimentation and siltation can be virtually eliminated during construction and operation, if proper mitigative steps are taken as discussed in Section 3.9.3. Current Canadian guidelines for suspended solids have been set by the CCME (2002 Update). Suspended solids should not increase by a level exceeding 10 mg/L when background suspended solids concentrations are equal to or less than 100 mg/L. Suspended solids should not increase by a level exceeding 10 percent of background concentrations when background concentrations are greater than 100 mg/L.

Sensitive habitats include spawning gravels, especially if they are at the site of construction, fording or immediately downstream. Eggs or alevins may be in the gravel between September to May of the following year. Eggs or alevins can be physically destroyed by fording activities or be displaced, becoming susceptible to predation or settling in less favourable habitat. Sediment that is mobilized during fording may settle on spawning habitat and cause smothering of eggs or alevins immediately downstream of the area of disturbance.

Clearing vegetation near riverbanks removes shaded habitat and increases bank erosion. Fish are sensitive to changes in water temperature (Kelsall et al. 1977). Shaded areas provide cooler temperatures during periods of warm, sunny weather. Any reduction in available spawning or rearing habitat or barriers to traditional spawning migrations routes could undermine the reproductive potential of the local stock.

Blasting can have physical and chemical effects on fish and fish habitat. Shock waves and vibrations from blasting can damage a fish's swim bladder and rupture internal organs, and may kill or damage fish eggs or alevins (Gosse et al. 1998; Wright and Hopky 1998). Blasting can cause resuspension of sediments (Munday et al. 1986), bank failure and resultant sedimentation, and habitat avoidance. Nitrogen-based explosives can affect aquatic life through direct toxicity of the compounds, reducing dissolved oxygen during nitrification and providing nutrients for aquatic plants. Nitrite is highly toxic to fish and can reduce the oxygen carrying capacity of blood; ammonia can cause gill damage and nitrate promotes algal growth. Pommen (1983) provides detailed information on the potential chemical effects of blasting. Guidelines for blasting near waterbodies, including specifications for blasting materials, their use, time of year and additional precautions, are outlined by DFO (Gosse et al. 1998; Wright and Hopky 1998).

Sulphide bearing rock may be encountered as a result of blasting and excavation along the highway route. Once exposed to the air, the sulphides may oxidize to produce ARD. This process is often accelerated by bacterial action on the exposed rock surfaces. The drainage from reactive rock surfaces will have a reduced pH, which may be detrimental to fish and aquatic fauna, particularly if the buffering capacity of local waters is low. The detrimental effects may be exacerbated by an elevation in dissolved metals such as arsenic, copper, aluminum, lead and zinc among others, which are often associated with sulphide bearing rock, and which will more readily dissolve at reduced pH. Once started, acid generation often accelerates and is difficult to stop at source.

There is ample literature on the potential effects of reduced pH and elevated metals on aquatic fauna, particularly in relation to the mining industry. Suffice it to say that as more parameters exceed the CCME Guidelines for the Protection of Aquatic Life (CCME 2002), the potential for harmful effects increase. Depending on the metal concentrations and the susceptibility or tolerance of specific fish or invertebrate species, the detrimental effects range from simple avoidance, to various degrees of impairment in reproduction, mobility and growth, to outright chronic or acute toxicity. Fortunately there are effective mitigations that will reduce the effects of acid rock drainage, and some of these are listed below, under geomorphology (Section 7.7) and water resources (Section 7.8). Unlike the mining industry, which is focusses on exploiting sulphide bearing mineralized rock, highway construction can detect and avoid the issue, wherever possible.

Hazardous materials spilled into the aquatic environment can contaminate food sources and fish eggs and alevins could be smothered (such as hydrocarbons), resulting in mortality. The nature and duration of these effects is dependent on the characteristics of the materials spilled and on-site specific factors such as species and life stages present, water temperature, wind conditions and water flow rates.

The introduction of liquid concrete products or wash residues into watercourses can destroy fish and aquatic plants due to sedimentation and changes in water chemistry (primarily pH). The control of deleterious discharges to waterbodies and the protection of fish habitat are covered under the federal *Fisheries Act* (Section 36(3)) and the operation of concrete batch plants are outlined in provincial guidelines (Department of Environment and Lands 1992).

The main concern with domestic sewage is the potential to increase nutrient loading, suspended sediment or introduce oil and grease or other contaminants into a watercourse. These introductions can lead to eutrophication of waterbodies, adverse sediment effects or water quality contamination.

Observations made in several studies describe the harmful effects of hydrocarbon contamination on aquatic life, including prevention of normal cell growth (Woodward et al. 1981; Tilseth et al. 1984). Levels of hydrocarbons above 10 ppm, water-soluble fraction, are toxic to fish but are not reached without vigorous mixing of the fuel and water. Invertebrates and developing fish eggs may be affected if located in shallow or turbulent water that is subjected to a fuel spill before any measurable dilution has occurred. There is little documentation concerning the effect of these contaminants on adult freshwater fish. Observations following the *Exxon Valdez* spill suggest that the Pacific salmon population in the area was not adversely affected by the presence of oil on the water surface (Baker et al. 1991). These marine effects are relevant to a migration of hydrocarbons from either Eagle River or Paradise River to Sandwich Bay. Although mortality may not result from exposure, these fish may experience some physiological stress when exposed to contaminants. Chronic and acute hydrocarbon contamination has been linked to tainting in fish flesh. In addition, the coating of the water surface by hydrocarbons could greatly reduce irradiance, and cause an effect upon levels of resident phytoplankton, which may affect the food chain for secondary producers (zooplankton and insect fauna). This in turn could reduce the food available to predators of these forms. A surface film of hydrocarbon may contaminate surface food (insects) that are taken by salmonids. Direct ingestion of hydrocarbons would likely be detrimental to those fish. The potential accumulation of hydrocarbons in stream sediment, with resulting re-mobilization at a later date or introduction into the food chain through the benthos, could prolong the duration of effects.

Several authors have reported that in the years following forest fires, sedimentation, alkalinity and temperature of streams and lakes in the area are increased, thereby slightly altering fish habitat in the affected area. However, the magnitude of change in these factors is dependent on the size of the burned area and the size and flow rate of affected streams. Smaller streams are probably more susceptible to habitat alteration as a result of fire than are large rivers (Kelsall et al. 1977).

Improperly installed culverts can impede fish migration either permanently or temporally. Complete barriers block the use of the upper watershed, which often provides the most productive spawning habitat. Fry produced in the upper portions of the watershed have access to the entire downstream watershed for rearing. Temporal barriers block migration some of the time and result in loss of production by the delay they cause (anadromous salmonids survive a limited amount of time in fresh water and a delay can cause limited distribution or mortality).

Some common conditions at culverts that create migration barriers include:

- excess drop at culvert outlet;
- high velocity within culvert barrel;
- inadequate depth within culvert barrel;
- turbulence within the culvert;
- debris accumulation at culvert inlet; and
- loss of flow beneath installed culvert (underflow).

Partial barriers block smaller or weaker fish of a population and limit the genetic diversity that is essential for a robust population. Fish passage criteria accommodate weaker individuals of target species including, in some cases, juvenile fish (WDFW 1999).

Culvert installations at a few locations along TLH - Phase II experienced water loss in the culvert, where most of the water flowed under the culvert barrel rather than through it, during low flow conditions. This was a result of the coarse fill used to embed the culvert pipe.

The issue of improved access leading to potential removal of excessive numbers of fish was addressed following the construction of TLH - Phase II by restrictions imposed by DFO on angling in the region. Restrictions were placed on brook trout fishing in two waterbodies (Gilbert Lake and Chateau Pond), which reduced the daily bag limit and possession limit. Modelled on the Indian Bay management plan, the restrictions were reduced season and bag limits on the recreational fishery. Other restrictions were placed on fishing in nine rivers (including Paradise River) that were designated as scheduled salmon rivers, with all of the regulations associated with that designation.

7.5.7 Mitigation

The WST is committed to minimizing adverse environmental effects of the project. Regulations, guidelines, codes of good practice, mitigation and environmental protection measures specifically related to the protection of fish and fish habitat are integral parts of the project description and environmental protection planning, and are outlined or detailed in Section 3.9.3 and include:

- watercourse crossing installation carried out in the dry by diverting or pumping water around the construction area;
- pipe arch culverts will be used on many streams;
- culverts will be countersunk where required to maintain a water depth in the pipe and to reduce any drop at the outlet;
- where the existing stream gradient warrants, baffles will be installed in the corresponding culverts to maintain a water depth to facilitate fish passage and to provide shelter from flow for smaller fish;
- all instream work will be carried out between June 30 and September 1, unless otherwise approved by DFO, to avoid sensitive periods for fish;
- fish will be removed from de-watered areas and returned unharmed to the watercourse;
- fording activities will be minimized or avoided, where possible;
- a 20-m buffer will be maintained along watercourses wherever possible ;
- riparian areas that must be disturbed will be stabilized to control erosion;
- during the clearing of the right-of-way, a temporary buffer zone will be left in place at each stream crossing until such time as the crossing is constructed;
- ARD potential will be investigated along the highway route to identify areas of potential acid generation and areas of acceptable source material and additional measures will be defined based on the results of the initial investigation;
- adherence to regulations, guidelines, codes of good practice;
- follow-up inspections verifying culvert installation and operation; and
- details provided in EPP.

There are no unique or extraordinary mitigation measures that apply to this project with regard to protecting fish and fish habitat.

Many of the potential adverse effects stem from the improved access provided by the highway, and the associated increase in human presence and activities in this previously remote area. Mitigating these potential effects is, for the most part, beyond the ability and responsibility of WST. Managing these actions and their potential effects will require the efforts of regulatory and resource management agencies, in order to ensure that applicable legislation and regulations are adequately enforced, and that future activities are undertaken in a responsible and sustainable manner. In this regard, the purpose of the environmental assessment is to identify these potential issues well in advance of their occurrence, so that appropriate measures can be identified and implemented by the appropriate agencies in an effective and timely manner.

During construction, WST is committed to maintaining and preserving existing fish habitat and fish stocks. To do this, WST will ensure that their personnel and those of the contractors are aware of the potential effects and appropriate mitigations required to reduce adverse effects, in order to ensure that applicable legislation and regulations are adequately enforced, and that all activities are undertaken in a responsible and sustainable manner. However, since the construction sites are not "closed" areas, such as the Voisey's Bay site where the project has control over who can come onsite and what they can/cannot do while on site, WST will not be able to ban fishing along the constructed route. The route must remain open as many of the construction personnel will commute from communities. Obviously, during work hours, WST and contractors can restrict activities of the workforce, but there is no authority to do this at other times.

Generally speaking, there will be no requirement for additional regulatory inspection or control to preserve fish and fish habitat during construction. WST have committed to close consultation with DFO during construction with regard to the design and placement of watercourse crossing structures. This will require site visits from DFO habitat management personnel.

An example of mitigation that could be implemented by regulatory agencies to reduce the anticipated effects during operations of the project, would be special recreational fishing regulations imposed on designated waterbodies in response to projected increases in angling effort. As noted above, this was done following the construction of TLH - Phase II. Paradise River was designated as a scheduled salmon river following the construction of TLH - Phase II, additional designations could be considered prior to the operation of outfitter route.

Continuing on this theme, the deficiency statement (Appendix A of the TLH - Phase III EIS/CSR Addendum) states: "Regarding the need for increase management measures to address potential effects on fish resources, DFO recognizes that new management approaches will be required to address the issues arising from Phase III of the Trans Labrador Highway. A regulatory amendment which will allow individual species management (in contrast to the current multi-species approach) is anticipated to be in place this year, and this will be a key component of DFO's management strategy for this area. In the fall of 2003, DFO will begin consultations with user groups, including aboriginal groups, in the development of its new five year management plan. DFO commits to the maintenance of aboriginal access to the resource for food, social and ceremonial purposed. The department has already had preliminary discussions in Goose Bay with the Labrador Salmonid Advisory Committee, which represents all major user groups. Key items discussed included the need for the development of a long-term management plan prior to the completion of the highway, monitoring and enforcement capacity, and the importance of education and public awareness in reducing the potential for detrimental effects on the fishery".

7.5.8 Environmental Effects Assessment

The following sections discuss the environmental effects of the proposed project on fish and fish habitat for each project phase.

7.5.8.1 Construction

Construction may have localized effects on fish and fish habitat. Effects will be limited to one construction season at any given location. Both instream and near-stream activities conducted during construction may affect fish and fish habitat from the point of disturbance to some distance downstream. The migration season is the most sensitive time of year for many fish species. The consideration of environmental sensitivities during the design of the project, with subsequent built-in mitigative measures as well as adherence to WST's standard mitigative measures to be developed and included in the construction EPP, will prevent or minimize any adverse effects. Also, WST's resident engineer or the ESO will ensure that the contractor complies with the EPP, and all permits, approvals and authorizations. WST also has the benefit of experience with the recently completed TLH - Phase II, which had similar challenges to those projected for outfitter route.

Any sedimentation and siltation, noise from construction activities, and discharges or spills into watercourses, may harm fish and/or fish habitat. While mitigation measures will minimize sediment disturbance, it is likely that temporary sedimentation will result from the limited instream construction. However, any sedimentation will be within permitted levels. Instream work, which may cause avoidance by fish and/or damage to local aquatic habitat, will be limited to the approximate "footprint" of the bridge foundation and culvert structures. With the proper mitigative and environmental protection measures, effects of sedimentation and siltation will be further reduced and environmental effects will be localized.

The proposed highway has not been surveyed; therefore, specific requirements for blasting have not yet been defined. It is anticipated that there will be requirements for blasting during construction, but it is unlikely that underwater blasting will be required. As well, blasting will not be required at all watercourse crossings. Noise (shock waves) from blasting could cause local disturbance to fish, resulting in short-term avoidance. Effects of blasting near watercourses will be reduced by timing activity to avoid sensitive seasons and by implementing additional measures as outlined by DFO (Gosse et al. 1998; Wright and Hopky 1998). With the proper mitigative procedures, as proposed by WST, it is anticipated that the environmental effects from blasting will be localized and limited to select watercourse crossings.

The potential effects of acid-generating rock can be greatly reduced by the identification of reactive rock sources. These areas may be avoided or the disturbance of such areas reduced to reduce the exposed rock surfaces (i.e., shallower cuts and careful control of waste). Drainage from such areas can be directed away from freshwater bodies to increase buffering of low pH. It is unlikely that actual treatment of drainage water (e.g., neutralization) would be required. With proper monitoring of the nature of source rock and excavated areas, and reasonable care of site drainage, the potential effects of ARD can be kept to a level that will not adversely affect fish and fish habitat.

Compliance with the existing provincial water and sewer regulations will ensure that adverse environmental effects from sewage are reduced to acceptable levels. WST is committed to ensuring that sewage and waste disposal for construction camps complies with the Department of Health guidelines and the *Environment Control Water and Sewage Regulation.*

Unless there is clear evidence that the stream where a culvert is to be located is not fish habitat, all watercourse crossings will be considered fish habitat and all structures will be designed and installed to provide fish passage. This will include proper siting and sizing of the culvert to ensure that water velocities are not excessive for any period of time beyond brief freshets. Many of the large culverts will be pipe arch culverts, to reduce the requirements for road fill (i.e., they have a lower profile with respect to capacity). Arch culverts provide a better range of flows for fish passage and often have substrate material settle in the culvert through bedload movement. Culverts will be adequately countersunk to maintain a minimum water depth in the culvert and avoid drops at the discharge end. Where required, baffles will be placed in culverts to provide cover and rest areas during fish passage and to provide adequate water depth for fish passage. These measures were applied with success in TLH - Phase II. One problem that did occur at a few locations along TLH - Phase II was the issue of water loss in the culvert during low flow conditions, where most of the water flowed under the culvert barrel rather than through it. This was primarily the result from using clean fill (blast rock) to embed the culvert - resulting in seepage through the rock fill. This will be rectified at the affected locations by sealing the inflow end with concrete. Measures will be taken to ensure the fill around culverts in the outfitter route is impermeable, to avoid water loss in the culvert. Gosse et al. (1998) provide DFO guidelines for proper culvert installation. WDFW (1999) also provide a comprehensive discussion on the issue of providing fish passage through culverts.

The permanent instream structures will include all culverts and bridges structures, where abutments are in the stream or pilings are placed for the three multi-span structures. These are not anticipated to cause destruction of productive fish habitat. In addition to these structures, there will be a partial causeway on the Churchill River, which will have a footprint of 25,000m^2. The existing foundation at the location of the proposed causeway is predominantly sand substrate. This substrate is not the most suitable habitat for spawning or rearing for any of the twenty species of fish reported in the lower Churchill River by Anderson (1985), particularly as most of the footprint area extends out into the river. The causeway will be constructed of clean rockfill with armour stone to protect the slopes from erosion. This texture will provide habitat and protection for some fish species.

7.5.8.2 Operation

Highway operation may affect fish populations (particularly salmonids) migrating to and from the upstream sections of the various watercourses. This effect will extend over the life of the highway. However, mitigative measures built into bridge and culvert design will reduce effects on migration. Regular inspection and maintenance will be conducted to avoid debris build-up or beaver workings in culvert inlets. Culverts will be kept free of blockages to avoid flooding and ensure that fish passage is not impeded.

Maintenance activities, such as grading and ice control, which will be limited to sand application, may also cause sediment to be deposited in the watercourses. Reasonable care in application of sand and controlling erosion from grading will reduce this effect substantially.

Improved access may lead to increased human presence around watercourses, in particular for fishing and cabin developments, if cabins are not specifically regulated, which may lead to increased disturbance in or near watercourses. Increased fishing pressure, either in compliance with all pertinent regulations, or in combination with increased potential poaching activities, will selectively remove reproductive adults from the localized fish populations. This, in turn, will reduce overall spawning activity and subsequent recruitment, to the detriment of the population. Recovery usually follows due either to a willful reduction in fishing effort based on low success rates, or due to resource management practices. Reversing the effects of ‘over-fishing’ may take some time, depending on the species and environmental circumstances.

Concern has been raised for the potential effects of airborne dust from highway operation on aquatic habitat and fish. Although this is a highly visible and possibly chronic phenomenon, the material that would be deposited in streams and ponds is mainly fine sediment. Accumulations of this material will be easily mobilized and flushed from the streams by high flows. The eventual fate will likely be ponds, lakes and other depositional areas as is the case for other suspended sediments.

7.5.8.3 Accidental Events

Fuel or chemical spills entering fish-bearing streams could temporarily degrade water quality and have subsequent effects on freshwater fish. In addition, contaminants can accumulate in sediments and be mobilized slowly over time. If a major spill of a highly toxic and soluble material were to occur at one of the watercourse crossings, the geographic extent would include both the crossing site and areas downstream in the watershed, potentially down to the mouth, depending on the quantity and toxicity of the material spilled. The time of year when effects would be most severe would be mid- to late September, through to hatch-out time for fry. Mortalities could potentially occur at all life stages of fish within the affected area. Changes in water quality could also affect other trophic levels, resulting in drift or direct mortalities of benthic organisms. Sublethal effects at the top and bottom of the affected area would include avoidance behaviour and disruption of migratory patterns. The extent of the effect would be dependent on the nature and volume of the material spilled. Again, the lack of detailed information on fish and fish habitat at each crossing location limits the ability to use these parameters in the context of an accidental event to evaluate alternatives.

The magnitude of the effect of a spill would be dependent on a number of factors, such as season, species, life stage. Reversibility of physical effects is high, due to the dynamic nature of lotic water systems and it, too, is dependent on species. The high spring flows and high bedload transport will effectively flush the system during the spring following the event. Insect populations would be replaced within a season or two; benthic drift from upper portions of the brook would re-establish other food resources. For resident fish populations, individuals from other portions of the watershed would re-establish within the affected area. For migratory fish populations, unaffected individuals of all age classes may be present in other areas of the watershed or may be at sea, depending on the time of the potential accidental event, allowing for re-establishment of these fish within the affected area over time. Migration runs of Atlantic salmon occur annually; therefore, re-establishment would probably increase the following fall.

Contingency procedures will be developed and included in the construction EPP to ensure that a fast and effective response will occur in the event of a spill.

The potential effects of a forest fire in the project area could be significant. A forest fire could alter water quality within streams, resulting in subsequent effects on the population of freshwater fish. Due to the limited number of available personnel during operation and the isolation of some areas, fire fighting capabilities would be limited. Fire within the project area could occur during any phase of the project due to lightning or human activities. Factors influencing the severity and duration of effects include time of year, extent of fire damage and type of fire (chemical, forest). Risk of forest fire is slightly higher than under natural conditions due to the presence of human activity along the highway route, which may be subsistence, recreational or commercial in nature.

A fire during late summer or early fall could interfere with migration and spawning of salmonid species if the interaction was of long duration. During early life stages (i.e., eggs, alevins), salmonids are more sensitive to the deposition of ash and sediment through runoff and have limited avoidance ability. Therefore, fires during the fall (spawning) and winter (incubation) present a greater risk to salmonid populations. Eggs are very sensitive to pH and temperature changes, thus a fire in the post-spawning period could result in high egg mortality. If the forest fire affects a large proportion of the stream and occurs during the late fall, the magnitude of the effect of such a fire would be moderate for salmonids. Reversibility of physical effects is high, but would occur over a number of years. Spring flows and high bedload transport will effectively flush the system during the spring following the event; however, erosion within the watershed would continue to contribute sediments to the stream system for a number of years. Changes to groundwater patterns and contribution to baseflow in the stream may be altered during this period due to changes in evaporation and infiltration rates. Restoration of bank stability and cool temperatures would rely on the re-establishment of riparian plant communities through vegetative succession.

As well, a temporary degradation of water quality due to increased sedimentation and culvert or concrete debris would occur in the event of highway failure or washout. This could have a subsequent effects on freshwater fish. Factors influencing the geographic extent, duration and magnitude of effects include time of year, and location in watershed. The extent of the effects of such a highway failure or washout on fish is predicted to be low due to the localized nature of the watercourse crossings and the normally limited amount of material that is available to be mobilized or displaced in a washout. Reversibility is high due to the dynamic nature of streams, high spring discharges and high spring bedload transportation.

Roads are most susceptible to washouts during the high flow period during and immediately following the spring snow melt. The highway design will focus on protection of the aquatic environment by incorporating buffer zones, drainage and erosion control features and very conservative culvert design criteria. Culverts will be installed with consideration for highway and stream gradient, ice conditions, bank stability and, where warranted, protection of fish habitat.

7.5.9 Environmental Effects Evaluation

The following definitions are used to rate the significance of the predicted residual environmental effects of the project on fish and fish habitat.

A **major (significant) effect** is one affecting a whole stock or population of a species in one of the watersheds in such a way as to cause a change in abundance and/or distribution beyond which natural recruitment (reproduction and in-migration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its former level within several generations. A residual environmental effect on fish habitat that has the same consequence for populations would also be a major residual environmental effect. Generally a major significant effect is not reversible.

A **moderate (significant) effect** is one affecting a portion of a population in one of the watersheds that results in a change in abundance and or distribution over one or more generations of that portion of the population, or any populations or species dependent upon it, but does not change the integrity of any population as a whole; it may be localized. A change in fish habitat (including food sources) that produces the same result in populations would also be assessed as a moderate effect. A moderate significant effect may or may not be reversible.

A **minor (not significant) effect** is one affecting a specific group of individuals in a population in one of the watersheds at a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself. As above, equivalent population environmental effects ratings are assigned to environmental effects on fish habitat. A minor effect is reversible.

A **negligible (not significant) effect** is one affecting the population or a specific group of individuals at a localized area and/or over a short period in such a way as to be similar in effect to small random changes in the population due to natural irregularities, but having no measurable environmental effect on the population as a whole.

Criteria for rating the significance of environmental effects on fish and fish habitat are population-based and were modified for this study after Conover et al. (1985). A population is defined as *a group of organisms of the same species occupying a particular area at the same time* (Curtis 1975). Fish populations under assessment are mainly resident and anadromous salmonid (brook trout and Atlantic salmon) stocks as well as other species of the five watersheds, through which the proposed outfitter route will cross. The populations (or stocks) under assessment extend throughout the wider region, beyond that bound by the study area. Residual environmental effects on fish populations associated with construction, operation and accidental events are summarized in Table 7.31.

Construction of the outfitter route will have minor (not significant) environmental effects. Effective mitigation and environmental measures will minimize effects during highway construction. The duration of any potential adverse effects on fish and fish habitat is limited to one construction season at any location.

Highway operation will have minor (not significant) environmental effects. The duration of the effect could be indefinite, as it would exist throughout the operation phase; the frequency reflects various maintenance schedules and natural perturbations. Again, knowledge and understanding of the potential effects of project operation on fish is reasonably high.

Accidental events would have a moderate (significant) environmental effect if these events occur. Due to the uncontrollable and unpredictable nature of events such as forest fires, and hazardous spills, potential exists for these events to occur. WST will implement mitigative measures to minimize the risk of these events occurring. However, accidental events (including hazardous materials spills, fires, and flooding/road washout) cannot be eliminated. Based on the environmental effects analysis, a worst-case accidental event would result in an adverse and moderate effect on fish and fish habitat. The likelihood of such events occurring is very low given the construction and design standards, and operating and maintenance procedures to be followed and routine monitoring. Reversibility is moderate.

Table 7.31 Environmental Effects Summary - Fish and Fish Habitat

	Construction	Operation	Accidental/Unplanned Events

Mitigation:

- watercourse crossing installation will be carried out in the dry by diverting or pumping water around the construction area;
- pipe arch culverts will be used on many watercourses;
- culverts will be countersunk, where required, to maintain a water depth in the pipe and reduce any drop at the outlet;
- where the existing stream gradient warrants, baffles will be installed in the corresponding culverts to maintain a water depth to facilitate fish passage and provide shelter from flow for smaller fish;
- all instream work will be carried out between June 30 and September 1, unless otherwise approved by DFO, to avoid sensitive periods for fish;
- fish removed from de-watered areas will be returned unharmed to the watercourse;
- fording activities will be minimized or avoided, where possible;
- a 20-m buffer will be maintained along watercourses, where possible;
- riparian areas that must be disturbed will be stabilized to control erosion;
- during right-of-way clearing, a temporary buffer zone will be left in place at each stream crossing until such time as the crossing is constructed;
- ARD potential will be investigated along the highway route to identify areas of potential acid generation and areas of acceptable source materials. Additional measures will be defined based on the results of the initial investigation;
- work will be carried out according to regulations, guidelines, and codes of good practice;
- follow-up inspections will be conducted to verify culvert installation and operation; and
- specific details will be provided in the construction EPPs.

Environmental Effects Criteria Ratings	Construction	Operation	Accidental/Unplanned Events
Magnitude	Nil - Low	Nil - Low	Low- High
Geographic Extent	1 to 10 km^2	1 to 10 km^2	11 to 100 km^2
Frequency (times per year)	< 10	< 10	< 10
Duration (months)	< 1	< 1	< 1
Reversibility	High	High	Moderate
Ecological/Socio-economic Context	May affect resource use and users, and tourism and recreation VECs	May affect resource use and users, and tourism and recreation VECs	May affect resource use and users, and tourism and recreation VECs
Environmental Effects Evaluation			
Significance	Not Significant (Minor)	Not Significant (Minor)	Significant (Moderate)
Level of Confidence	High	High	Moderate
Likelihood[1]	n/a	n/a	Low
Sustainable Use of Resources[1]	n/a	n/a	n/a

[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).

Environmental Monitoring and Follow-up:

- Resident engineer or the ESO will be on-site during highway and watercourse crossing construction.
- Regular monitoring along highway route evaluating flow, erosion, debris and sedimentation at watercourse crossings.
- Regular monitoring of public use of highway including accidents, spills and waste disposal.
- All project personnel will be briefed during environmental awareness sessions on minimizing construction effects to fish and fish habitat.

Key:

Magnitude:	High, Medium, Low, Nil or Unknown
Geographic Extent (km^2):	<1, 1-10, 11-100, 101-1,000, 1,001-10,000, >10,000 or Unknown
Frequency (events/year):	<10, 11-50, 51-100, 101-200, >200, Continuous or Unknown
Duration (months):	<1, 1-12, 13-36, 37-72, >72 or Unknown
Reversibility:	Reversible, Irreversible or Unknown
Context:	Existing Disturbance (High, Medium, Low, Nil or Unknown)
Significance:	Significant, Not Significant, Positive or Unknown
Level of Confidence:	High, Medium, Low
Likelihood:	High, Medium, Low or Unknown
Sustainable use of Resources:	High, Medium, Low or Unknown

7.5.10 Cumulative Environmental Effects

The potential environmental effects of the construction and operation of outfitter route on fish and fish habitat have been discussed in the preceding sections. Past and on-going development activity in the project area has been relatively limited. Fish resources in the region have been affected by resident and non-resident angling in the area, although the intensity and distribution of the recreational fishery in the area has been limited due to the relative inaccessibility of the project area to date. Fish populations are considered to be relatively stable at present, although the actual status of the stocks are poorly known.

Although there is some potential for direct interaction between the potential effects of the proposed highway on fish and fish habitat in combination with those of Phases I and II of the TLH, this would be largely limited to watersheds at the ends of the proposed new highway section (i.e., Paradise River and Churchill River). The effects to fish and fish habitat in the lower portion of the Churchill River by other past and ongoing activities include the Churchill Falls Power Project and various developments along the river. Potential new effects of the proposed Churchill River Power Project would focus on Gull Island; some distance upstream from Muskrat Falls, which is the limit to fish migration past the proposed Churchill River crossing of the outfitter route. However, for the most part, fish and fish habitat along most of the proposed highway route have been largely unaffected by human activity. Other past, ongoing and potential projects and activities elsewhere in Labrador, such as the Voisey's Bay Mine/Mill, have not or will not have an effect on fish populations which occur within the proposed project area. There is little potential for interaction between the effects of these actions and those of the proposed project.

The new highway will provide increased and year-round access to this previously remote area. As discussed previously, this will likely result in an increase in angling activity throughout the region, particularly in ponds and rivers which are in close proximity to the highway. The highway will also facilitate future resource development such as forestry, mineral exploration, cabin development, and other land and resource use activities which have the potential to affect fish and fish habitat. The various projects and activities which may be induced by the proposed highway are regulated under provincial and federal legislation and as such, there are measures available to assess and mitigate their potential adverse environmental effects. Forestry guidelines, for example, stipulate that a minimum 20-m (but more likely a larger) vegetation buffer be maintained along waterbodies during forest harvesting. This would provide a measure of protection to fish and fish habitat. These potential projects and activities will proceed only in compliance with applicable regulations, and many would themselves be subject to environmental assessment.

Details such as the likelihood, nature, location and timing of any actions induced by the outfitter route are not known and the control of most potential induced actions and related effects is beyond the ability and responsibility of WST. Control depends on appropriate enforcement, management and planning on the part of relevant regulatory agencies to ensure that any such effects are avoided or reduced. As a result, a number of assumptions have been made in considering induced actions in the cumulative effects assessment, including:

- other projects and activities will be subject to appropriate planning and management;
- other projects and activities will be subject to the appropriate government requirements (e.g., legislation, regulations and guidelines) for protecting crown resources;

- relevant government agencies will have adequate resources to effectively carry out their mandate with respect to enforcement;
- adherence to existing regulatory requirements will not measurably change; and
- the TLH - Phase III will be designated a protected road and subject to the *Protected Road Zoning Regulations* administered by MAPA.

With the implementation of these mitigation measures, particularly appropriate planning and enforcement, the proposed project is not likely to result in significant adverse cumulative effects to fish and fish habitat in combination with other projects and activities that have been or will be carried out.

In a case where relevant government agencies do not have the resources to adequately carry out their mandate, it is conceivable that violations may increase as a result. This is not projected to lead to a measurable change as far as the direct operation of the road is concerned as the effects would be limited to areas near the road and exposure of any local stock would be limited to one or two crossing locations. If unregulated forest harvesting, mining or cabin development occurs, a moderate (significant) cumulative effect (i.e., one affecting a portion of a population in one of the watersheds that results in a change in abundance and or distribution over one or more generations of that portion of the population, or any populations or species dependent upon it, but does not change the integrity of any population as a whole; it may be localized. A change in fish habitat (including food sources) that produces the same result in populations would also be assessed as a moderate effect) could conceivably be the result of these activities. However, this would only be the case for cumulative effects rather than direct operational effects, and it would only result from negligence or carelessness in the implementation of other projects or activities.

The various resource management agencies should consider a cooperative management or regional land use planning approach to managing the land and resources along the highway and surrounding area. In addition, the departments and agencies responsible for managing wildlife resources may need to review existing management policies and programs to ensure that they are appropriate. There may also be a need for agencies to increase their enforcement staff levels.

7.5.11 Environmental Monitoring and Follow-up

A resident engineer or the Environmental Surveillance Officer will be present during construction of all watercourse crossings to ensure proper bridge and culvert installation and proper sediment control techniques are used. DFO will be consulted throughout construction to ensure that bridges and culverts are installed according to agreed specifications. In addition, watercourse crossings and runoff from the highway will be monitored after construction to ensure that erosion and sedimentation are minimized and culverts do not become blocked.

Also, all bridges and culverts will be monitored during the spring runoff after construction to ensure that culvert and bridges along the route can adequately handle the large amount of water runoff during this time of the year. As an example of this, follow-up monitoring of the TLH - Phase II culvert installations was conducted by DFO in 2003 to determine which culverts need to be adjusted or if necessary replaced.

Regular monitoring will occur throughout operation, including a review of garbage disposal practices, requirements for washroom facilities, potential accidents and spills, culvert blockages and forest fire hazards.

Commencing in the summer of 2003, WST and the Inland Fish and Wildlife Division implemented a monitoring program designed to collect information on fish populations in affected watersheds. The study will provide baseline data for assessing the long-term effects of improved access on fish populations and it will support the development of management strategies to conserve fish populations if/when they become necessary. The study will be conducted over a 10-year period and will include data from the construction and operational phases of the TLH - Phase III. WST and the Inland Fish and Wildlife Division are seeking other partners for this work, which would permit an expanded focus. The results of this monitoring program will greatly enhance the database on existing conditions and provide information that will verify the assumptions made in this assessment.

7.6 Species at Risk

The species at risk considered for the assessment of the outfitter (A13 section) route are short-eared owl and harlequin duck. Short-eared owl and harlequin duck were chosen because they are listed as a species of special concern under COSEWIC and under the provincial *Endangered Species Act*. Short-eared owls are known to occur within the project region and, while there are no records of harlequin ducks breeding in the project region, the species has been documented breeding to the west and some individuals may make seasonal use of the area during migration.

Woodland caribou, specifically the MMCH, are considered threatened under COSEWIC and under provincial endangered species legislation. A detailed effects analysis for the MMCH is provided in Section 7.6.3. Therefore, this species is not considered in this section.

Other species at risk such as Barrow's goldeneye, peregrine falcon, eskimo curlew and wolverine are not likely to occur within the project region and are not specifically considered in this section. Flora species at risk were also not specifically included in this section as any such species occurring along the highway route will not be identified until a field study is completed following final determination of the highway alignment. This is the same type of procedure used during the EIS for Phase II (Red Bay to Cartwright). As a result of the rare plant surveys conducted for that phase of the TLH, alignment alterations were made to avoid some areas supporting uncommon plant species. The results of a review to identify potential rare plant sites along the outfitter (A13 section) route are outlined in Appendix C.

7.6.1 Boundaries

Project boundaries for species at risk are defined by the spatial and temporal extent of project activities and the anticipated zones of influence in the area surrounding the proposed highway route. This boundary for short-eared owl is a 2-km-wide corridor centered on the highway. For harlequin ducks, the boundary is 10 km on either side of watercourse crossings on rivers determined to be potential habitat.

The spatial environmental assessment boundary for short-eared owl and harlequin duck is defined as the range of the populations of these species which may occur in the project region. Predictions of environmental effects will be made for the eastern North American population of harlequin duck and the Atlantic Canadian population of short-eared owl.

Refer to Section 6.6.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion of boundaries for species at risk.

7.6.2 Methods

Numerous surveys have been conducted for harlequin ducks within the project region, including five aerial surveys conducted by the study team along the outfitter route between early May and late August 2003 (JW/MLP 2003a). As a result, there is sufficient baseline information available for undertaking the effects analysis for harlequin ducks.

The effects analysis for short-eared owls relies on available literature (including published and unpublished sources), as well as observations made during aerial surveys for waterfowl and raptors in 2003 (JW/MLP 2003a; 2003b).

7.6.3 Existing Environment

7.6.3.1 Short-eared Owl

The short-eared owl is an open ground hunter whose main prey is small mammals. The owl inhabits relatively open habitats such as marshes and tundra and is nomadic, covering extensive areas within its winter and summer range. In Canada, this species breeds in every province and territory, withdrawing from the northern parts of its range and remaining only in the southern parts of provinces in winter. Populations in Newfoundland and Labrador and the Maritimes have remained stable (Environment Canada 2002). Short-eared owls are found at low densities throughout their range; exact numbers are not known.

One short-eared owl was observed during a waterfowl survey of the outfitter (A13 section) route in July 2003. The individual was flying low over an area of open bog and scrub, typical hunting habitat for this species. The location of the observation is indicated in Figure 7.1.

Refer to Sections 6.1 and 6.6.3.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a), the Raptor Component Study completed for the preferred route (JW and LMSS 2003b) and the results of surveys along the outfitter (A13 section) route (JW/MLP 2003b) for further discussion on existing knowledge related to short-eared owls.

7.6.3.2 Harlequin Duck

Harlequin ducks have not been observed to breed in the project region. However, individuals may use the area during migration. The current estimate of the eastern North America wintering population is approximately 1,500 birds (Robertson and Goudie 1999) and 6,200 moulting harlequin ducks were counted along the western coast of Greenland during surveys in 1999 (Boertmann and Mosbech, cited in CWS 2000).

Refer to Sections 6.2 and 6.6.3.2 of the TLH - Phase III EIS/CSR (JW/IELP 2003a), the Waterfowl Component Study completed for the preferred route (JW and LMSS 2003a) and the results of surveys along the outfitter (A13 section) route (JW/MLP 2003a) for further discussion on harlequin duck.

7.6.4 Potential Interactions

During construction, the clearing of vegetation may result in the loss of nesting habitat for short-eared owl. Noise and general disturbance, including use of lights, blasting activities and vehicular movement during construction of the highway, may also disturb nesting or foraging short-eared owl. During operation, noise and regular vehicular activity may also cause disturbance, resulting in avoidance of habitat in the vicinity of the highway. Fire could destroy nesting and foraging habitat for short-eared owls. Collisions with vehicles may cause mortality to short-eared owls.

While harlequin ducks are not known to breed in the project region, potential interactions are discussed pursuant to Guideline requirements. Removal of riparian habitat at watercourse crossings may result in loss of nesting habitat for harlequin duck. Noise and general disturbance, including use of lights, blasting activities and vehicular movement, during construction of the highway and at watercourse crossings, may also disturb nesting or foraging harlequin ducks. Contamination of waterbodies resulting from spills of fuel or other hazardous materials or siltation could lead to oiling of harlequin ducks, as well as reduced foraging opportunities. Fire could destroy nesting habitat for harlequin ducks.

7.6.5 Issues and Concerns

Issue and concerns related to short-eared owls include:

- loss of nesting and foraging habitat due to vegetation removal;
- avoidance of habitat due to project-related disturbances (i.e., noise);
- loss of nesting and foraging habitat through fire; and
- mortality through vehicle collisions.

Issue and concerns related to harlequin duck (if they did occur in the project region) include:

- avoidance of habitat due to project-related disturbances (i.e., noise);
- removal of riparian nesting habitat at watercourse crossings;
- siltation from upstream construction activities that negatively affect invertebrate forage;
- alteration of nesting habitat as a result of fire; and
- mortality or lost foraging opportunities through spills of fuel or other hazardous materials.

7.6.6 Existing Knowledge

7.6.6.1 Short-eared Owl

There is little specific research with respect to the effects of roads on short-eared owls. However, studies done on other diurnal, open-ground species is applicable. Raptors will usually avoid areas of human presence and activity (Stalmaster 1987; Nelson 1979). However, there have been some reports of raptors continuing normal activities in areas of construction or human disturbance (reviewed in Nelson 1979). Raptors may experience mortality on roads, particularly if the road is traversing open country. The openness of the landscape and the lack of tall vegetation, particularly along the roadside, may cause raptors hunting in these open areas to see a flat landscape into which the road merges (Harding 1986).

Refer to Section 6.1 and Section 6.6.6.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further details on the environmental effects of disturbance and highways on short-eared owls and other raptors.

7.6.6.2 Harlequin Duck

While there is little research with respect to effects of roads on harlequin ducks, studies have been conducted on the effects of human disturbance. Human activities along the banks of rivers where harlequin ducks nest may adversely affect breeding success. While the species is tolerant of moderate disturbance, chronically disturbed areas may eventually be abandoned (Thomas and Robert 2000).

Refer to Section 6.2 and Section 6.6.6.2 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further details on the effects of disturbance and highways on harlequin duck (and other waterfowl).

7.6.7 Mitigation

WST is proposing to reduce the project's potential effects on short-eared owls and harlequin ducks through project design and planning. Specific mitigative measures for short-eared owl include the following:

- notification of Inland Fish and Wildlife Division if an active nest is encountered;
- minimization of vegetation removal to a maximum of 30 m within the right-of-way;
- drainage to and through wetlands will be maintained to ensure continued wetland function;
- blasting activities timed to avoid sensitive areas such as active nest sites;
- construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes, avoiding wetland areas wherever possible;
- no harassment of raptors (including short-eared owl) by project personnel;
- locations of raptors nests (including short-eared owl) will not be released to the public;
- WST will confer with Inland Fish and Wildlife Division on appropriate mitigations for all active short-eared owl nests found within 800 m of the highway; and
- vehicles will adhere to established speed limits and will yield to all wildlife.

Although harlequin ducks are not known to breed in the project region, WST is proposing the following specific mitigative measures:

- blasting activities coordinated to avoid sensitive areas such as incubation and early brood rearing areas;
- reduction or avoidance of in-stream activity;
- the highway right-of-way will be located a minimum of 20 m from the shoreline of waterbodies, where possible;
- construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes, avoiding riparian areas wherever possible;
- use of accepted practices for erosion control or slope stabilization;
- removal of riparian vegetation will be restricted to that required construction of watercourse crossings;
- WST will give consideration to using native species in any re-vegetation activities;
- construction camps will be located outside of riparian zones; and

- design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.

7.6.8 Environmental Effects Assessment

7.6.8.1 Construction

Short-eared Owl

The potential environmental effects of highway construction on short-eared owls will be similar for the preferred route and the outfitter route. There will be some loss of potential foraging and nesting habitat for short-eared owls through vegetation removal along the highway right-of-way. The amount of wetland or otherwise unforested area (includes lichen/soil barren) that will be removed is approximately 194 ha.

Noise and human disturbance during construction may cause short-eared owls to avoid habitat in the vicinity of the activity. Individuals may be particularly sensitive during the nesting and brood-rearing period from mid-May through mid-August.

Refer to Section 6.6.8.1. of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion on the environmental effects of highway construction on short-eared owls.

Harlequin Duck

The potential environmental effects of highway construction on harlequin ducks will be similar for the preferred route and the outfitter route. During construction, a minimum of 20 m of vegetation will be retained around all waterbodies that are adjacent to the highway route, where possible. In most areas, this amount of buffer will encompass the entire riparian zone around lakes and rivers, thereby ensuring that riparian habitat (potential harlequin duck habitat) function is maintained and there will be minimal disturbance to any harlequin duck that may be using habitat in the area of construction. There are no documented occurrences of harlequin duck within the project region. Therefore, the likelihood of individuals of the Labrador population being negatively affected by construction of the highway is negligible.

Refer to Section 6.6.8.1 of the TLH - Phase III EIS/CSR (JW/IELP 2003a) for further discussion on the environmental effects of highway construction on harlequin ducks.

7.6.8.2 Operation

Short-eared Owl

The potential environmental effects of highway operation on short-eared owls will be similar for the preferred route and the outfitter route. There will be no further loss of habitat during operation. An alteration of foraging patterns may result once the highway is in operation. However, a car moving along the highway without stopping would not likely be perceived as a threat to foraging short-eared owls in the vicinity. In the event of disturbance due to human presence, effects would be localized and short in duration.

Harlequin Duck

The potential environmental effects of highway operation on harlequin ducks will be similar for the preferred route and the outfitter route. There are no documented occurrences of harlequin duck within the project region. No additional riparian habitat will be removed during operation. The maintenance of a minimum 20-m vegetation buffer between the highway and adjacent waterbodies, where possible, will limit the effects of highway-related disturbance on harlequin duck. However, if resources agencies do not have adequate resources to plan or manage induced activities such as cabin development, harlequin ducks using rivers in the project area may be displaced by cabin construction and other human activities.

7.6.8.3 Accidental and/or Unplanned Events

Short-eared Owl

The potential environmental effects of an accidental or unplanned event on short-eared owls will be similar for the preferred route and the outfitter route. A forest fire could destroy nesting and foraging habitat for short-eared owls. However, short-eared owls living in the boreal ecosystem have adapted to a cycle of naturally occurring fires and the proportion of a population affected during any one fire would be small and burned areas will provide increased foraging opportunities as small mammal populations re-colonize these areas. While open ground hunters such as short-eared owls are at greatest risk for vehicle collisions, due to the low density of the species in the region and the low volume of traffic expected along the highway, there is likely to be little mortality of individuals.

Harlequin Duck

The potential environmental effects of an accidental or unplanned event on harlequin ducks will be similar for the preferred route and the outfitter route. An accidental spill of fuel or other hazardous materials into waterbodies or in riparian zones in the project area could cause mortality to harlequin ducks. A forest fire could destroy nesting habitat for harlequin ducks. However, this species has adapted to breeding in the boreal ecosystem where fires naturally occur on a regular basis and the proportion of the population affected during any one fire would be small. Also, as noted above, there are no documented occurrences of harlequin duck within the project area.

7.6.9 Environmental Effects Evaluation

The key potential interactions between project activities and species as risk such as harlequin duck and short-eared owl include direct disturbance and habitat loss. The following definitions are used to rate the significance of the predicted residual environmental effects of the project on species at risk:

A **major (significant) environmental effect** is one affecting the population of short-eared owl or harlequin duck in such a way as to cause a change in abundance and/or distribution beyond which natural recruitment (reproduction and in migration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its pre-project level within several generations. The effect is not reversible.

A **moderate (significant) environmental effect** is one affecting a portion of the population of short-eared owl or harlequin duck in such a way as to cause a change in the abundance and/or distribution of that portion of the population or any populations or species dependent upon it over one or more generations, but does not change the integrity of any population as a whole. The effect may not be reversible.

A **minor (not significant) environmental effect** is one affecting a specific group of individuals of the population of short-eared owl or harlequin duck in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself. The effect is reversible.

A **negligible (not significant) environmental effect** is one affecting a specific group of individuals of the population of short-eared owl or harlequin duck in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less) in a manner similar to small random changes in the population due to natural irregularities, but having no measurable effect on the population as a whole. The effect is reversible.

The proposed highway is a linear development that will avoid wetland areas, where possible, and will maintain a 20-m buffer of vegetation around waterbodies. Therefore, interactions between highway effects and short-eared owl or harlequin duck will be reduced. For both species, the environmental effects will be restricted to removal of habitat in the immediate highway corridor and potential noise disturbance during highway operation. If resources agencies do not have adequate resources to plan or manage induced activities such as cabin development, harlequin ducks using rivers in the project area may be displaced by cabin construction and other human activities. However, if harlequin ducks are using habitat in the project region, they are present at low densities and the potential for interaction with human activity is low. Based on the preceding discussion and proposed mitigations, the residual effects of the project on short-eared owl and harlequin duck are assessed as minor (not significant) for construction and operation (Tables 7.32 and 7.33). The residual effects of an accidental event on both species is also considered minor (Tables 7.32 and 7.33). Overall, the project is not likely to result in significant adverse environmental effects on short-eared owl or harlequin duck.

Table 7.32 Environmental Effects Summary - Short-eared Owl

	Construction	Operation	Accidental/Unplanned Events
Mitigation: • prior to construction each day, the right-of-way will be canvassed for any active migratory bird nests; • any short-eared owl nests found will be left undisturbed until nesting is complete; • notification of Inland Fish and Wildlife Division if an active nest is encountered; • minimization of vegetation removal to a maximum of 30 m within the right-of-way; • drainage to and through wetlands will be maintained to ensure continued wetland function; • blasting activities coordinated to avoid sensitive areas such as active nest sites; • construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes, avoiding wetland areas wherever possible; • no harassment of raptors (including short-eared owl) by project personnel; • locations of raptors nests (including short-eared owl) will not be released to the public; and • vehicles will adhere to established speed limits and will yield to all wildlife.			
Environmental Effects Criteria Ratings			
Magnitude	Low	Low	Unknown
Geographic Extent	<1 km^2	1 to 10 km^2	100 km^2
Frequency	Continuous	Continuous	<10
Duration	72	>72	>72
Reversibility	Reversible	Reversible	Unknown
Ecological/Socio-economic Context	Low		
Environmental Effects Evaluation			
Significance	Not Significant (Minor)	Not Significant (Minor)	Not Significant (Minor)
Level of Confidence	High	High	High
Likelihood[1]	n/a	n/a	n/a
Sustainable Use of Resources[1]	n/a	n/a	n/a
[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).			
Environmental Monitoring and Follow-up: • Inland Fish and Wildlife Division will be notified if any species at risk are identified during pre-construction raptor surveys or during construction.			

Key:

Magnitude:	High, Medium, Low, Nil or Unknown
Geographic Extent (km^2):	<1, 1-10, 11-100, 101-1000, 1001-10,000, >10,000 or Unknown
Frequency (events/year):	<10, 11-50, 51-100, 101-200, >200, Continuous or Unknown
Duration (months):	<1, 1-12, 13-36, 37-72, >72 or Unknown
Reversibility:	Reversible, Irreversible or Unknown
Context:	Existing Disturbance (High, Medium, Low, Nil or Unknown)
Significance:	Significant, Not Significant, Positive or Unknown
Level of Confidence:	High, Medium, Low
Likelihood:	High, Medium, Low or Unknown
Sustainable Use of Resources:	High, Medium, Low or Unknown

Table 7.33 Environmental Effects Summary - Harlequin Duck

	Construction	Operation	Accidental/Unplanned Events
Mitigation: • blasting activities coordinated to avoid sensitive areas such as incubation and early brood rearing areas; • reduction or avoidance of in-stream activity; • the highway right-of-way will be located a minimum of 20 m from the shoreline of waterbodies, where possible; • construction vehicles will remain in the right-of-way and all-terrain vehicles will use designated routes, avoiding riparian areas wherever possible; • use of accepted practices for erosion control or slope stabilization; • removal of riparian vegetation will be restricted to that required construction of watercourse crossings; • WST will give consideration to using native species in any re-vegetation activities; • construction camps will be located outside of riparian zones; and • design and implementation of fuel and other hazardous material spill contingency plans and emergency response in the event of an accident.			
Environmental Effects Criteria Ratings			
Magnitude	Low	Low	Unknown
Geographic Extent	<1 km^2	1 to 10 km^2	100 km^2
Frequency	Continuous	Continuous	<10
Duration	72	>72	>72
Reversibility	Reversible	Reversible	Unknown
Ecological/Socio-economic Context	Low		
Environmental Effects Evaluation			
Significance	Not Significant (Minor)	Not Significant (Minor)	Not Significant (Minor)
Level of Confidence	High	High	High
Likelihood[1]	n/a	n/a	n/a
Sustainable Use of Resources[1]	n/a	n/a	n/a
[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).			
Environmental Monitoring and Follow-up: • CWS will be notified if any species at risk are identified during pre-construction raptor surveys or during construction.			
Key:			
Magnitude:	High, Medium, Low, Nil or Unknown		
Geographic Extent (km^2):	<1, 1-10, 11-100, 101-1,000, 1,001-10,000, >10,000 or Unknown		
Frequency (events/year):	<10, 11-50, 51-100, 101-200, >200, Continuous or Unknown		
Duration (months):	<1, 1-12, 13-36, 37-72, >72 or Unknown		
Reversibility:	Reversible, Irreversible or Unknown		
Context:	Existing Disturbance (High, Medium, Low, Nil or Unknown)		
Significance:	Significant, Not Significant, Positive or Unknown		
Level of Confidence:	High, Medium, Low		
Likelihood:	High, Medium, Low or Unknown		
Sustainable Use of Resources:	High, Medium, Low or Unknown		

7.6.10 Cumulative Environmental Effects

If resources agencies do not have adequate resources to plan or manage activities such as cabin development, human disturbance around nesting and foraging areas may cause short-eared owls to be displaced. Similarly, uncontrolled access to wetlands by ATVs could result in noise disturbance or destruction of nests by ATVs. As short-eared owls are associated with open areas, forestry activity would have a negligible effect, although other activities such as mineral exploration may cause disturbance to short-eared owls. However, even if large numbers of people were to travel large distances from the highway on ATVs, the low density of short-eared owls in the region means that only a few individuals from the population would likely interact with such activity. As a result, even with inadequate planning or management of induced activities, the cumulative effects of highway development on short-eared owls is predicted to be minor (not significant) (i.e., one affecting a specific group of individuals of the population of short-eared owls in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself).

Travel through riparian zones is likely to increase in order to access waterbodies from the highway. Cabin development and forest harvesting in riparian zones may also occur, creating areas of permanent alteration to riparian habitat. With inadequate planning and enforcement, these activities could cause disturbance to breeding harlequin ducks and degrade water quality, thus affecting forage availability. Similarly, illegal harvesting of harlequin ducks could occur if hunting regulations are not enforced. However, if harlequin ducks are present in the region surrounding the proposed highway, they are present at low densities and the likelihood that unchecked induced activities would interact with harlequin duck is low. Therefore, the residual cumulative effects of highway development on harlequin ducks is predicted to be minor (not significant) (i.e., one affecting a specific group of individuals of the population of harlequin ducks in such a way as to cause a change in abundance and/or distribution in a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself).

The various resource management agencies should consider a cooperative management or regional land use planning approach to managing the land and resources along the highway and surrounding area. In addition, the departments and agencies responsible for managing wildlife resources may need to review existing management policies and programs to ensure that they are appropriate. There may also be a need for agencies to increase their enforcement staff levels.

For a detailed discussion on cumulative environmental effects, refer to Section 6.6.10 of the TLH - Phase III EIS/CSR (JW/IELP 2003a).

7.6.11 Environmental Monitoring and Follow-up

The Inland Fish and Wildlife Division and CWS will be notified in the event of encounters with any species at risk during pre-construction raptor surveys or during construction.

7.7 Geomorphology

Geomorphology encompasses a broad spectrum of surficial materials and landforms that result from the ongoing natural processes that shape the earth's surface.

7.7.1 Boundaries

The project boundary is the 40-m right-of-way and associated areas of physical disturbance. Although geomorphological features are not managed resources with an associated mandated regulatory agency, mineral or aggregate deposits that may be mined or quarried are administered by the Department of Mines and Energy. The area within which the environmental effects predictions are made is the highway right-of-way.

7.7.2 Methods

Information on the surficial materials, formed and shaped by geomorphological processes, is available on 1:250,000 scale surficial mapping prepared during the late 1960s and early 1970s by provincial and federal government geologists (i.e., Fulton et al. 1969; 1970). Using this available mapping, this study evaluated the surficial geology of an area covering approximately 5,000 km^2, within a 10-km zone, around the proposed highway (refer to Figure 4.8) . Existing information on the surficial geology of the 10-km zone surrounding the outfitter (A13 section) route was entered into a geographic information system (GIS) (Map Info GIS software was used). Mineral occurrences and bedrock geology were compiled from existing digital databases also available from the Department of Mines and Energy.

7.7.3 Existing Environment

Within the area surrounding the proposed outfitter (A13 section) route, the dominant surficial materials are glacial till, consisting of basal lodgement tills and ablation till. The glacial till, also referred to as morainal deposits, comprise more than 90 percent of the study area (Figures 4.7 to 4.10). The till covers much of the area as gentle rolling terrain. It was formed by the release and consolidation of debris from a glacier when the basal ice reached its pressure melting point as the ice moved; the moving ice aligned fragments of this debris, known as lodgement till, in the same direction as the flow of the glacier. Approximately 30 to 40 percent of the lodgement till occurs as a thin veneer, less than 1 m over bedrock. The other 50 to 60 percent occurs as a 1- to 5-m thick layer covering bedrock.

Morainal deposits are dominantly sandy and gravelly basal (lodgment) till. However, they can include ablation till and minor amounts of other drift materials, locally mantled by boulders and blocks. Other surficial materials found in the area are alluvial deposits (covering approximately 0.3 percent of the area) and glaciofluvial deposits (approximately 0.7 percent) (Figures 4.7 to 4.10). Fulton et al. (1969; 1970) outline the characteristics of these surficial materials:

- alluvial deposits are sand and gravel, 1- to 15-m thick, in the form of terraces and plains that formed as stream floodplains and deltas. Generally, they occur in large valleys and commonly overlie considerable thicknesses of finer-grained lacustrine or marine sediment. They can also be overlain by extensive bogs, where cemented soil horizons have impeded drainage.

- marine nearshore deposits are comprised of sand, gravel, boulders, and minor finer material less then 4 m thick, commonly developed on unconsolidated materials of other origins. These deposits are subdivided into two classes: gravel and sand 1- to 4-m thick, generally in the form of beaches and strand plains; and gravel, sand and boulders, with local pockets of finer material. These deposits commonly overlie and include areas of till. They are developed as a lag on till or by concentration of boulders due to the action of floating ice.

- marine and lacustrine sublittoral deposits are comprised of silt, fine-grained sand and clay, commonly laminated. They can have variable thickness and can exceed 100 m. They commonly occur in coastal sections of large valley or flat surfaces in places deeply dissected, commonly overlain by alluvial sand and gravel. These deposits are subdivided into three classes: fine-grained lacustrine deposits (rarely exposed but probably present at depth in many large valleys); fine-grained marine deposits, locally subject to landsliding and what appears to be failure by liquefaction; and fine-grained material undifferentiated as to depositional environment.

- glaciofluvial deposits are sand and gravel deposits of variable thickness (1- to 15-m) deposited by water from melting glaciers. Deposits occur as ridges, hummocks, terraces and plains, and are generally located within or at the mouths of valleys. Due to the discontinuous nature of many of these deposits, areas mapped as this unit may commonly contain other deposits.

No mineral deposits of economic significance are known to occur near the proposed TLH - Phase III. No recent mineral exploration activity has been reported near the proposed highway, and the closest activity is approximately 80 km to the southeast.

Soil types are considered similar to other types that have been identified in other areas of southern and eastern Labrador. There has been limited development activity in the area of the proposed highway. Therefore, it is not anticipated that any contaminated soils will be encountered.

As outcrop exposure along the outfitter route is relatively limited, the disturbance of any potential acid-generating rock will be limited. There are seven mineral occurrence sites, identified by past reconnaissance mapping and sampling, in the vicinity of the outfitter route. These were identified by the provincial Department of Mines and Energy, presented in the Mineral Occurrence Database (MODS), and represent areas of outcrop that contain anomalous traceable quantities of that mineral. However, five of these occurrences are common to the preferred route (four on the eastern portion and one in the vicinity of Happy Valley-Goose Bay). On the A13 section of the outfitter route, there were two mineral occurrences identified (Figure 4.3). Neither of these two mineral occurrences are associated with sulphide-bearing rock (i.e., the rock that hosts minerals having acid generating potential). The lithologies along the proposed highway route that typically contain higher amounts of sulphide minerals are metasedimentary gneiss, mafic intrusions and sedimentary rocks. The potential areas for ARD are shown on Figures 4.3 to 4.6. Field investigations will be conducted prior to highway construction to identify acid-bearing rocks, with subsequent application of mitigation and/or design modification (Section 3.4.2.4).

The proposed highway occurs within an area defined as having isolated patches of permafrost (0 to 10 percent) (NRCAN 2002). If encountered, permafrost is most likely to occur in areas of thick peat or organic deposits.

7.7.4 Potential Interactions

The areas where highway construction and quarrying occurs, or where temporary construction camps and laydowns areas are established, will be physically disturbed. The extent of disturbance will be a function of highway design and construction methods and will be related to watertable location, proximity of waterbodies, drainage regimes, type of surficial material, and terrain type.

7.7.5 Issues and Concerns

Where construction activities interact with the natural environment, there are several potential issues and concerns which will require planning and management. These issues and concerns are typical of most construction projects and include exposure of acid-generating rock, slumping and erosion of soil, removal of fill material, and disturbance to areas of permafrost.

7.7.6 Existing Knowledge

Highway construction typically requires placement or the removal of soil or rock materials to achieve the desired design grades. Where the highway requires a cut through potentially acid-generating rock, ARD may be promoted when the rock is exposed to water and air. This ARD can affect water quality in the surrounding area.

Highways constructed over native soil deposits may be prone to instability resulting in slope failures, slumps, lateral spread of organic terrain, or landslides. Although potentially acid-generating rocks were identified during preliminary discussions with geologists from the Department of Mines and Energy when the TLH - Phase II was being planned, later ground-truthing and field investigation, along with chemical analyses, confirmed that the rocks in the area of the highway construction would not produce harmful effects to the surrounding area. Similar rocks types have been identified in the Phase III project area.

In order to meet the requirements for the design grade of a highway, landforms may be altered or removed. For example, an esker may be used for quarry or borrow material or it may be covered by the bed of the highway.

The TLH - Phase II indicated that the highway traversed fine-grained marine deposits where slumping (soil instability) was predicted. These potentially problematic soils were identified during initial geotechnical investigations, and the anticipated slumps or soil failures were controlled or managed during construction. Similar soil conditions have been identified in the western portion of the proposed TLH - Phase III, approximately 10 km south of Happy Valley-Goose Bay (refer to Figure 4.7).

When highways are constructed over permafrost areas, thawing may occur. Thawing could lead to soil instability and subsequent damage to the highway bed, altered drainage patterns in the area, or increased siltation to nearby waterbodies.

7.7.7 Mitigation

WST is committed to minimizing adverse environmental effects of the project. Specific mitigative measures to address issues related to geomorphology include:

- the highway will be designed according to acceptable standards of practice reflecting the geotechnical characteristics of the native soils and fill materials;
- rock for highway construction, from areas determined to have acid-generating rock potential, will be tested and only materials with less than 0.3 percent total sulphur would typically be used for construction;
- minimize disturbance to eskers and other landforms, where possible;
- use material obtained from excavations within the right-of-way, where possible;
- minimize number of borrow pits established and deplete resources of borrow pits, where practical, before establishing new borrow pits;
- geotechincal field investigation for best design of highway embankments and slopes (areas of cuts and in-fill); and
- field investigation to examine areas of potential permafrost.

7.7.8 Environmental Effects Assessment

7.7.8.1 Construction

The proposed highway will cross fine-grained marine deposits in the western portion of its route. The potential for slumping will be identified during geotechnical investigations, and slumps or soil failures will be controlled or managed during construction using techniques similar to the ones used during the construction of the TLH - Phase II.

In the areas where acid-generating potential has been identified, ground-truthing and field investigation will be conducted. Geochemical assessment of potential acid-bearing rocks will be conducted prior to construction to determine sulphur content. Only materials with less than 0.3 percent total sulphur will be used for highway construction, and the highway will be designed to avoid exposing materials that may generate acid.

A number of eskers occur in the area of the outfitter (A13 section) route. The eskers that interact with the right-of-way tend to cross perpendicular to the route. Few drumlins occur in the right-of-way and those that do also cross perpendicularly to the highway route. No major morainal ridges will be affected by highway construction (Figures 4.8 to 4.11).

The project area is within a zone where permafrost is considered sporadic and may occur in up to 10 percent of the area. The likelihood of encountering permafrost along the highway route is low. However, the potential for permafrost along the route will be assessed prior to construction.

7.7.8.2 Operation

There are no planned activities that will result in physical disturbance during operation. Some borrow pits developed during construction may continue to be used during operation and maintenance. No additional landforms will be altered or removed during highway operation and no additional construction activities will occur to interact with areas of permafrost. As well, no additional bedrock will be exposed, thereby eliminating any additional potential for generation of acid runoff to the environment.

7.7.8.3 Accidental and/or Unplanned Events

Slumping or erosion may occur following unusually heavy rainfalls or spring runoff. The likelihood of this occurring is low as the highway will be designed and constructed to meet the worst anticipated conditions based on historical precipitation and other weather patterns in the region. With implementation of appropriate design specifications and construction methods, slumping or erosion along the TLH - Phase III is unlikely to occur. In the event that slumping or erosion occurs along the highway route, the effects will likely be of short duration and relatively localized. The most obvious effect would be sedimentation of nearby waterbodies or wetlands. If the event occurred in an area with extensive wetlands or a large river or waterbody, sedimentation could occur over a relatively large area.

7.7.9 Environmental Effects Evaluation

The following definitions are used to rate the significance of the predicted residual environmental effects of the project on geomorphological components of the environment.

A **significant environmental effect** is one that alters geomorphological features along the highway right-of-way, such that there is a measurable, sustained degradation in water quality as a result of the exposure of acid-generating rock, slumping and erosion, and/or disturbance to permafrost.

A **not significant environmental effect** is one that does not alter geomorphological features along the highway right-of-way, such that there is a measurable, sustained degradation in water quality as a result of the exposure of acid-generating rock, slumping and erosion, and/or disturbance to permafrost.

The environmental effects of the project will be restricted to possible removal of some portions of eskers and drumlins in the immediate highway corridor. Based on the preceding discussion and proposed mitigations, the residual effects of the project on the geomorphological environment are predicted to be not significant for construction, operation, and accidental events (Table 7.34). Overall, the project is not likely to result in significant adverse environmental effects.

Table 7.34 Residual Environmental Effects Summary - Geomorphology

	Construction	Operation	Accidental/Unplanned Events

Mitigation:

- the highway will be designed according to acceptable standards of practice reflecting the geotechnical characteristics of the native soils and fill materials;
- source materials for highway construction will be tested for acid-generating potential and only materials with less than 0.3 percent total sulphur would typically be used for construction;
- minimize disturbance to eskers and other landforms, where possible;
- use of material obtained from excavations within the right-of-way, where possible;
- minimize number of borrow pits established and deplete resources of borrow pits, where practical, before establishing new borrow pits;
- geotechincal field investigation for best design of highway embankments and slopes (areas of cuts and in-fill); and
- field investigation to examine areas of potential permafrost.

	Construction	Operation	Accidental/Unplanned Events
Environmental Effects Criteria Rating			
Magnitude	Low	Low	Low
Geographic Extent	<1	<1	11 to 100
Frequency	<10	<10	<10
Duration	37-72	>72	Unknown
Reversibility	Irreversible	Irreversible	Irreversible
Ecological/Socio-economic Context	n/a		
Environmental Effects Evaluation			
Significance	Not Significant	Not Significant	Not Significant
Level of Confidence	High	High	High
Likelihood[1]	n/a	n/a	n/a
Sustainable Use of Resources[1]	n/a	n/a	n/a

[1] Likelihood is only defined for effects rated as significant, and Sustainable Use of Resources is only defined for those effects rated as significant and likely (Canadian Environmental Assessment Agency 1994).

Environmental Monitoring and Follow-up:

- Field investigation to ground-truth sites identified as having acid-generating rock potential will be conducted prior to construction.
- Surveillance monitoring for potential acid-generating rock may be required during construction.
- Laboratory screening for total sulphur and acid base accounting. Follow up with tests for total metals, inorganic carbon and paste pH, where required.

Key:

Magnitude:	High, Medium, Low, Nil or Unknown
Geographic Extent (km^2):	<1, 1-10, 11-100, 101-1,000, 1,001-10,000, >10,000 or Unknown
Frequency (events/year):	<10, 11-50, 51-100, 101-200, >200, Continuous or Unknown
Duration (months):	<1, 1-12, 13-36, 37-72, >72 or Unknown
Reversibility:	Reversible, Irreversible or Unknown
Context:	Existing Disturbance (High, Medium, Low, Nil or Unknown)
Significance:	Significant, Not Significant, Positive or Unknown
Level of Confidence:	High, Medium, Low
Likelihood:	High, Medium, Low or Unknown
Sustainable Use of Resources:	High, Medium, Low or Unknown

7.7.10 Cumulative Environmental Effects

Past and on-going development activity in the project area has been relatively limited. Therefore, it is unlikely that surficial or bedrock geology have been previously disturbed along most of the outfitter route. Recreational and subsistence resource use activities in the area are not likely to have any effect on geomorphology. Other past, ongoing and potential projects and activities elsewhere in Labrador, such as the TLH - Phases I and II and other roads, the Voisey's Bay Mine/Mill, hydroelectric development and related transmission infrastructure, and low-level flying activity, have not or will not have an effect on geomorphology within the proposed project area. Therefore, there is little potential for interaction between the effects of these actions and those of the proposed project.

Potential future development activities which may occur as a result of the access provided by the highway once it is operational (such as forestry, mineral exploration and mining) may affect geomorphology in the project area. Details such as the likelihood, nature, location and timing of any such actions induced by the TLH - Phase III are not known and legislation and regulations are in place to control these projects and activities and their potential environmental effects. Appropriate management and planning on the part of relevant regulatory agencies will ensure that any such effects are avoided or reduced.

If the appropriate planning is not applied, surficial features could be affected. For example, uncontrolled quarrying activity could result in the disturbance of glacial features such as moraines, eskers, and drumlins, or exposure of acid-generating rock. However, quarrying activity would likely only occur close to the highway and the potential for acid-generating rock along the proposed highway route is low. As a result, a not significant cumulative effect (one that does not alter geomorphological features along the highway right-of-way, such that there is a measurable, sustained degradation in water quality as a result of the exposure of acid-generating rock, slumping and erosion, and/or disturbance to permafrost) is predicted.

The various resource management agencies should consider a cooperative management or regional land use planning approach to managing the land and resources along the highway and surrounding area. In addition, the departments and agencies responsible for managing wildlife resources may need to review existing management policies and programs to ensure that they are appropriate. There may also be a need for agencies to increase their enforcement staff levels.

With the implementation of these mitigation measures the proposed project is not likely to result in significant adverse cumulative effects on geomorphology in combination with other projects and activities that have been or will be carried out.

The creation of the Akamiuapishku/Mealy Mountains National Park would provide increased protection to geomorphological features in the proposed project area from the effects of human activities, such as use of motorized vehicles, forest harvesting and potential mineral exploration and development activities.

7.7.11 Environmental Monitoring and Follow-up

Following finalization of the detailed highway route, and prior to construction, a geological field investigation will be required to determine the actual condition of bedrock in areas where there is potential for ARD to occur. Testing will include laboratory screening for total sulphur, followed by analysis using the modified Sobek method (or other approved acid base accounting test), if required. Based on test results, further tests will be conducted on a select number of samples that are found to be "acid producing". These tests may include metals scan, total inorganic carbon and paste pH.

Similar field investigations will be required to characterize the nature and geotechnical parameters of the surficial soils and bedrock for highway design.