HAMLET OF TUKTOYAKTUK, TOWN OF INUVIK
GOVERNMENT OF NORTHWEST TERRITORIES

ENVIRONMENTAL IMPACT STATEMENT FOR CONSTRUCTION OF THE INUVIK TO TUKTOYAKTUK HIGHWAY, NWT





REPORT

MAY 2011
ISSUED FOR USE
EIRB FILE NO.: 02/10-05
EBA FILE: V23201322.006

KIGGIAK - EBA

Hamlet of Tuktoyaktuk, Town of Inuvik,
Government of Northwest Territories

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May 2011

EIS Inuvik to Tuktoyaktuk Highway.doc

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EXECUTIVE SUMMARY

INTRODUCTION

Since the 1960s, the completion of the Inuvik to Tuktoyaktuk Highway (the Highway) has been a long standing goal of the Town of Inuvik, the Hamlet of Tuktoyaktuk and the residents of the Inuvialuit Settlement Region. The first initiative to construct the Highway Project took place in 1974 when Public Works Canada (PWC) identified and surveyed a 140 km land route between Inuvik and Tuktoyaktuk. Preliminary engineering studies were undertaken on this route at that time. Quarry sources were identified and survey maps and design profiles were produced.

In the 1990s, the Government of the Northwest Territories (GNWT) reviewed earlier studies, collected additional environmental and socio-economic information, conducted community consultations, and re-examined the routing and the design. In 1998, the GNWT produced a comprehensive report entitled the "Proposed Inuvik to Tuktoyaktuk Road Environmental and Socio-Economic Baseline Report". Further studies, including a Cost Benefit Analysis, were completed in 1999. The October 1999 GNWT Department of Transportation Highway Strategy identified the completion of the Highway as one of the Strategy's goals.

Building upon the Highway Strategy, the GNWT included the Inuvik to Tuktoyaktuk Highway as a potential project in a number of strategic funding proposals to Canada for infrastructure development including "Investing in Roads For People and the Economy" (November 2000), "Corridors For Canada" (May 2002) and "Connecting Canada – Coast to Coast to Coast" (November 2005).

These funding proposals and other supportive actions have resulted in the federal government's renewed interest in developing road and other infrastructure in the arctic, through cost-shared funding including the current Building Canada Plan (BCP) program. BCP funding led directly to the development of the first new road project in the Northwest Territories, the 19 km all-weather access road from Tuktoyaktuk south to Granular Source 177. This stretch of road is located along the proposed alignment of the Inuvik to Tuktoyaktuk Highway. Construction on this road began in the winter of 2009 and was completed with the exception of a final surface topping in the summer of 2010.

PROJECT PARTNERSHIP (DEVELOPER)

The Project Partnership, generally referred to collectively as the Developer or Project Team, for the proposed Inuvik to Tuktoyaktuk Highway are the Hamlet of Tuktoyaktuk, the Town of Inuvik and the GNWT Department of Transportation (DOT). In September 2009, the three parties signed an MOU to see work on the Project Description Report (PDR) for the Inuvik-Tuktoyaktuk Road completed. Initial funding for this work was provided directly by the Canadian Northern Economic Development Agency (CanNor).

Two of the partners, DOT and the Hamlet of Tuktoyaktuk had previously collaborated to facilitate the development of the all-weather access road from Tuktoyaktuk to Granular Source 177. This project, which is generally considered to be a success, with only few and minor concerns arising (i.e. DFO concerns with culvert heights) has provided the current Project Partnership with much experience and information on construction techniques and related environmental management that will be utilized for the current Project.

PROJECT RATIONALE

The Inuvik to Tuktoyaktuk Highway provides the opportunity for major potential benefits for the region, for the North, and for Canada as a nation.

Based on the most recent economic analysis presented in this EIS, the construction of the Inuvik to Tuktoyaktuk Highway is expected to cost about $230 million. However, the resulting direct, indirect and induced economic spin-offs over the lifespan of the Highway are expected to generate about $248 million in net purchases of goods and services (material inputs) in the NWT and an additional $97 million in the rest of Canada. Furthermore, the Highway is projected to contribute to a net increase in GDP to the NWT of about $186 million and an increase in GDP in the rest of Canada of $84 million. The four year main construction period is estimated to create about 1,086 one-time (construction-related) jobs in the NWT and another 860 one-time jobs in the rest of Canada, with a more limited number of long-term jobs and business opportunities related to the ongoing operation and maintenance of the Highway.

The construction of the proposed Highway will achieve the following goals:

- Complete the Highway to the arctic coast and provide year-round overland access to Tuktoyaktuk;
- Reduce the cost of living in Tuktoyaktuk by enabling goods to be shipped year-round;
- Provide Tuktoyaktuk residents with cheaper, easier and safer access to regional services including:
  - Health care;
  - Educational opportunities; and
  - Recreational opportunities.
- Enhance opportunities for family, social, recreational and sporting interactions by providing year-round access between communities;
- Promote the tourism and hospitality industry in Inuvik and Tuktoyaktuk;
- Strengthen Inuvik's role as the regional commercial hub;
- Provide more opportunities for business expansion;
- Reduce costs of future oil and gas exploration and development and encourage new activities;
- Reduce the cost of government services delivered to Tuktoyaktuk and the Region;
- Support national security and northern sovereignty objectives; and
- Deliver on current governmental policies to stimulate the economy in response to the recent economic downturn.

In summary, the construction of the Highway Project will help to address the goals of bolstering Northern economic development; enabling future natural resource exploration, development and production; and reinforcing Canadian sovereignty objectives.

CONSULTATIONS

Meetings and consultation sessions for the proposed Highway were held in Inuvik and Tuktoyaktuk in October 2009 and January 2010. These meetings were an important opportunity to share information about the Project with the communities and to hear directly from residents about their interests, questions and concerns.

The first round of meetings and consultations in October, 2009 served to provide the communities, organizations, and regulatory agencies with an introduction to the proposed Inuvik to Tuktoyaktuk Highway Project (see Figure 1); to identify the Project Partnership, Project status, anticipated study and review schedule; to answer preliminary questions; and to receive advice, input and recommendations. Key messages from the October consultations highlighted the importance of the Husky Lakes area to the communities. Some residents of Tuktoyaktuk and Inuvik requested an examination of other possible alignments, in particular, Alternative 2 (also known as the Upland Route). There was a distinct interest in receiving engineering and preliminary design detail that would be comparable to the Primary 2009 Route.

The second round of meetings and consultations, held in January, 2010, allowed the Project Team to respond to questions and issues raised during the October 2009 consultations; to solicit community feedback on the updated Project information; and to gauge the perceived acceptability of the Primary 2009 Route for submission to the EISC screening process that was ongoing at that time. The two community meetings, held concurrently in Inuvik and Tuktoyaktuk on January 14, 2010, were well attended and the overall response arising from both meetings was that there was a high level of support for the Highway.

A number of community members indicated their general confidence in the ability of the Inuvialuit co-management bodies and other regulatory agencies to protect their environmental, cultural, and socio-economic interests in relation to the Highway Project.

Following referral of the Project by the EISC to the EIRB for further assessment and review in April 2010, community scoping sessions were held by the EIRB in Tuktoyaktuk and Inuvik. Prior to participating in those sessions, the Project Team had received some additional input from Inuvialuit interests on a possible further refinement of one of the alternative minor realignments being considered by the Project Team in the vicinity of the Husky Lakes area.

This refinement, referred to as Alternative 3 (2010 Minor Realignment) recommended by Inuvialuit interests, was presented during the scoping sessions by the Project Team as another potential alignment that warranted further consideration. This alignment not only preserves and increases the setback of the Highway from Husky Lakes but it would also shorten the overall length of the Highway by about 2 km.

Following the EIRB scoping sessions, the Inuvialuit Land Administration arranged an additional but complementary series of consultation meetings on the Highway Project in Tuktoyaktuk and Inuvik in November of 2010. The meetings were attended by 30 people in Inuvik and 98 people in

Tuktoyaktuk. While some were concerned with the routing, environmental, and wildlife effects, the beneficiaries supported the concept of a highway between Inuvik and Tuktoyaktuk.

Regarding the proposed alignment of the Highway in the vicinity of the Husky Lakes, the participants in the Tuktoyaktuk meeting expressed particular support for Alternative 2 (Upland Route) because this route is furthest from the Husky Lakes. The Inuvik participants voiced less concern about the realignment options under consideration, but some indicated that the Alternative 3 (2010 Minor Realignment) recommended by Inuvialuit interests was a good compromise between the Alternative 2 (Upland Route) and the Primary 2009 Route (proposed route).

ROUTE ALIGNMENT ALTERNATIVES

Based on the community inputs from the October 2009 consultation sessions, the Project Team conducted a more detailed evaluation of several alignment options. The alternatives that were initially considered are illustrated in Figure 1 and include:

- Primary Alignment - the Primary 2009 Route, which is an updated and refined version of the 1977 PWC alignment, but includes a minor encroachment on the Husky Lakes 1 km setback;
- Alternative 1 – the 2009 Minor Realignment of the Primary 2009 Route to fully achieve the Husky Lakes 1 km setback requirements; and
- Alternative 2 - the Upland Route, which diverts west from the Primary 2009 Route about 70 km north of Inuvik and re-joins the alignment near Source 177.

Also shown in Figure 1 is the proposed Alternative 3 (2010 Minor Realignment) recommended by Inuvialuit interests. The Project Team considers this alternative alignment in the Husky Lakes area to be a promising route option, but has not yet been able to assess the engineering considerations related to this option in the field. As a result, modeling results to more accurately identify the necessary geometric design factors are not yet available. However, Alternative 3 is similar to Alternative 1 (2009 Minor Realignment), in that it does not encroach on the Husky Lakes setback, yet it is shorter in length at approximately 135 km. If the Inuvik to Tuktoyaktuk Highway Project is approved, Alternative 3 would be further considered and likely adopted in the detailed design stage based on additional information to be gathered in future survey, geotechnical and other investigations.

Borrow material quantities and cost estimates were based on the conceptual designs for the alignments initially considered. Table 1 summarizes the overall quantity and cost estimates for each alignment. The quantity estimates include future upgrading of the now existing Tuktoyaktuk to Source 177 Access Road, based on the proposed Highway design. Table 1 differentiates between Highway surfacing material and embankment (base or subgrade) borrow material requirements.

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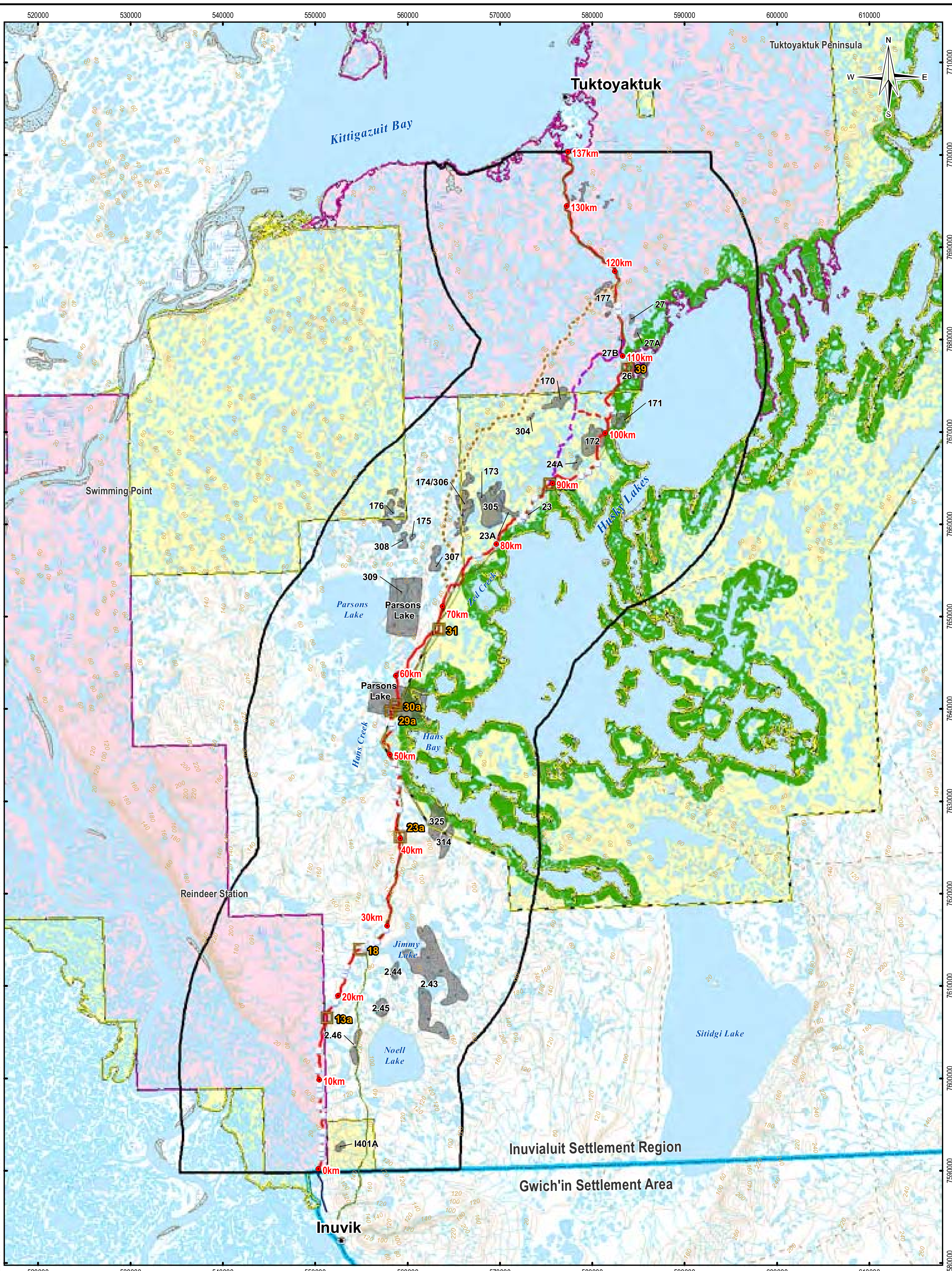

LEGEND

- Stream Crossing
- Stream Crossing - Potential Bridge
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Primary 2009 Route and Other Alternative Alignments Considered

PROJECTION: UTM Zone 8
DATUM: NAD83
Scale: 1:400,000 (Kilometres)
FILE NO.: V23201322_EIS_Map033_ExecutiveSummary.mxd
PROJECT NO.: V23201322 | DWN: SL | CKD: TS | REV: 0
OFFICE: EBA-VANC | DATE: May 2, 2011

Figure 1

TABLE 1: SUMMARY OF QUANTITY AND COST ESTIMATES FOR ALIGNMENTS CONSIDERED

Element	Primary 2009 Route	Alternative 1 (2009 Minor Realignment)	Alternative 2 (Upland Route)
Estimated Highway Length	137 km	142 km	134 km
Estimated Embankment Quantity	4.5 million m^3	4.8 million m^3	5.4 million m^3
Estimated Surfacing Quantity	250,000 m^3	259,000 m^3	242,000 m^3
Estimated Capital Construction Cost	$221,000,000	$233,000,000	$258,000,000

The estimated capital construction costs presented in Table 1 do not include royalties or administrative fees associated with materials borrowed from sources that are on Inuvialuit owned lands. The initial constructability and cost analysis presented in this table favours the Primary 2009 Route with minor encroachment on the Husky Lake setback area, which represented a road length of less than 2 km.

However, based on a multiple accounts analysis that was undertaken and is presented in this EIS, the Project Team believes that the Primary 2009 Route (with incorporation of Alternative 3 (2010 Minor Realignment) should remain in consideration for the future design of the Highway and may even be considered the preferred final alignment.

It presents a balance of favourable and most favourable in consideration of the sub-indicators that were considered in the analysis and does not have a sub-indicator as presented in this evaluation where it is least favourable. Most importantly the adoption of this alternate realignment fully respects the Husky Lakes setback without significant negative impact relative to the remaining sub-indicators.

In particular, the Project Team believes that the adoption of this alternate realignment as part of the total Primary 2009 Route will capitalize on several important technical and economic advantages:

- One of the lowest cost alternatives for construction;
- Requires the least borrow material to construct;
- Closer to known borrow sources;
- Reduces project footprint (less land disturbance);
- Full conformance with the Husky Lakes setback;
- Traverses less rugged terrain and makes it easier to meet the design requirements for a public highway;
- Safer driving; and
- Easier and lower cost maintenance.

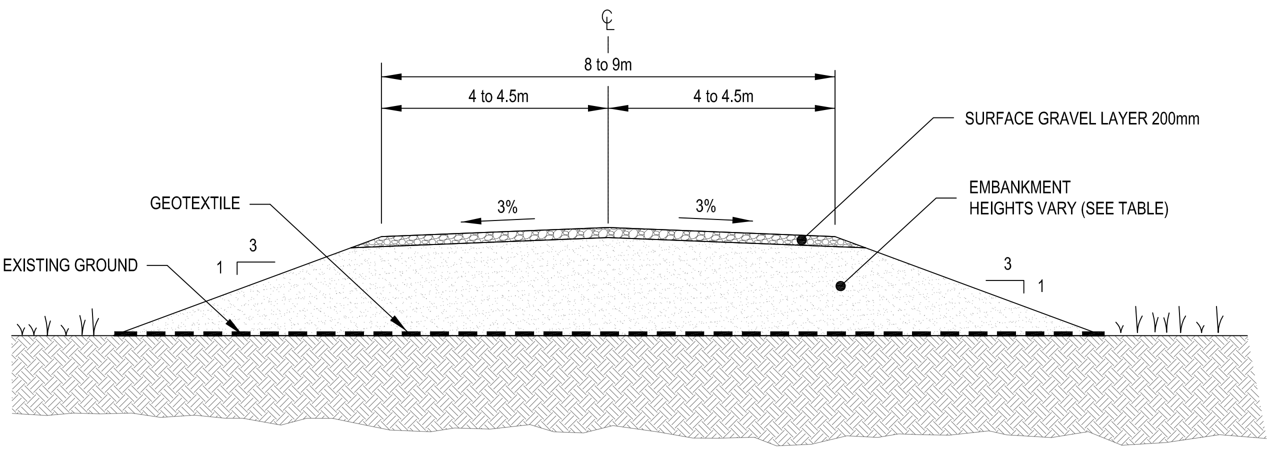
HIGHWAY DESIGN CONSIDERATIONS

For the purposes of this EIS, the proposed Inuvik to Tuktoyaktuk Highway remains about 137 km long and will be located entirely within the ISR (Figure 1). As previously mentioned this length could be reduced by about two kilometres with the adoption of Alternative 3 (2010 Minor Realignment) to fully meet the Husky Lakes setback. Approximately 71 km or 51.5% of the alignment will be located on Inuvialuit private lands which are regulated and administered by the Inuvialuit Lands Administration (ILA). Approximately 67 km, or 48.5% of the route will be located on Crown lands, which are regulated and administered by Indian and Northern Affairs Canada (INAC). Granular resource requirements for the Highway will be met using material from selected borrow sources located in the vicinity of the Highway alignment.

The Inuvik to Tuktoyaktuk Highway will be constructed and operated to the GNWT DOT standards/ guidelines for public highways under the management and operation of GNWT DOT. This will allow for year round use by haul trucks and passenger vehicles according to the size and weight limitations as defined in the Northwest Territories highway regulations. The posted speed limit on the Highway will be 80 km/hr.

The Highway operations will require a two lane gravel roadway (8 to 9 m wide with 3:1 side-slopes) with short span single lane bridges at select stream crossings. Assessments to date have determined that about eight stream crossing locations will likely require a bridge. Culverts will be used for all of the smaller streams and to manage overland surface flows. To protect the permafrost terrain along the proposed Highway alignment, typical 'cut and fill' techniques commonly employed in southern areas of the Northwest Territories and elsewhere will not be used for this Project. Such traditional construction methods cut into protective layers of surface vegetation and organics, with the possible results of a thawing in the permafrost below. Therefore, the current design involves the placement of frozen fill materials directly onto the frozen surface of the tundra along the Highway alignment.

The geometric design parameters (summarized in Table 2) incorporated during the design process were based on the operational needs of the Highway, the need to protect the permafrost layer below the road surface, and the application of the guidelines for public highways in the Northwest Territories. Figure 2 summarizes the design parameters for a typical highway cross section. Geotextile fabric will be placed between the existing ground and the base of the Highway along the entire alignment to prevent the migration of granular materials from the Highway embankment into the permafrost.



TYPICAL HIGHWAY CROSS SECTION

TERRAIN TYPE	DESCRIPTION	EMBANKMENT HEIGHTS
1	DRY (ICE POOR) TILL AND OUTWASH DEPOSITS	1.4 m
2	WET (ICE-MEDIUM TO ICE-RICH) TILL AND OUTWASH DEPOSITS	1.4 to 1.6 m
3	WET SILTS AND CLAYS (ICE-RICH)	1.6 to 1.8 m
4	THICK ORGANIC PEATLANDS AND ICE-RICH PERMAFROST	1.8 m

LEGEND

PROPOSED INUVIK - TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

TYPICAL HIGHWAY CROSS SECTION

PROJECTION

DATUM

Scale 1:150

1 0 1 3m

FILE NO.
V23201322 TYPICAL SECTIONS.dwg

PROJECT NO.	DWN	CKD	REV
V23201322	SM	RM	0

OFFICE
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DATE
March 16, 2011

Figure 2

Q:\Vancouver\Drafting\Environmental\V232\V23201098\Conceptual Design\Typical Sections\Environmental Impact Statement\V23201322 TYPICAL SECTIONS.dwg [FIGURE 2 (Exec Summary)] March 16, 2011 - 10:12am adeepwell

TABLE 2: GEOMETRIC DESIGN PARAMETERS FOR THE INUVIK TO TUKTOYAKTUK HIGHWAY	
Design Parameters	
Desired Design Speed	90 km/hr
Minimum Design Speed	80 km/hr
Horizontal Alignment	
Desired Curve Radius	440 m
Minimum Curve Radius	250 m
Desired Sight Distance	500 m
Minimum Sight Distance	180 m
Length of Spiral	160 m
Vertical Alignment	
Minimum Passing Sight Distance	605 m
Minimum Stopping Sight Distance	150 m
Minimum Sag K Value	40
Minimum Crest K Value	50
Minimum Distance between PVI	90 m
Desired Maximum Slope	3%
Maximum Slope Full Speed	6%
Cross-Section	
Desired Finish Top Shoulder Rounding to Shoulder Rounding	9 m
Minimum Finish Top Shoulder Rounding to Shoulder Rounding	7 m
Lane Cross Fall	3%
Superelevation	6%
Side Slopes – All Sections	3:1
Embankment Height	
Dry (ice poor) Till and Outwash Deposits	1.4 m
Wet (ice medium to ice rich) Till and Outwash Deposits	1.4 m to 1.6 m
Wet Silts and Clays (ice rich)	1.6 m to 1.8 m
Thick Organic Peatlands and Ice Rich Permafrost	1.8 m
Thickness of Surfacing Gravel	200 mm

Although much work has been done by the Project Team so far, it will be necessary to undertake further engineering, environmental and heritage resource studies following approval of the Highway to confirm borrow source quality and quantities and to further refine the Highway alignment and stream crossing designs. This information will also be used to support follow-up regulatory applications and approvals to permit construction of the Inuvik to Tuktoyaktuk Highway to proceed.

HIGHWAY CONSTRUCTION AND SCHEDULE

An important principle of the Project's construction methodology is to complete most of the construction activities during the winter months. This strategy offers several advantages:

- Allows the use of temporary ice/winter road construction to provide access to borrow sources, without the need to construct more permanent all-weather access roads.
- Allows the placement of Highway base material directly onto frozen ground (with geotextile separation layer).
- Minimizes potential effects on vegetation and soils adjacent to the actual roadway.

Following each year of winter construction, it is anticipated that most embankment settlement will occur in the top layers of the emplaced borrow material as it thaws, dries and consolidates. Little to no thaw is expected in the lower layers of the embankment, leading to greater Highway stability. This is also expected to reduce potential longer term maintenance problems.

Construction activities will be limited, to the extent possible, to the planned footprint of the Highway. A temporary winter road will run roughly parallel to the alignment and other temporary winter roads, as necessary, will provide access to borrow sources during the winter construction periods. Before the beginning of construction, the route will be surveyed and staked, and temporary winter roads will be constructed to select borrow sources. Initially snow cats and small dozers will be used to clear snow from the staked footprint. Dozers used for snow clearing will be equipped with mushroom pads to protect the ground surface on the right-of-way. After the route is staked, the snow is cleared, and adequate material is stockpiled at the borrow source, the construction activities will commence.

Construction material will be loaded at the borrow sources using excavators and hauled along the temporary winter roads using both tractor-trailer units and articulated trucks. Material will be placed by end dump and spread with D6 and/or D7 Cats. An initial lift of approximately 300 mm to 400 mm will be placed, followed by smaller lifts, with the final surface elevation being left some 150 mm to 200 mm higher than design to accommodate settlement.

Culvert and bridge installation will proceed along with construction of the Highway. The bridges will typically be prefabricated as single spans that will be installed on binwall abutments. Design, ordering and fabrication of bridges will be undertaken months before the scheduled installation so that shipping schedules are achieved and structures and binwall materials arrive on site in time for installation.

Stream crossings will be accommodated by temporary ice crossings on the adjacent seasonal winter road near the bridge site. Prefabricated bridge structures will be shipped to the individual bridge sites by truck along the constructed portions of the Highway or along the winter road. Each of the four years of primary roadway construction and installation of drainage structures will be carried out in a similar manner.

Final compaction, adjustments of grade to correct settlements, adjustments to culverts or installation of additional culverts, completion of bridge construction, and placement of surfacing materials on the sections of Highway embankment constructed during the previous winter will be undertaken in the following summer periods.

The Tuktoyaktuk to Source 177 Access Road provides a practical model for the construction of the Highway:

- The Highway will be built by local and regional contractors;
- Construction will proceed from both the north and south ends;
- The Project will take advantage of the winter seasons to develop materials sources and for construction of the main Highway embankment;
- Construction will begin by placing geotextile fabric and building forward in lifts of granular material;
- Construction will continue in a similar way for each of the four main winter construction seasons;
- Bridge construction and culvert installation will generally begin in the winter periods;
- Bridge completion and adjustments to culverts previously installed will generally occur during the summer periods;
- Certain culverts, such as those to be installed across identified fish habitat, may be installed during the summer periods; and
- Final shaping, compaction and placement of granular topping will take place on the constructed Highway embankment in the summer periods.

Subject to completion of the EIRB review process, regulatory approvals and funding, the current generalized construction schedule for the Inuvik to Tuktoyaktuk Highway is outlined in Table 3.

TABLE 3: GENERALIZED CONSTRUCTION SCHEDULE

Schedule	Activities
Spring 2012	Initiate upgrading of Tuktoyaktuk to Source 177 Access Road to Highway Standards
Summer 2012	Complete biophysical (e.g., rare plant, wildlife, and fish), archaeological, and engineering surveys and plans, as necessary, for permitting needed for the upcoming year of work
October 2012	Strip and develop initial borrow source(s) Pre-position equipment at next borrow source (e.g., pit located south of Source 177)
Nov - Dec 2012	Continue work at borrow sources, construct winter access and haul roads
Jan - April 2013	Transport, spread borrow material, construct road and install bridge(s) and culverts
June - Sept 2013	Complete installation of bridges and culverts. Compact and grade Year 1 embankment
Fall 2013 - Summer 2016	Repeat cycle of construction similar to Year 1

ENVIRONMENTAL CONSIDERATIONS AND MITIGATION MEASURES

Climate, Air Quality and Noise

Emissions from diesel engine combustion exhaust and dust generated during the construction and future operations phases are considered to be relatively minor. These emissions are expected to be localized, short-term and intermittent.

Highway construction activities will be intermittent, temporary and transient in nature. Most of the noise dust, and air emissions during the construction phase will be associated with equipment operation and blasting activities, if required, to break up the frozen borrow material during excavation. As indicated in Table 3, construction activities that will take place during the summer periods will be mainly related to the completion of bridges, culvert installation, and compaction and grading of the Highway. The diligent application of the GNWT *Guideline for Dust Suppression* is expected to be effective in controlling dust created by summer activities during both the construction and operations phases of the Highway.

While there are no local noise regulations that directly apply to construction noises, the contractors will be directed to apply reasonable mitigation to reduce possible effects associated with construction noise. These will include adequate maintenance of their construction equipment, including mufflers. Blasting activities, if required, will be timed to avoid periods when sensitive wildlife species are in the area. Prudent design, best management practices and mitigation will be combined to reduce sound levels during the construction phase.

Examples of prudent design and management practices include:

- Limiting construction activity during sensitive periods (based on available background information and recommendations from wildlife monitors) to reduce possible effects on wildlife;
- Effective logistics planning to minimize vehicle movements, such as the use of vans or extended cab pick-up trucks to transport workers;
- Regular maintenance of equipment and provision of appropriate mufflers for internal combustion engines; and,
- Minimizing and managing dust caused by construction materials handling, and the grading and compaction of the Highway.

Permafrost Protection and Climate Change Adaptation

The Inuvik to Tuktoyaktuk Highway corridor is located entirely within the zone of continuous permafrost. Ground temperatures are within the range of minus 2°C to 5°C. Permafrost is defined as rock or soil material that has remained below 0°C continuously for two or more years, without consideration of material type, ground ice distribution, or thermal stability. The stability of permafrost and the stability of infrastructure constructed on permafrost depend on maintaining ground temperatures to minimize the thickness of the active layer, and to impede thaw.

A risk-based approach for incorporating climate change into the design of highway infrastructure on permafrost is now recommended practice. This risk-based approach is documented in the national guidelines entitled *Development and Management of Transportation Infrastructure in Permafrost Regions* published by the Transportation Association of Canada (TAC) in May 2010. The challenge for design and construction over thaw-sensitive permafrost terrain is to balance the capital cost of constructing the Highway, against the long term maintenance implications. The design parameters and construction techniques noted above are based on experience in the area and the case studies and lessons learned as presented in the TAC guideline.

These parameters and techniques take into consideration these risks and provide mitigative approaches in the Highway design. The two most significant elements of the design are the use of non-woven geotextile fabric between the existing ground and placed construction material, and maintaining a minimum thickness in the material placed, based on terrain type, to insulate the permafrost. Other risk factors that are related to climate uncertainty are precipitation, including both summer rain and winter snow. Key mitigative measures have been incorporated into the design parameters to manage uncertainty related to future climate trends and extremes in the permafrost region that this Highway will be constructed in. The measures include:

- The used of thick embankments that insulate and stabilize the active layer and the use of non-woven geotextile fabric to assist in maintaining the integrity of the Highway embankment;
- The use of appropriately sized culverts to accommodate seasonal overland surface flows where needed; and
- Adoption of construction methods that avoid cuts and minimize disturbance of the natural vegetation before fill is placed.

During the Highway operations phase, given the uncertainty of the events associated with climate change, greater vigilance and effort on the part of maintenance operators will be required including, greater effort for spring culvert clearing and fall protection of culverts and drainage structures, more frequent inspections, and monitoring of the performance of the infrastructure.

As with the design parameters and construction techniques noted above, the mitigative measures proposed for the operations phase of the Highway are based on experience in permafrost regions and the risk-based approach that is documented in the TAC May 2010 guide for Development and Management of Transportation Infrastructure in Permafrost Regions.

Vegetation

The proposed Highway is located mainly within the Tundra Plains Level II Ecoregion, with a small portion of the Highway alignment extending into the Taiga Plains Level II Ecoregion, near Inuvik. The Tundra Plains Level II Ecoregion, which includes the Tuktoyaktuk Peninsula, is characterized by fairly level topography that rises from sea level to approximately 100 m in elevation at Granular Source 177. Lakes, ponds, and streams are common across the Peninsula.

Vegetation grows on a veneer of unfrozen organic or granular substrate overlying permafrost. The dominant vegetation along the proposed Highway alignment is characterized by a continuous cover of shrubby tundra species, consisting of dwarf birch, willow, northern Labrador tea, *Drya*s spp., and sedge tussocks. In wetter areas, sedges, cotton-grasses, and *Sphagnum* moss species dominate high-centered and low-centered polygons. Drier areas support ericaceous shrubs. Riparian communities include wet sedge communities and taller shrubs.

The proposed Highway also traverses approximately 2.8 km of the Taiga Plains Level II Ecoregion near Inuvik. This Ecoregion is dominated by Canada's largest river, the Mackenzie, and its tributaries. Taiga Plains Level II Ecoregions are characterized by open, generally slow growing, conifer-dominated forests of predominantly spruce. The shrub component is often well developed and includes dwarf birch, Labrador tea, and willow. Bearberry, mosses, and sedges are dominant understory species. Upland and foothill areas and southerly locales tend to be better drained, are warmer, and support mixed wood forests characterized by white and black spruce, tamarack, white birch, trembling aspen, and balsam poplar.

As indicated in this EIS, the average width of the Highway footprint will be 20 to 28 m (depending on the surface finish width) including the embankment. Considering the 137 km length of the current preferred alignment, the total Highway footprint would directly affect approximately 383 ha of terrain and associated vegetation.

Construction of the Highway will involve the excavation of material from borrow sites and the end-dumping of this material over geotextile fabric placed on the frozen ground surface along the right-of-way. These activities will affect vegetation cover through direct removal at the borrow sites and the burial of vegetation beneath the embankment along the Highway right-of-way.

To minimize direct effects to vegetation cover, construction activities will be limited, to the extent possible, to the planned footprint of the Highway. Care will be taken to keep heavy equipment and trucks within the right-of-way on snow-compacted and flooded access roads and constructed road embankments. Temporary winter access roads, constructed of snow and ice over the frozen ground, will be used to access the borrow sites. The use of these winter access roads will also assist in minimizing potential effects to terrain and associated vegetation.

As indicated previously, to reduce possible effects of dust on vegetation during the summer, water will be applied. With the application of the proposed mitigation measures, effects on vegetation are generally expected to be limited to the physical footprint and are considered to be minor in the context of the overall Project area.

Wildlife

The Tuktoyaktuk Peninsula and Delta area in the vicinity of the proposed Highway supports a wide variety of wildlife. Records identify 34 terrestrial mammal species that may use the proposed Highway corridor. Key mammal species of greatest interest for the communities include caribou, moose, grizzly bear, wolverine and fox. The local and regional abundance and distribution of these species varies considerably depending on habitat availability and access to terrain suitable for various life history phases, such as calving and denning.

Approximately 108 bird species, including geese, ducks, swans, raptors and upland birds, have been recorded in the Regional Study Area. Most are migratory; but a few are year round residents.

Caribou are an important terrestrial mammal species, and have traditionally been harvested by the residents of Tuktoyaktuk and Inuvik. Three caribou herds occur in the Regional Study Area, the Bluenose-West herd, Cape Bathurst herd and Tuktoyaktuk Peninsula herd. All three herds' annual ranges overlap that of the proposed Highway alignment during part of the year, particularly the winter.

The proposed Highway alignment is located south of the traditional summer and fall caribou harvesting areas, but within the spring and winter caribou harvesting areas. As well, the alignment occurs within the Bluenose-west winter range management area. This area provides important winter habitat for the Bluenose-West caribou herd, which is valued for subsistence harvesting year-round by Inuvialuit communities and other Aboriginal communities outside the ISR.

Future management decisions related to the protection of wildlife and wildlife habitat for the Inuvik to Tuktoyaktuk Highway will be based on background information; field investigations; input from the Tuktoyaktuk and Inuvik Hunters and Trappers Committees; the Wildlife Management Advisory Committee (WMAC) and GNWT Department of Environment and Natural Resources (ENR) and the application of, appropriate best management practices. The objectives of wildlife management activities along the proposed Highway will be to mitigate potentially negative effects on wildlife in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- Minimize direct mortality due to collisions with vehicles;
- Reduce attractants at construction camps through responsible waste management and effective environmental awareness programs;
- Reduce the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conformance with pre-determined setback distances from key wildlife habitat features;
- Effective transportation, storage and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage organizations such as the Hunter and Trapper Committees, Wildlife Management Advisory Council and GNWT Department of Environment and Natural Resources to work together to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

The GNWT Department of Transportation's operational policies are designed to mitigate potential impacts on wildlife and wildlife habitat. With the application of the numerous available mitigation measures described in this EIS, effects on wildlife and wildlife habitat are generally expected to be localized and limited and are considered to be minor in the context of the overall Project area.

Fish Resources

The proposed Inuvik to Tuktoyaktuk Highway will cross approximately 46 ephemeral and/or permanent streams, and come near many lakes along its route. The proposed Highway alignment is located in the vicinity of the spring, summer, fall, and winter fish harvesting area near Husky Lakes and the Fish Lakes and Rivers management area, an area which provides important fish habitat and historic and current subsistence harvest areas for the people of Inuvik and Tuktoyaktuk.

Limited fish surveys have been conducted previously in streams along the proposed Highway. These surveys identified the following fish species in some streams along the proposed Highway route: lake whitefish, round whitefish, inconnu, northern pike, Arctic grayling, lake trout, burbot, least cisco, ninespine stickleback, and sculpin. Actual species presence is dependent on several habitat and watershed characteristics, often including the availability and accessibility of upstream lakes that provide feeding, rearing, and/or overwintering habitats. It is unlikely that the streams along the Highway route would provide overwintering habitat.

A preliminary fish habitat field reconnaissance was carried out in fall 2009, and follow-up aquatic studies were completed in the spring of 2010 for two 25 km sections of the proposed highway alignment, the first extending north of Navy Road (just outside Inuvik) and the second extending south of Granular Source 177 (to the south of Tuktoyaktuk). Further site investigations will need to be carried out in future years, matched to the phased annual construction program, to assist with the design of the appropriate stream crossing structures including potential bridges and culverts.

The assessment of the potential effects of road construction on fish and fish habitat, and the development of effective avoidance or mitigation measures, are major components of the proposed Inuvik to Tuktoyaktuk Highway Project. From the perspective of fish and fish habitat protection and management, three categories of streams are recognized along the Highway route:

- non fish-bearing: streams that are not used by fish for any part of their life cycles;
- migratory channels: ephemeral and perennial (except in winter) streams that are used by fish only for migration during open water periods or that contribute to downstream habitat quality; and
- spawning/rearing/feeding streams: ephemeral and perennial streams that are used by one or more life cycle stages of fish during open water periods, in addition to migration.

Based on the work completed to date, the majority of the stream channels to be crossed by the proposed Highway are small, ephemeral streams that generally drain terrestrial upland areas or small, shallow lakes or ponds, most of which do not provide suitable fish habitat features. For these types of stream crossings, appropriately-sized and designed culverts will be installed and sediment and erosion control best management practices will be employed to protect downstream aquatic resources.

At this time, about eight of the larger streams, including Trail Valley Creek, Hans Creek and Zed Creek, will likely need single-span bridges to minimize or prevent potential impacts on fish and fish habitat. To the extent possible, DFO's Operational Statement for Clear Span Bridges and sediment and erosion control best management practices will be followed. These and other mitigation measures to protect fish and fish habitat will be incorporated into an overall fish and fish habitat protection plan that will be developed for the Highway construction program in consultation with DFO. The Project Team is committed to working closely with DFO to design appropriate crossing structures for each stream and to obtain *Fisheries Authorizations*, if determined to be required.

Considerable amounts of water will be required for winter access road construction and dust suppression during summer months. It is proposed that water for these purposes will be extracted from lakes in proximity to the Highway corridor. It is anticipated that Project water requirements will exceed 300 m^3/day, which will trigger the need for a Type A Water Licence from the Northwest Territories Water Board.

In addition, water withdrawals from designated lakes along the Inuvik to Tuktoyaktuk Highway route will be conducted in conformance with the DFO *Protocol for Winter Water Withdrawal in the Northwest Territories*.

With the application of the available mitigation measures, effects on fish and fish habitat are generally expected to be localized and limited and are considered to be minor in the context of the overall Project area.

Archaeological Resources

Within the general study region encompassing the area east of the Mackenzie River and west of the Husky Lakes and from the coast to the southern limits of the Project area, 103 archaeological sites have been documented. Types of sites found in this region include lithic scatters and quarry/workshops; stone features such as tent rings, caches and cairns; hearths and fire cracked rock concentrations; cabin remains and semi-subterranean house remains; cache pits; middens; graves; various types of wood features; and cut/worked wood remains. A number of sites have been confirmed to range from the Northwest Microblade tradition (over 5000 years old) to the Paleoeskimo (as old as 4,300 years ago), through Neoeskimo representations (between 1,000 to 200 years old).

There are 12 previously recorded archaeological sites within 5 km of the proposed Highway route, which typically represent Mackenzie Inuit occupations with some small components ascribed to the Paleoeskimo period. Most of these sites are small camps characterized by lithic, bone and artifact scatters, some with structural features such as tent rings, hearths, semi-subterranean house remains, middens and caches.

An archaeological overview assessment of the proposed road route and selected borrow sources was completed in September 2009. The main goal was to assess the archaeological potential of terrain to be affected by this Project. The primary method used to rate archaeological potential was visual assessment of terrain by low and slow helicopter overflight following the proposed alignment using GPS coordinates. Potential borrow sources were also overflown and the boundaries were roughly approximated using topographic maps. Data gathered during the overview assessment were used to identify specific portions of the Highway Project that will require more detailed archaeological impact assessment before the commencement of each season of construction.

No previously recorded archaeological sites occur within the Primary 2009 Route; however, the sections of the Highway route that are closer to Husky Lakes and which cross elevated, dry terrain are judged to have good archaeological potential.

Archaeological sites in the Northwest Territories are protected by law. In the Northwest Territories, new regulations were enacted on June 15, 2001. These regulations provide greater protection for archaeological artifacts and sites and require that archaeological investigations be conducted under permit. The Project Team is committed to ensuring that archaeological and traditional sites are protected by:

- Conducting a survey of the road right of way and borrow sites during the summer 2012 and 2013;
- Submitting an Archaeological Impact Assessment to the PWHNC one month prior to construction activities each year;
- Undertake any site mitigations determined by the PWHNC and Proponents' Archaeologist;
- Abiding by the archaeological regulations in the *Territorial Land Use Regulations* or Terms and Conditions set by the ILA.

Environmental Protection and Incident Response

There exists the potential for accidents or malfunctions to occur in association with any human activity, including those proposed for the construction of the Inuvik to Tuktoyaktuk Highway. Environmental consequences of potential accidents or malfunctions associated with the Highway and associated aggregate borrow and construction camp activities would be primarily limited to those related to:

- Vehicle accidents; and
- Fuel storage, transportation and handling system failures.

To reduce the potential environmental risks associated with potential vehicle/equipment accidents or malfunctions and/or fuel management activities, several preventative and mitigation measures will be employed. These measures and response activities are detailed in the EIS and its appendices. In overview, preventative and mitigative measures to be employed will include:

- Implementation of best management practices to prevent or minimize the occurrence of accidents or malfunctions;
- Ensuring that on-site contractors have industry-compliant and satisfactory Health, Safety and Environmental (HSE) policies, programs and manuals and that they are successfully implemented throughout the Project;
- Compliance with the terms and conditions of the necessary Inuvialuit Land Administration and Indian and Northern Affairs Canada Land Use and Quarry permits and authorizations that will be issued for the construction project; and
- Implementation of spill reporting, containment, and cleanup protocols in accordance to Project-specific spill contingency plans.

The key strategy will be to prevent accidents and malfunctions through education, monitoring, and follow-up.

Worst Case Scenario

A fundamental goal of the EIRB as set out in the IFA is to consider a potentially possible scenario as a legitimate test by which to judge whether negative impacts to wildlife, wildlife habitat and wildlife harvesting can be minimized to acceptable levels by mitigative and remedial measures. Such a worst case scenario will also be used by the EIRB to establish the Developer's potential liability.

The Project Team determined that the most probable, although highly unlikely worst case scenario associated with the construction and operation of the proposed Highway would involve potential environmental damage to the Husky Lakes and effects to traditional activities and harvesting, caused by a fuel supply truck crash on the Highway, resulting in a fuel spill of greater than 10,000 litres into an open watercourse, which leads directly to the Husky Lakes.

The worst case scenario was further defined to assume that:

- The fuel supply truck crash occurs during spring freshet when water levels, discharge and velocity are at their yearly peak and the potential for the greatest number of available pathways for conveyance downstream to the Husky Lakes is present;
- The spill of diesel fuel into a fish-bearing watercourse and ultimately into Husky Lakes would result in residents avoiding consumption of fish because of the perception that the fuel would taint the fish;
- The fish harvest season from Husky Lakes would be lost as a result of the diesel fuel input to Husky Lakes; and
- The fouling of fishing gear would result in replacement costs.

The detailed analysis determined that the threat of the worst case scenario occurring is considered low due to: the short open water period, the small number of fuel truck deliveries during the open water season; the relatively short duration of persistence of diesel in the environment; the sufficiency of mitigation measures such as spill contingency plans employed by transportation contractors to respond to a potential spill; and safe road and bridge design to reduce the likelihood of accidents.

However, to estimate the potential liability of the Developer for impacts of the proposed Highway development as a result of such a worst case scenario occurring, the estimated potential monetary loss of an entire summer season of fishing from the Husky Lakes for all residents involved in fish harvesting was determined to be in the order of $486,000. It is also recognized by the Project Team that this estimated worst case loss does not, however, account for the possible effects on the psyche, spiritual or cultural values of the people who use and enjoy the Husky Lakes area.

Next Steps Towards Construction of the Inuvik to Tuktoyaktuk Highway

As evidenced by decades of planning, investigation, and consultation, the completion of the proposed Inuvik to Tuktoyaktuk Highway has been a long standing goal of the Town of Inuvik, the Hamlet of Tuktoyaktuk, and the residents of the Inuvialuit Settlement Region. It has also been a stated objective of the Government of the Northwest Territories.

From the regional perspective, the Highway is predicted to help reduce the cost of living in Tuktoyaktuk and produce a range of other benefits for both Tuktoyaktuk and Inuvik residents. It will improve Tuktoyaktuk residents' access to healthcare professionals and educational opportunities. The Highway will support year-round social, recreational and tourism opportunities and will enable family and community interactions that are currently limited to the winter months when the ice road is open. From a National perspective, completing the Highway and connecting Canada from Coast to Coast to Coast will address Canada's goal of establishing a year round transportation link to the Arctic coastline. The proposed all-weather infrastructure will be integral

Canadian sovereignty interests in the Arctic and providing diverse economic development opportunities for the future.

Based on the consultations that have been conducted over the past several years with the communities, regulatory authorities and other interested parties, the Project Partners have a high degree of confidence that the proposed Highway can proceed efficiently through the regulatory process to permitting, construction, and responsible long-term operation and maintenance. From many perspectives, the proposed Highway will be a key component of the Northwest Territories future transportation system.

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APPENDICES

ACRONYMS

Table A lists the acronyms used throughout the EIS and Table B lists the Acronyms for Units and Elements

TABLE A: ACRONYMS

Abbreviation	Definition
ABE	Adult Basic Education
ABLE	Adult Literacy and Basic Education
ALCIP	Aboriginal Language and Cultural Instructor Program
ASTt	Arctic Small Tool tradition
ATV	All-Terrain Vehicle
AUDIT	Alcohol Use Disorder Identification Test
BAM	Beta Attenuation Monitor
BCP	Building Canada Program
BDHSS	Beaufort Delta Health and Social Services
BDR	Beaufort Delta Region
BMPs	Best Management Practices
CanNor	Canadian Northern Economic Development Agency
CCME	Canadian Council of Ministers of the Environment
CCP (s)	Community Conservation Plan (s)
CEA	Cumulative Effects Section
CEAA	Canadian Environmental Assessment Act
CEPA	*Canadian Environmental Protection Act*
CI	Continuous Improvement
CIMP	Cumulative Impact Monitoring Program
CMHC	Canadian Mortgage and Housing Corporation
COGOA	Canada Oil and Gas Operations Act
COPE	Committee for Original Peoples Entitlement
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPA	Canadian Petroleum Association
CWSs	Canada-wide Standards
CWS	Canadian Wildlife Service
DETR	Department of the Environment, Transport and the Regions
DIAND	Department of Indian and Northern Affairs

TABLE A: ACRONYMS	
Abbreviation	**Definition**
DFO	Department of Fisheries and Oceans, or Fisheries and Oceans Canada
DOT	Department of Transportation, GNWT
DRR	Department of Renewable Resources, Government of the Yukon
EC	Environment Canada
ECE	Education, Culture and Employment, GNWT
e.g.	exempli gratia (for example)
EGT	E. Gruben's Transport Ltd.
EIRB	Environmental Impact Review Board
EIS	Environmental Impact Statement
EISC	Environmental Impact Screening Committee
EMP	Environmental Management Plan
EMS	Environmental Management System
ENR	Environment and Natural Resources Department, GNWT
EOSD	Earth Observation for Sustainable Development of Forests
ERP	Emergency Response Plan
EUB	Energy and Utilities Board, Province of Alberta
FJMC	Fisheries Joint Management Committee
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMVF	Genuine Mackenzie Valley Furs
GNWT	Government of the Northwest Territories
GPS	Global Positioning System
GSA	Gwich'in Settlement Area
GSC	Geological Survey of Canada
HADD	Harmful Alteration, Disruption or Destruction
HSE	Health, Safety and Environment
HSS	Department of Health and Social Services, GNWT
HTC	Hunters and Trappers Committee
HWMP	Hazardous Waste Management Plan
IBL	Inuvialuit Business List
IICP	Inuvik Inuvialuit Conservation Plan

TABLE A: ACRONYMS

Abbreviation	Definition
ICC	Inuvik Community Corporation
ICRC	Inuvialuit Cultural Resource Centre
ICS	Inuvialuit Communications Society
i.e.	id est (that is)
IFA	*Inuvialuit Final Agreement*, as Amended April 2005
IGC	Inuvialuit Game Council
IHS	Inuvialuit Harvest Study
INAC	Indian and Northern Affairs Canada
ILA	Inuvialuit Land Administration
IOL	Imperial Oil Resources Ventures Limited Partnership
IRC	Inuvialuit Regional Corporation
IDRC	International Development Research Centre
ISR	Inuvialuit Settlement Region
ITC	Inuit Tapirisat of Canada
ITI	Department of Industry, Tourism, and Investment, GNWT
JRP	Joint Review Panel
KCAC	Keeping-Clean-Areas-Clean
LICO	Low Income Cut Offs
LIM	Low Income Measure
LSA	Local Study Area
LWD	Large Woody Debris
MACA	Ministry of Municipal and Community Affairs, GNWT
MBM	Market Basket Measure
MEMP	Mackenzie Environmental Monitoring Program
MGP	Mackenzie Gas Project
MOU	Memorandum of Understanding
MSC	Midnight Sun Complex
MSW	Municipal Solid Waste
MVAPL	Mackenzie Valley Aboriginal Pipeline Ltd.
N/A	Not Applicable
NAAQO	National Ambient Air Quality Objectives
NAPS	National Air Pollution Surveillance

TABLE A: ACRONYMS	
Abbreviation	**Definition**
NCP	Northern Contaminants Program
NCPC	Northern Canada Power Commission
ND	No Date
NEB	National Energy Board, Government of Canada
NGLs	National Gas Liquids
NNL	No Net Loss
NOAA	National Oceanic and Atmospheric Administration
NOGAP	Northern Oil and Gas Action Program
NPRI	National Pollutant Release Inventory
NRC	National Research Council
NRCAN	Natural Resources Canada
NT	Northwest Territories
NTCL	Northern Transportation Company Ltd.
NTPC	Northwest Territories Power Corporation
NWT	Northwest Territories
NWTLC	Northwest Territories Literacy Council
NWTWB	Northwest Territories Water Board
OSB	Ocean Studies Board
OS	Operational Statement
PDPs	Pit Development Plans
PDR	Project Description Report
PFB	Prime Fur Bonus
PG	Pasquill-Gifford
PM	Particulate Matter
POPs	Persistent Organic Pollutants
PWC	Public Works Canada
PWNHC	Prince of Wales Northern Heritage Centre
RCMP	Royal Canadian Mountain Police
RIC	Resource Information Committee
RKL	Ripley Klohn Leonoff International Ltd.
ROW	Right-of-Way
RSA	Regional Study Area

TABLE A: ACRONYMS	
Abbreviation	**Definition**
RWED	Resources, Wildlife and Economic Development, GNWT
SARA	*Species At Risk Act*
SCP	Spill Contingency Plan
SNWT	Spectacular Northwest Territories
Spp.	Species
STD	Sexually Transmitted Diseases
Subsp.	Sub-species
SWD	Small Woody Debris
TAC	Transportation Association of Canada
TCCP	Tuktoyaktuk Community Conservation Plan
TK	Traditional Knowledge
TSP	Total Suspended Particulate
UTM	Universal Transverse Mercator
US EPA	United States Environmental Protection Agency
US DOT FHWA	United States Department of Transortation Federal Highway Administration
UV	Ultraviolet
VC	Valued Components (referring to VECs and VSCs collectively)
VEC	Valued Ecosystem Component
VSC	Valued Socio-Economic Component (including cultural considerations)
WMAC	Wildlife Management Advisory Committee
YTG	Government of the Yukon
ZOI	Zone of Influence

TABLE B: ACRONYMS – UNITS AND ELEMENTS	
Abbreviation	**Definition**
Al	Aluminum
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
˚C	Celsius
Cd	Cadmium
CH_4	Methane
cm	Centimeters
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
Co	Cobalt
Cr	Chromium
Cu	Copper
dBA	Decibels
Fe	Iron
Ft	Feet
ha	hectare
H_2S	Hydrogen Sulphide
Hg	Mercury
hr	Hour
KM or Km	Kilometre
kPa	kilopascal
Kt	Kilotonne
kV	kilovolts
kW h	Kilowatt Hour
L	Litre
Leq	Energy Equivalent Sound Level
L/s	Litres per Second
m	Metre
M^3	Cubic Metres

TABLE B: ACRONYMS – UNITS AND ELEMENTS	
Abbreviation	**Definition**
m^3/s	Metres Cubed per Second
mg	Milligrams
mg/L	Milligrams per Litre
Mi.	Mile
$Mi.^2$	Miles Squared
Mm or mm	Millimeters
Mn	Manganese
Mo	Molybdenum
m/s	Metres per Second
MW	Megawatt
NH_3	Ammonia
Ni	Nickel
N_2O	Nitrous Oxide
NO	Nitric Oxide
No.	Number
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxide
O	Ozone
O_3	Ground Level Ozone
OCs	Organochlorines
Pb	Lead
pH	Potential of Hydrogen
psi	Pounds per Square Inch
s	Second
Se	Selenium
Si	Silicon
Sn	Tin
SOx	Sulphur Oxides
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
Sr	Strontium
Te	Tellurium

TABLE B: ACRONYMS – UNITS AND ELEMENTS	
Abbreviation	**Definition**
Th	Thorium
Tl	Thallium
U	Uranium
V	Vanadium
μm	Micrometers

DEFINITIONS

The following definitions provide guidance for the purposes of the environmental impact review process.

TABLE C: DEFINITIONS

Term	Definition	Source
Airshed	The air supply of a given region; also the geographical area covered by such an air supply. In terms of air quality, it is the space in which air emissions interact.	Merriam-Webster's Dictionary
Archaeological Artifacts	Defined as any tangible evidence of human activity that is more than 50 years old, in respect of which an unbroken chain of possession cannot be demonstrated.	*Northwest Territories Archaeological Sites Regulations*
Archaeological Site	Defined as a site where an archaeological artifact is found.	*Northwest Territories Archaeological Sites Regulations*
Cumulative Effects	Changes to the environment that "are likely to result from the project in combination with other projects or activities that have been or will be carried out".	CEAA
Developer	A person, the government, or any other legal entity owning, operating or causing to be operated any development in whole or in part in the Inuvialuit Settlement Region (ISR), and includes any co-contractant of such owner or operator.	IFA s.2
Development	(a) any commercial or industrial undertaking or venture, including support and transportation facilities related to the extraction of non-renewable resources from the Beaufort Sea, other than commercial wildlife harvesting; or (b) any government project, undertaking or construction whether federal, territorial, provincial, municipal, local or by any Crown agency or corporation, except government projects within the limits of Inuvialuit communities not directly affecting wildlife resources	IFA s.2
Environment	Means the components of the Earth, and includes: (a) land, water and air, including all layers of the atmosphere, (b) all organic and inorganic matter and living organisms, and (c) the interacting natural systems that include components referred to in paragraphs (a) and (b).	CEAA s.2
Environmental Assessment	Means, in respect of a project, an assessment of the environmental effects of the project.	CEAA s.2
Environmental Effect	Means, in respect of a project, (a) any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*,	CEAA s.2

TABLE C: DEFINITIONS

Term	Definition	Source
	(b) any effect of any change referred to in paragraph (a) on i. health and socio-economic conditions, ii. physical and cultural heritage, iii. the current use of lands and resources for traditional purposes by Aboriginal persons, or iv. any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or (c) any change to the project that may be caused by the environment.	
Exclusive Right to Harvest	Means the sole right to harvest the wildlife referred to in paragraphs 12(24)(b) and (c) and 14(6)(b) to (d), to be allocated the total allowable harvest and to permit non-Inuvialuit to harvest any such wildlife.	IFA s.2
Fish Habitat	Means the spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.	*Fisheries Act*
Follow-up Program	Means a program for (a) verifying the accuracy of the environmental assessment of a project, and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project.	CEAA s.2
Furbearers	Means all species of game that are or may be harvested by trapping and, for greater certainty but without limiting the generality of the foregoing, includes: Castor including beaver; Alopex including white fox, arctic fox; Lutra including otter; Lynx including lynx; Martes including martens and fishers; Mephitis including skunk; Mustela including ermine, weasel, least weasel and mink; Ondatra including muskrat; Tamiasciurus including red squirrel; Vulpes including red, cross, black and silver fox; Gulo including wolverine; Canis including wolves and coyotes; Marmota including marmots; Lepus including hares; Spermophilus including ground squirrels; but does not include members of the genus Ursus including black and grizzly bears;	IFA s.2
Gross Domestic Product	Defined as the complete unduplicated value of the goods and services produced in an economic territory of a country or region during a specific period of time.	Statistics Canada 2009a
Inuvialuit	Those people known as Inuvialuit, Inuit or Eskimo who are beneficiaries under [the *Inuvialuit Final Agreement*] by reason of the settlement of their claim to traditional use and occupancy of the land in the ISR and who are represented by the Committee for Original Peoples" Entitlement (COPE) and, where the context requires, includes the Inuvialuit Regional Corporation, the	IFA s.2

TABLE C: DEFINITIONS

Term	Definition	Source
	Inuvialuit Land Corporation, the Inuvialuit Development Corporation, the Inuvialuit Investment Corporation, the Inuvialuit community corporations and any other corporation, trust or organization controlled by the Inuvialuit that may be established by or pursuant to [the *Inuvialuit Final Agreement*]. Inuvialuit includes the Inuvialuit Game Council and the Hunters and Trappers Committees.	
Inuvialuit Corporations	Means the Inuvialuit Land Corporation, the Inuvialuit Development Corporation, the Inuvialuit Investment Corporation, the Inuvialuit Regional Corporation, the Inuvialuit community corporations, and any other corporations controlled by the Inuvialuit established by or pursuant to this Agreement.	IFA s.2
Inuvialuit Lands	Means all lands provided to the Inuvialuit by or pursuant to the IFA.	IFA s.2
Inuvialuit Settlement Region	Means that portion of the Northwest Territories shown in Annex A of the IFA.	IFA s.2
Invasive Plants	Refer to plant species (native or introduced) that have the ability to out-compete native species when introduced into a particular environmental setting.	Haber 1997
Life of the Project	The planned length of time the development will be operational, as determined by the Developer in its Project Description.	EIRB
Local Study Area	The area within 0.5 km of the Highway center-line (1 km total width).	
Mitigation	Means, in respect of a project, the elimination, reduction or control of adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through re-placement, restoration, compensation or any other means.	CEAA s.2
Noise	Loud, unwanted, unpleasant or unexpected sound.	
Permafrost	A ground condition of either soil or rock that remains at or below 0ºC for long periods. The minimum period is at least one full year.	TAC 2010
Precautionary Principle	Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.	CEPA 1999
Project	Means, in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work.	CEAA, s.2
Propagule	A structure in a plant from which a new individual may arise, and which may often also be a unit of dispersal.	Begon et al. 1990
Regional Study Area	The area within 15 km of the Highway center-line (30 km total width).	

TABLE C: DEFINITIONS

Term	Definition	Source
Residual Effects	Residual effects are those effects remaining after the application of appropriate mitigation/ management measures.	
Resource Use	Defined as subsistence and recreational use of well managed renewable resources is desirable and consistent with their conservation.	Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008
Responsible Authority	In relation to a project, means a federal authority that is required pursuant to subsection 11(1) to ensure that an environmental assessment of the project is conducted;	CEAA, s.2
Subsistence Usage	Means: a) with respect to wildlife other than migratory game birds, migratory non-game birds and migratory insectivorous birds, subject to international conventions, the taking of wildlife by Inuvialuit for their personal use for food and clothing and includes the taking of wildlife for the purpose of trade, barter and, subject to section 12, sale among Inuvialuit and trade, barter and sale to any person of the non-edible by-products of wildlife that are incidental to the taking of wildlife by Inuvialuit for their personal use; and b) with respect to migratory game birds, migratory non-game birds and migratory insectivorous birds, subject to the *Migratory Birds Convention Act*, the taking of such birds by Inuvialuit for their personal use for food and clothing, and includes the taking of such birds for the purpose of trade Inuvialuit and trade, barter and sale to any person of the non-edible parts of such permitted under regulations made pursuant to *Migratory Birds Convention Act*.	IFA s.2
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs	Brundtland Commission
Valued Component	The components of the environment that are valued by society are the recommended focus of an assessment.	Beanlands and Duinker 1983
Valued Ecosystem Component	Environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic, or aesthetic value.	Sadar 1994
Valued Socio-Economic Component	The socio-economic and cultural components, identified as a result of a social scoping exercise, that have a positive direct or indirect influence on the lives and circumstances of people, their families and their communities.	MVEIRB 2007
Wildlife	All fauna in a wild state other than reindeer.	IFA s.2

For the purposes of these Terms of Reference, the following pairs of terms have the same meaning and may be used interchangeably in this document:

TABLE D: TERMS WITH THE SAME MEANING

Term 1	Other Term(s)
Highway	Project
Development	Project
Developer	Proponent, Project Team, Project Partnership
Effect	Impact
Environmental Assessment	Impact Assessment, Impact Review

Please note that all references in this document to the IFA are to: The Inuvialuit Final Agreement, As Amended, Consolidated Version, April 2005.

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
4.0	**Executive Summary**	Executive Summary
5.0	**Introduction**	1.0
5.1	**Introduction to the Developer**, Consultants, Contractors and key personnel that prepared the EIS. Contact information and record of the environmental performance.	1.1, 1.1.1, 1.1.2
5.2	**Contextual Summary of the Development** Brief summary of the development, location, components, phases, spatial extent, temporal extent, workforce, and equipment, associated activities, schedule, and cost.	1.2
5.3	**Purpose and Justification**, including any regional and national interests.	1.3
5.4	**Development Setting** General overview of the geographic, ecological, social, economic and cultural setting and similar information for all considered alternatives.	1.4
5.5	**Permits and Authorizations** and all land-tenure requirements (including area and ownership), and on any non-regulatory requirements that may be needed for the development to proceed.	1.5
5.6	**Study Strategy and Methodology** Steps in EIS Preparation. Approach, strategy, and methodology and justification. Guidance documents or BMP's used or modified for proposed construction and operation – Plus, justification for modifications. How EIRB Goals and Principles were incorporated into the EIS Methodology.	1.6
5.6.1	**Traditional Knowledge**	
	How TK influenced assessment results and overall Project design. Includes, details of how the Developer and TK holders have worked together; where TK and scientific knowledge differed and how these differences were resolved; TK Study methodology; How TK was gathered and verified. Summary of issues, concerns, and recommendations arising from TK studies. Discusses how, issues, concerns, and recommendations were responded to.	1.6.1, 1.6.3, 1.6.5, 3.1.2, 3.1.9, 3.1.9, 3.1.10, 3.1.10, 4.1.2, 4.3.9, 6.0
5.6.2	**Engagement and Consultation**	
	Issues and concerns raised by potentially affected parties, including communities, regulators and other reviewers. How these issues and concerns have been or will be addressed.	1.6.2
	Summary of the public engagement process in the EIS, including the following: Community, competent authority or Party contacted; Contact names; Dates of contact; Communication/consultation format ; and Reason(s) for communication/consultation, and topic(s) of discussion, including the issues and concerns that were raised, and how the issues and concerns were responded to and/or resolved.	1.5, 1.5.1, 1.5.7, 1.5.2, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 3.2.8, 3.2.9, 4.3.5, 4.3.6, 4.3.7, 5.3, Appendix B

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Any commitments made by the Developer as a result of the communication/ consultation.	1.6.1, 1.6.2, 1.6.4, 4.4.3
	How the planning, design and/or implementation of the proposed development was influenced and/or changed as a result of consultation and by any issues and concerns raised.	1.6.5, 2.1.1, 2.1.2, 2.1.2, 2.2.1, 2.2.4, 2.2.7,4.4.5, 6.0
5.6.3	**Recognition of IFA and CPP**	
	Potential development affects on the various land categories identified in applicable community's CCP. Demonstration that Developer has reviewed applicable CPPs and consulted with appropriate communities and organizations about any potential conflicts. Mitigation measures and commitments to eliminate potential impacts potentially caused by the development to identified category lands and waters. Environmental Management Integration Plan: demonstration of how information and guidelines from CCPs and other regional plans will be adhered to and complied with.	1.5, 1.6.2, 1.6.3, 3.0, 4.0, 6.0
5.6.4	**Sustainability Goals**	
	Summary of how the principles of sustainability were incorporated into the Project and how sustainability goals have been achieved.	1.6.4
	Provides a methodology and list of indicators used.	1.6.4
	The extent to which the development makes a positive overall contribution towards environmental, social, cultural and economic sustainability – locally, regionally, territorially, and nationally.	1.6.4, 4.0, 5.3, 5.4
	How the planning and design of the development have considered how it affects achieving sustainable development.	1.6.4, 2.0, 4.0
	How monitoring, management and reporting systems have incorporated indicators of sustainability.	1.6.4, 4.0, 6.0, 7.0
	How the public and communities have been given opportunity to participate in and contribute to the planning and design of the development and that their views have been considered in the review process.	1.6.2, 2.0, Appendix B
5.6.5	**Precautionary Principle**	
	Identifies which Project components may warrant a precautionary approach. Discusses the potential for serious or irreversible adverse impact to the environment as a result of the Project and how they can be avoided. Describes ways to reduce the risk to the environment, including a discussion of Project design and available technology with respect to effectiveness and cost.	1.6.5, 2.2, 3.0, 4.0, 5.0, 6.0
6	**Detailed Project Description**	
	Plus, required management plans, and management related activities.	1.5, 2.0, 4.0, 6.0, 7.0, Appendix E
6.1	**Alignment Alternatives**	
	Information on the preferred alignment and the alternatives considered.	2.1, 2.2

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Plus, information on the nature and rationale for any changes since the Project Description submission.	1.6.2, 2.0, 2.1, 2.2
6.2	**Scope of Project Components and Activities**	
	Description of Project components, their timing, and location.	2.0, 2.6
	Description of related Project activities, their timing and location.	2.0, 2.6, 4.0, 7.0
	Including as applicable: Construction, operation and maintenance; Closure, decommissioning and restoration; Modification; and Abandonment of permanent and temporary structures.	2.6
6.3	**Development Phases and Schedule**	
	Location, spatial and temporal extent of Project components and activities as they relate to workforce, roles and responsibilities of governing agencies; and costs.	2.7
6.3.1	**New Work and Additional Field Studies Required**	
	Discussion of field work conducted, since filing the Project Description, and any additional field work proposed to be conducted, including a schedule and how results may affect the environmental review and the final decision on the development. Explanation of why this work wasn't included in the current development submission.	2.7.7
6.4	**Life of the Project**	
	How this development fits with the overall goals, objectives, and long term planning of the Government of the Northwest Territories (GNWT) for Territorial Highways. Including: responsible governing bodies, funding sources, anticipated use, government response to increased use, contribution of the Project to the objectives of the Government of Canada.	2.7.5, 2.8
6.4.1	**Other Parties**	
	Roles and responsibilities of the Hamlet of Tuktoyaktuk and the Town of Inuvik to support and promote this development proposal, including long-term management.	2.7.5
7	**Consideration of Alternatives**	
7.1	**Alternative Means of Carrying out the Project**	
	Discussion and analysis of alternative technical and economical options, their feasibility, environmental effects, and how they contribute to sustainable development in the ISR.	1.6.2, 2.1, 2.2, 2.3, 2.4, 2.5, 4.0
	Evaluation of relationships and interactions among the various components of the ecosystem, including affected communities.	2.2, 4.0
	Discussion of environmental effects, and technical and economic feasibility for the preferred option and comparison to alternatives.	2.2, 4.0, Appendix F
	Criteria and/or constraints used to identify any alternative means as acceptable or unacceptable, and how these criteria and/or constraints were applied.	1.6.2, 2.1, 2.2, 3.0, 4.0
	Rationale for selection of route and rejection of alternatives. Identification of the environmental effects of the various route alternatives.	1.6.2, 2.2.6, 2.2.7, 4.2

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
7.2	**Alternative Route Options**	
	A description of each alternative route considered and the criteria for selecting them.	1.6.2, 2.1.2, 2.2
	Environmental assessment of the alternatives to substantiate their inclusion as viable alternatives.	2.2, 4.2
	How or why they are not environmentally, technically and/or economically feasible (constraints), and the rationale for rejecting any alternatives that are excluded from further assessment.	2.1, 2.2, 2.3, 2.7.6
	How community engagement/consultation, TK and valued components (from the impact assessment) have influenced these determinations.	1.6.1, 1.6.2, 1.6.3
	Answers to the following safety questions: What makes the preferred alignment safer than the alternative routes? Which parts of the alternate routes are dangerous and why? How many dangerous areas are present in each of the three routes? How much additional risk is posed by these dangerous features, compared to the preferred alignment? What mitigations can be put in place to alleviate these additional risks? What is the cost of these additional risk mitigation features? What sources of information were used in these determinations?	2.1, 2.2, 2.3, 2.4, 2.7
8.0	**Key Issues and Study Area Boundaries**	
8.1	**Key Issues**	
	Identification of VCs, for which effects have been predicted, and justification of the methods used to select them.	4.1, 4.1.2
8.2	**Study Boundaries**	
8.2.1	**Spatial Boundaries**	
	Description of the boundaries used to assess each biophysical or socio-economic element, for all components of the development.	4.1.3
	Justification and rationale for all of the study area boundaries.	4.1.3
	Description of the boundaries in a regional context showing existing and planned future land use, surface disturbance, and any current infrastructure.	3.2.9, 4.1.3
8.2.2	**Temporal Boundaries**	
	Description of temporal boundaries for construction, operation, maintenance, and where relevant, closure, decommissioning and restoration of the sites affected by the development.	2.6, 2.7, 4.1.3
	Discussion of seasonal and annual variations of environmental components, as applicable, in relation to each phase of the development.	2.6, 2.7, 4.1.3

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
9	**Existing Environment and Baseline Information**	
	Identification of all potential direct and indirect biological, physical and human elements which could be affected by the proposed development, focusing on relevant issues and considering historical conditions.	3.0
	List of Elements and Goal statements, plus any additional elements identified by the developer. Justification for any deviation from the elements used in the EIRB goals.	4.0
	Details on any data manipulation, including accuracy assessments, confidence intervals, and margins of error.	3.0
9.1	**Biophysical Environment**	
	Demonstration of the Developer's understanding of the biophysical environment of the proposed development area, through the presentation of appropriate and current data on the following:	3.1
	Terrain, Geology, Soils and Permafrost;	3.1.1
	Climate;	3.1.2
	Air Quality;	3.1.3
	Noise;	3.1.4
	Water Quality and Quantity;	3.1.5, 3.1.6
	Fish and Fish Habitat;	3.1.7
	Wildlife and Wildlife Habitat;	3.1.9
	Birds and Bird Habitat; and	3.1.10
	Vegetation.	3.1.8
9.2	**Human Environment**	
	Demonstration of the Developer's understanding of the Human environment of the proposed development area, through the presentation of appropriate and current data on the following:	3.2
	Demographics;	3.2.2
	Regional and Local Economies;	3.2.3
	Education, Training and Skills;	3.2.4
	Infrastructure and Institutional Capacity;	3.2.5
	Human Health and Community Wellness;	3.2.6
	Socio-cultural Patterns;	3.2.7
	Harvesting;	3.2.8
	Land Use; and	3.2.9
	Heritage Resources.	3.2.10
10	**Impact Assessment**	
	Methods used for the environmental effects assessment, in sufficient detail so the reviewers can understand the rationale, logic, assessment process, and how conclusions were reached.	4.1, 4.2, 4.3, 4.4, 4.5

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
	Description of environmental effects of all development components over all phases of the development, including long-term operations and maintenance, including: Direct, indirect, reversible, irreversible, short-term, long-term, and cumulative;	4.0, 5.0
	The location, extent, and duration of affected elements and their overall impact;	4.1, 4.2, 4.3
	Focus on the biophysical and socio-economic elements (valued components) identified for the development;	4.0
	Reference of impacts to elements and goal statements;	4.0
	Quantified confidence levels for impact predictions that can be used in follow monitoring programs to verify predictions; and	4.0, 5.4.1
	Consideration of the historic biophysical and human environment conditions in impact assessment and mitigation/ reclamation plans.	1.6.2, 3.0, 4.0, 5.0, 6.0
10.1	**Biophysical Components**	
	Potential impacts of the Project on physical environment VECs.	4.2
	Assessment of the Areas of Concern.	4.0
	The nature of potential impacts and how conclusions were reached, for each VEC.	4.2, 5.4.1
	Clear description of the path from the baseline (current) conditions, to potential impacts, mitigation, residual impacts and determination of significance.	4.2
	Consider how natural variation or events (e.g., Climate Change) could affect the descriptions of Project impacts.	2.6, 3.1.2, 4.5
10.1.1	**Terrain, Geology, Soils, and Permafrost**	
	Potential impacts of the Project on terrain, geology, soils and permafrost, including a consideration of:	4.2.1
	Slope and soil stability;	4.2.1
	Erosion on overland low angle sloping terrain;	4.2.1
	Subsidence;	4.2.1
	Granular resource extraction areas (include quantity and quality of granular resources);	4.2.1
	Thaw slumps and compaction of organic peatlands and potential for melt of ice-rich ground;	4.2.1, 4.2.6
	Drainage beside and beneath the road;	4.2.1, 4.2.4
	Channelization and non-channelization flow; and	4.2.1, 4.2.4
	Consideration of mitigation to prevent degradation of permafrost.	2.6, 4.2.1

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
	With respect to potential impacts of the Project on permafrost, include the consideration of: Permafrost as a design feature in the road bed; failure modes analysis and associated contingency plans; Thermal condition, active layer thickness, thaw depth, distribution and Stability; Ice rich soils (thaw settlement, thermokarst) permafrost thaw and related settlement; Frost heave of frost susceptible soils in thin permafrost as well as seasonally frozen soils; Thaw or settlement-related impacts on drainage and surface hydrology; and Shorelines, channels, taliks.	2.6, 4.2.1, 4.2.4
	Combined impacts of the Project and tundra fires.	4.5.4
10.1.2	**Air Quality**	
	Potential impacts of the Project on air quality including a consideration of: the Project activities and components which would be sources of air emissions;	4.2.2
	Emissions of concern by source for each Project phase, including quantity, timing and duration, normal operation conditions and upsets;	4.2.2
	If appropriate, secondary particulate matter, diesel particulate matter, and air pollutants on the List of Toxic Substances in Schedule 1 of CEPA Registry;	4.2.2
	Air quality parameters that could be affected by these emissions;	4.2.2
	Acid deposition;	4.2.2
	How changes in air quality could impact humans, wildlife and vegetation (short-term and long-term over the Project lifespan);	4.2.2, 4.2.6, 4.2.7
	Ice fog, visibility; and	4.2.2
	Terrain.	4.2.2
	Also includes: Discussion of relevant territorial, provincial and federal air quality standards or guidelines, including their purpose and use in relation to the Project phases; Consideration of the CCME's guidance document (CI and KCAC); and Discussion and evaluation of dust suppression techniques.	3.1.3, 4.2.2
10.1.3	**Noise**	
	Potential impacts of Project-related noise, including a consideration of: Project components or activities that could produce noise levels of concern, including source location, timing and duration;	4.2.3
	Terrain and weather;	4.2.3
	Disturbance to fish, wildlife and birds including barren-ground caribou and grizzly bear;	4.2.3, 4.2.5, 4.2.7
	Disturbance of harvest and recreational activities, including tourism;	4.2.3
	Potential impacts to harvesting activities;	4.2.3

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
	Impacts to communities;	4.2.3
	Discussion of relevant territorial, provincial and federal noise standards or guidelines, including their purpose and use in relation to the Project phases;	3.1.4, 4.2.3
	Comparison of anticipated noise levels along the highway with current industrial, municipal or ambient noise levels;	3.1.4, 4.2.3
	Assessment of the potential health impacts related to Project-related changes in noise levels, including potential impacts of sleep disturbance and annoyance; and	4.2.3
	Description of the proximity of the Project to sensitive receptors and environmental elements.	4.2.3
10.1.4	**Water Quality and Quantity**	
	Potential impacts of the Project on water quality and quantity, including a consideration of: Changes to surface drainage patterns and surface water hydrology including changes caused by Project-related impacts on terrain, soils and permafrost;	4.2.4
	Hydrogeological resources;	3.1.6, 4.2.4
	Drinking water quality for humans and wildlife;	3.1.5, 4.2.4
	Recreational water quality;	3.1.5, 4.2.4
	Discharge or seepage of wastewater effluent, contaminants, chemical additives;	4.2.4, 4.3.4, 4.4.3
	In-stream activities (e.g. watercourse crossings);	4.2.4
	Changes to water quality at water crossings (bridges, culverts and other wetted areas);	4.2.4
	Changes to water quality due to thaw slumps;	4.2.4
	Erosion, sediment deposition, sediment re-suspension;	4.2.4
	Dust and dust suppression;	4.2.4
	Increased turbidity;	4.2.4
	Subsidence;	4.2.4
	Slope stability;	4.2.4
	Flow or water levels including the formation of frost bulbs and related icings at watercourse crossings;	4.2.4
	Water withdrawal and volume of withdrawal; and	1.5.1, 4.2.4
	Gravel extraction.	1.5.1, 4.2.4
10.1.5	**Species of Concern**	
	Consideration of any change that the Project may cause to a listed wildlife species, its critical habitat, or the residences of individuals of that species, as outlined in subsection 2(1) of SARA.	4.2.7
	Discussion of the potential impacts of the Project on species of concern and proposed mitigation in relation to applicable legislation, policy, management plans, recovery strategies, action plans or land use planning initiatives.	4.2.7

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
10.1.6	**Fish and Fish Habitat**	
	Potential impacts of the Project on VECs related to fish and fish habitat, including: Proposed watercourse crossings and temporary vehicle crossing methods;	4.2.4, 4.2.5
	Standards or guidelines related to watercourse crossings that would be applied;	1.5.1, 4.2.4, 4.2.5
	Relevant policies, management plans or other measures to protect or enhance fish and fish habitat, including timing restrictions, protected areas or regulations;	1.5.1, 4.2.4, 4.2.5
	Disruption of sensitive life stages or habitat including loss of substrate habitat, known sensitive or important sites;	4.2.4, 4.2.5
	Features such as in-stream structure, riparian zones, water quality and flow regimes;	3.1.5, 3.1.6, 3.1.7, 4.2.4, 4.2.5
	Impacts on food resources;	4.2.5,4.3.7
	Impacts on water quality or quantity;	4.2.4, 4.2.5
	Distribution or abundance;	4.2.5
	Sensitive or important areas or habitat;	4.2.5
	Contaminant levels in harvested species that could be changed by the Project, if applicable;	4.2.5
	Fish health and condition;	4.2.5
	Blockages to movement;	4.2.5
	Blasting (if required);	4.2.5
	Dredging or disposal of sediments;	4.2.5
	Underwater noise associated with Project activities;	4.2.5
	Water withdrawal;	1.5.1, 4.2.5
	How Project-related changes in harvest pressures could impact the resource;	4.2.5, 4.3.7
	Effects to fish populations and harvest activities;	4.2.5
	Description of any works that may result in potential impacts to fish and fish habitat that cannot be avoided or mitigated, and that may result in harmful alteration, disruption, or destruction (HADD) on fish habitat;	4.2.5
	The condition(s) to which the ROW (instream and riparian) and temporary work areas would be reclaimed or restored, and maintained once construction has been completed;	4.2.5
	Criteria for evaluating the success of mitigation or reclamation measures, and indicate when and how this evaluation would be conducted; and	4.2.5, 5.4.1, 6.0, 7.0
	The monitoring program for fish and habitat resources of waterbodies along the highway corridor.	4.2.5, 7.0
10.1.7	**Wildlife and Wildlife Habitat**	
	Potential impacts of the Project on VECs related to wildlife or wildlife habitat, including a consideration of: Direct and indirect alteration of habitat including Project footprint impact;	4.2.7

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Visual or auditory disturbance, including habitat avoidance and effective habitat loss in relation to Project facilities or activities;	4.2.7
	Wildlife mortality due to harvesting and vehicle collisions;	4.2.7
	Disruption of sensitive life stages or habitat;	4.2.7
	Wildlife movement patterns, home ranges, distribution and abundance;	4.2.7
	Sensitive or important areas or habitat;	4.2.7
	Population cycles;	4.2.7
	Predatory-prey relationships;	4.2.7
	Increased human-wildlife interactions;	4.2.7
	How Project-related changes in harvest pressures could impact the resource;	4.2.7, 4.3.7
	Contaminant levels in harvested species that could be changed by the Project;	3.1.9, 4.2.7
	Wildlife health and condition; and	4.2.7
	Discussion on the duration and geographic extent of potential impacts in relation to how wildlife populations and harvest activities could be affected.	4.2.7, 4.3.7
10.1.8	**Birds and Bird Habitat**	
	Potential impacts of the Project on VECs related to birds and bird habitat, including a consideration of: Disruption of sensitive life stages or habitat;	4.2.7
	Direct and indirect alteration of habitat including footprint;	4.2.7
	Sensitive or important areas or habitat;	4.2.7
	Visual or auditory disturbance, including habitat avoidance in relation to Project facilities or activities and light disturbance;	4.2.7
	Bird distribution or abundance;	4.2.7
	Contaminant levels in harvested species that could be changed by the Project;	4.2.7
	Bird health and condition;	4.2.7
	How Project-related changes in harvest pressures could impact the resource;	4.2.7
	Project-induced subsidence;	4.2.7
	Highway maintenance;	4.2.7
	Attraction of predators of birds and bird eggs to the Project, or the provision of nesting or denning habitat for predators and scavengers;	4.2.7
	Potential mortality from collisions with temporary or permanent tall structures or wires;	4.2.7
	Potential mortality from vehicle collisions.	4.2.7
10.1.9	**Vegetation**	
	Potential impacts of the Project on vegetation, including consideration of: Alteration or loss of species, or vegetation assemblages that are rare, valued, protected or designated sensitive or important areas or habitat;	4.2.6
	Sensitive or important areas;	4.2.6

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Introduction of non-native and/or invasive species;	4.2.6
	How road dust might impact vegetation and surface albedo near highway;	4.2.6
	How changes might impact permafrost and the highway itself;	4.2.6
	Changes to the soil, hydrological or permafrost regimes;	4.2.1, 4.2.4, 4.2.6
	Re-establishment of vegetation and reclamation of borrow sites and other disturbances;	2.6.8, 4.2.6
	How Project-related changes in harvest pressures could impact vegetation resources;	4.2.6, 4.3.6, 4.3.7, 4.3.8
	Changes in contaminant levels in harvested species that could be changed by the Project, including parts of plants such as roots, leaves and berries; and	4.2.6
	Vegetation control.	4.2.6
10.1.10	**Biodiversity**	
	Discussion about changes to the biodiversity of the Study Area(s) during construction, operations and any post-reclamation and the significance of these changes in a local and regional context. Description of how the Project could result in changes to biodiversity, including a consideration of: Ecosystem and habitat loss;	4.2.2, 4.2.5, 4.2.6, 4.2.7
	Habitat fragmentation/ barriers to movement and gene flow;	3.1.9, 4.2.7
	Ability of habitat or species to recover;	4.2.6,4.2.7
	Response to edge effects;	4.2.7
	Species distribution and abundance;	4.2.6, 4.2.7
	Invasive/non-native species;	4.2.6
	Changes to special management areas;	4.3.8
	Pollution – spills, runoff, water and emissions to air;	4.2.2, 4.2.4, 4.4
	Species of special management concern;	3.1.7, 3.1.8, 3.1.9, 3.1.10, 4.2.6, 4.2.7
	Project-related changes in harvest levels; and	4.2.7, 4.3.7
	Changes to important habitat areas.	4.2.7
10.1.11	**Country Foods**	
	Linkages and related sources of contaminants and other impacts in relation to the potential for contamination of country foods.	3.1.9, 3.2.6, 4.3.7
	Identification of which country foods are consumed, or expected to be consumed, contaminants of concern, and an indication of whether transport pathways of contaminants into country foods will result from the proposed Project and associated activities.	3.1.9, 3.2.6, 4.3.7

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
10.2	**Human Environment Components**	
10.2.1	**General**	
	Positive and negative impacts of the Project on the VCs selected for the human environment.	4.3, 5.4.1
	Potential changes to social, cultural, and economic conditions that may occur as a result of Project-related biophysical impacts.	1.6.2, 4.3, 4.4.5, Appendix F
	Social, cultural, and economic impacts, both positive and negative, of year-round access between Tuktoyaktuk and Inuvik, and opened access to harvesting areas and areas of ecological and cultural importance.	1.6.2, 4.3, Appendix F
	Direct and indirect impacts of the Project that may enhance and/or impair the current social, cultural, and economic ways of life in the communities, and community aspirations for the future.	1.6.2, 3.2.10, 4.3, Appendix F
	The needs and interests of various segments of the local populations (e.g. youth, Elders, women, harvesters), and how the Project may affect each of them.	1.6.2, 3.2.4, 4.3
	Possible reactions to Project-related effects, as well as the capacity of local residents, communities, and institutions to respond to the Project.	1.6.2, 4.3
	How people, communities, institutions, and governments might be expected to adapt to Project-induced changes to the human and biophysical environments.	4.3
	Local residents' perceptions of impacts and how these are grounded in their culture, social organization, and historical experience.	1.6.2, 4.3
	The limitations of this study in identifying any of the potential effects.	4.3
	How mitigation would address impacts experienced by residents: by age group, gender and ethnicity (where appropriate).	4.3, 5.4.1, 6.0
	How Inuvialuit organizations will be involved in the development, application and ongoing evaluation of mitigation measures. Parties responsible for the implementation of mitigation measures and how a lack of resources and/or information may have the potential the effectiveness of mitigation measures.	1.5.1, 4.2, 4.3, 6.0
10.2.2	**Demographics**	
	Potential impacts of the Project on demographics and mobility, including a consideration of:	4.3.1
	Age and gender;	4.3.1, 4.3.2
	Residence patterns; and	4.3.1
	In/out migration, by community and for the Inuvialuit Settlement Region (ISR).	4.3.1
10.2.3	**Regional and Local Economies**	
	Potential impacts of the Project on local, regional (ISR), and territorial economies, including consideration of: Project contribution to the GDP - direct, indirect, and induced economic activities for the regional (to the extent possible), provincial, territorial, and national economies;	4.3.2, Appendix F

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
	Direct taxes (estimated) for business and persons;	4.3.2, Appendix F
	Employment and income for every year of construction and operation;	4.3.2, Appendix F
	The extent to which the skills of the available workers match the job requirements;	4.3.2
	The level of interest in Project-related work;	1.6.2, 4.3.2
	Commuting arrangements for workers;	2.6.9
	How any unionized labour could impact employment and income;	4.3
	Hiring opportunities, priority hiring practices;	2.7.3, 2.7.4, 4.3.2
	Skill or certification requirements;	2.7.4, 3.2.4, 4.3.2
	The equitable distribution of benefits to residents and communities in the Project area;	1.6.2, 2.2.4, 2.6.8, 4.3.2, 4.3.8
	Competition for labour between the Project and existing businesses, government institutions and traditional activities and related wage and salary impacts;	1.3, 4.3.2, 4.3.7
	Community income and household economics, including subsistence activities and the sustainability of traditional economies;	3.2.3, 3.2.4, 3.2.8, 4.3.2, 4.3.7
	Local consumer prices, inflation and costs of living, particularly with regard to food, transportation, utilities, and shelter; and	3.2.3, 3.2.4, 3.2.8, 4.3.2, 4.3.5, 4.3.7
	How Project-related impacts on harvested resources or harvest activities (both positive and negative) affect community income and household economies, and sustainability of traditional economies.	4.3.7, 4.3.8, 4.4.5, 5.4.1
10.2.4	**Education, Training and Skills**	
	Describe and evaluate the potential impacts of the Project on education, training and skills, including a consideration of: Participation in education and training, by age, gender and ethnicity;	4.3.3
	Educational achievement and attainment;	4.3.3
	Literacy levels (English and Inuvialuktun);	4.3.3
	Education and training programs required for Project-related construction and operation employment, including: Local and regional training opportunities available to local people;	3.2.4, 4.3.3
	Timing and duration of programs, in relation to the Project schedule;	2.7.2, 3.2.4, 4.3.3
	Which skills and experience gained in the Project workforce that could be applied to other available projects or sectors; and	2.7.4, 4.2.7, 4.3.3
	Programs that would be provided by, or sponsored by, the Proponents.	1.1.2, 2.7.4, 4.2.7, 4.3.3

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
10.2.5	**Infrastructure and Institutional Capacity**	
	Describe and evaluate the potential impacts of the Project on infrastructure and institutional capacity, including a consideration of: Temporary and permanent changes to infrastructure and services and the capacity of institutions and organizations to deliver those services identified in the baseline description;	1.3, 4.3.1, 4.3.4
	Changes in the capacity of the service industries to provide local goods and services;	1.3, 4.3.1, 4.3.4
	Changes in the availability, quality and affordability of housing in communities, including factors that influence accessibility to housing (e.g. age, gender); and	4.3.4
	Measures to address any changes in the level of demand for infrastructure and institutional capacity and an estimate of incremental costs to municipal, regional, territorial, and federal governments resulting from the Project.	4.3.2, 4.3.4
10.2.6	**Human Health and Community Wellness**	
	Potential impacts of the Project on human health and community wellness, including a consideration of: Local perceptions of physical, mental and social health and changes in the quality of life, including differences or similarities in perceptions within and between Inuvik and Tuktoyaktuk;	1.6.2, 4.3.5, 4.3.6, 4.3.7
	Measures of mortality and morbidity, and of social pathology and dysfunction such as teen pregnancies, sexually transmitted infections, communicable diseases, substance abuse, family violence, and crime; and	3.2.2, 3.2.6, 4.3.5
	Changes in diet and use of country food.	1.6.2, 3.2.6, 3.2.8, 4.3.5, 4.3.7
	How Project-related changes in the quality of country food affect health, including possible sources of contaminants, exposure pathways and consumption patterns (i.e., age group, sex).	1.6.2, 3.1.9, 3.2.6, 4.3.5, 4.3.7
	How Project-related impacts on harvested resources or harvest activities affect health and wellness.	1.6.2, 4.3.5, 4.3.6, 4.3.7
	Describe and evaluate potential impacts that may arise from changes in: Water quality and air quality;	4.2.4, 4.2.5, 4.3.5, 4.4
	Poverty and homelessness;	3.2.4, 4.3.5
	Literacy skills and education levels; and	3.2.4, 4.3.3
	The presence or absence of support systems and programs, regionally and locally and their capacity to address human health and community wellness.	3.2.6, 3.2.7, 4.3.6
10.2.7	**Socio-cultural Patterns**	
	Describe and evaluate the potential impacts of the Project on social and cultural patterns and cohesion, including: How Project-related impacts on harvested resources or harvest activities affect social and cultural patterns and cohesion;	1.6.2, 4.3.6, 4.3.7
	Traditional lifestyles, values and culture;	3.2.7, 4.3.6, 4.3.7, 4.3.8, 4.4.5

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Cultural and spiritual life of the communities, including language loss or retention;	3.2.7, 4.3.3, 4.3.6, 4.3.8, 4.4.5
	Patterns of social organization at the household and community level, including the organization of work, mutual aid and sharing;	3.2.7, 4.3.6
	Family dynamics or structure, including child and elder care;	1.6.2, 3.2.5, 3.2.7, 4.3.5, 4.3.6
	How the influx of tourists, and potential influx of Project-related employees for future projects and workers could impact communities;	1.6.2, 4.3.1, 4.3.2, 4.3.4, 4.3.6, 4.3.8
	Social relations between residents and non-residents, and between Aboriginal and non-Aboriginal persons; and	1.6.2, 3.2.7, 4.3.1, 4.3.2, 4.3.6, 4.3.8
	Programs that could support cultural patterns and cohesion.	3.2.5, 3.2.7, 4.3.3, 4.3.6
10.2.8	**Harvesting**	
	Potential impacts of the Project, for the preferred and alternate routes, on harvesting during both construction and operation including a consideration of: Changes in access, including increased access to the land and surrounding lakes, as well as increased access to an environmentally and culturally sensitive area (Husky Lakes);	4.3.7, 4.3.8
	Changes in the abundance and distribution of harvested resources, including wildlife, birds, fish and vegetation that would negatively affect harvesting;	4.2.5, 4.2.6, 4.2.7, 4.3.7
	Disturbance of harvest patterns, or loss or alteration of high-value harvest areas;	4.2.7, 4.3.7, 4.3.8, 4.4.5
	Changes in the quality of harvested species (including contamination) that would negatively affect their consumption or sale;	3.1.9, 4.2.5, 4.2.6, 4.2.7, 4.3.7, 4.4.5
	Measures to avoid or minimize changes in the abundance, distribution, or quality of harvested species, or mitigate the consequences of such changes;	4.2.5, 4.2.6, 4.2.7, 4.3.7
	Mechanisms to control Project workforce-related hunting, fishing, or harassment of wildlife; and	4.2.5, 4.2.7, 4.3.7, 6.0
	Mechanisms of resource management agencies and other parties to control hunting, fishing, or harassment of wildlife.	3.1.9, 3.2.8, 4.2.5, 4.2.7, 4.3.7, 6.0
10.2.9	**Land Use**	
	Potential impacts of the Project on land use, including a consideration of various land uses, including: Traditional use; Tourism and changes in tourism access; Industrial use and changes in access;	3.2.9, 4.3.8
	Patterns of use and changes in these patterns; and	3.2.9, 4.3.8
	Impacts on particular sites or features.	3.2.9, 4.3.8

TABLE E: CONDORDANCE TABLE		
ToR Section	Information Requested	EIS Location
	Conformity of proposed Project-related land uses with designated land use management areas as described in approved and draft management plans, community conservation plan, and proposed land use designations and identification of discrepancies.	3.2.9, 4.3.8
	An evaluation of the potential impacts of the Project on protected areas and special management areas, including a consideration of the following: Community conservation plans; Regional land use plans; Existing and proposed protected areas; Special management areas; Other proposed special management areas such as parks, sanctuaries or preserves; and Implementation of plans, action plans, strategies and guidelines.	3.2.9, 4.3.8
10.2.10	**Heritage Resources**	
	Describe and evaluate the potential impacts of the Project on cultural heritage and special management areas, including a consideration of the following: Historic, archaeological, paleontological, cultural and heritage resources/ sites/ trails;	3.2.10, 4.3.9
	Resource potential;	3.2.10, 4.3.9
	Encounter of resources during Project activities; and	3.2.10, 4.3.9
	Valued visual and aesthetic locations and their attributes.	3.2.9, 4.3.8
10.3	**Potential Accidents and Malfunctions**	
	Possible accidents or malfunctions, their probable and potential effects on the environment, including impacts on social, economic, and cultural elements of the environment and human health to people in close proximity of accidents or malfunctions, including spills of contaminants for the life of the Project.	4.4
	The process for the implementation of any mitigation measures or contingency plans.	4.4.5
	Discussion of the developer's commitment to having an Environmental Protection Plan (EPP) and Emergency Response Plan (ERP) that would address potential accidents and malfunctions for the life of the Project.	4.0, 4.4, 6.0, Appendix E
	Sensitive elements, including those identified in the IFA and CPPs, of the environment that could be affected in the event of an accident or malfunction over the life of the Project.	4.4
	The probability of impacts, taking into account weather or extreme external events that present contributing factors.	4.4, 4.5
	For each Project phase, the potential accidents or malfunctions that may occur as a result of the Project.	4.4
10.4	**Effects of the Environment on the Project**	
	The effects of the environment on the Project.	4.5
	How the Project is engineered and designed to integrate into its environmental surroundings and operate safely and reliably over its life.	4.5

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
	How physical and biological changes in the environment could have implications for the Project.	2.4, 4.5
10.5	**Determination of Significance**	
	Approaches used to determine the significance of effects for each biophysical or socio-economic element assessed	4.1
	Definition of impacts in terms of magnitude, geographic extent, duration, and frequency.	4.0, 4.1
	Justification and rationale for thresholds relating to the impacts criteria and how the impacts criteria inform the assessment about the significance of impacts, under the assumption that mitigation measures will be implemented successfully.	4.1, 4.2, 4.3, 5.4.1
	Positive and negative impacts.	4.1, 4.2, 4.3, 5.4.1
11	**Cumulative Effects**	
	Assessment of cumulative effects, showing that long-term cumulative effects are adequately considered and can be successfully mitigated.	5.0
	Discussion of the incremental contribution of all projects or activities (including operation of the hwy) in the delineated Study Area(s), and of the Project alone, to the total cumulative effect on the VEC or VSC over the life of the Project.	5.0
	Spatial and temporal boundaries for the cumulative effect assessment for each VEC selected.	5.1, 5.2
	Analysis of impacts of Project activities when they are combined with the impacts of other past, present, and future projects and activities.	5.3, 5.4
	Different types of potential impacts, different forms of effects, such as synergistic, additive, induced and spatial or temporal overlap; and impact pathways and trends.	5.0, 5.4.1
	Rationale for the process chosen to carry out the cumulative effects assessment; and description of, and rationale for, the approach and methods used to identify and assess cumulative effect; and the approach of the assessment in the context of the IFA and updated CCPs.	5.0
	Identification and justification of (VECs or VSCs) for all Project components involved in the cumulative effects assessment, including those for alternative routes.	4.1, 5.4
	Evaluation of the potential for this Project to catalyze future projects and the effects these potential projects and the associated loss of remoteness.	1.3, 2.8, 3.2.8, 4.3.2, 5.3, 5.4.1, Appendix F
	Contribution of the Project to a total potential cumulative effect.	5.3, 5.4
	Potential cumulative Project effects in a regional context, considering regional plans, community conservation plans, species recovery plans, management plans, objectives and/or.	5.3, 5.4
	Identification of any changes in the original environmental effects and significance predictions for the Project.	5.4

TABLE E: CONDORDANCE TABLE		
ToR Section	**Information Requested**	**EIS Location**
	Effectiveness of the proposed mitigation and/or other restitution measures, the response to such changes, and implications for monitoring and follow-up programs.	4.0, 5.4, 6.0, 7.0
	Proposed management tool(s) for cumulative effects resulting from the proposed Project.	4.0, 5.4, 6.0
12	**Mitigation, Mitigative and Remedial Measures, and Worst Case Scenario**	
	Examination of all mitigation measures, identified during the impact assessment to identify development impacts that could affect wildlife harvesting, from a worst case scenario perspective.	4.2.7, 4.3.7, 4.3.8, 4.4.5
	Discussion and conclusions reached in this chapter are necessary to address the specific requirements of the IFA and have been requested for liability/compensations purposes.	4.4.5
12.1	**Mitigation**	
	Summary table of detailed mitigation commitments of the Developer, including: measures, implementation methods, identified impacts and VCs.	4.2, 4.3, 6.0
12.2	**Mitigation and Remedial Measures**	
	Mitigative and remedial measures designed to reduce or eliminate negative impact to wildlife, wildlife habitat and wildlife harvesting in the EIS.	4.2, 4.3, 6.0
12.2.2	**What Developers Shall Consider**	
	A description of any potential impacts to the biophysical and human environment, wildlife, wildlife habitat, and wildlife harvesting activities.	4.2, 4.3, 5.4, 6.0
	A description of the proposed mitigation to reduce or eliminate potential impacts.	4.2, 4.3, 6.0
	Measures to address sensory disturbances to wildlife, particularly barren-ground caribou and grizzly bear.	4.2.7, 6.0
	An outline of emergency response plans and any management and monitoring plans proposed and/or required for the development to proceed.	4.0, 4.4, 6.0, Appendix E
	Where appropriate, a clear indication of the party responsible for implementing the mitigation.	2.7.5, 4.0, 6.0
	Mitigation to reduce the potential negative effects of a development.	4.2, 4.3, 6.0
	Measures that are built into the design of the development can be included in the discussion of development activities.	1.6.2, 2.6, 3.0, 4.0
	Rationale for mitigation measures and examples of where these measures have been used effectively.	2.6.1, 4.2, 4.3, 6.0
12.3	**Worst Case Scenario**	
	Worst case scenario estimate for negative impacts to wildlife, wildlife habitat and wildlife harvesting, as a result of the proposed development.	4.4.5

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
12.3.1 12.3.2	**Wildlife Compensation, Liability and Worst Case Scenario**	
	The Developer's potential Liability, based on worst case scenario. If there is a possibility that damage to wildlife or wildlife habitat may occur as a result of the Project, the EIRB must recommend terms and conditions relating to mitigative and remedial measures that are necessary to minimize the negative impact of a proposed development on wildlife harvesting. The Worst Case Scenario will be used to calculate a security amount to be held by the federal Minister.	4.4.5
12.3.4	**Wildlife Habitat Restoration**	
	Restoration includes post-development measures that would enhance recovery of harvested populations to pre-development levels. Determining the practicality and potential costs of restoration resulting from a "worst case scenario".	4.4.5
13	**Follow-up and Monitoring**	
	"Follow-up" program for verifying the accuracy of the environmental assessment of the Project, and determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the Project, including: Regulatory and non-regulatory monitoring requirements for the life of the Project; Purpose of each program, responsibilities for data collection, analysis and dissemination, and how results will be used in an adaptive management process; and How Project-specific monitoring will be compatible with the NWT CIMP or other regional monitoring programs.	4.0, 7.0
13.1	**Environmental and Socio-Economic Effects Monitoring**	
	Table with effects monitoring requirements, including: effects, indicators and parameters for each effect or concern; and the target or management goal.	7.0
13.2	**Compliance Monitoring**	
	Environmental Monitoring Inspection Requirements Table, that includes: Current conditions of any applicable permits, licenses and approvals; The frequency, nature, and period of time of inspections; and Demonstrates how the terms and conditions set out in regulatory approvals, licenses and permits, and in the commitments submitted by the Developer will be adhered to and met and will be used by the environmental monitoring to verify and report the work being done.	7.0
13.3	**Environmental Management Plans**	
	Environmental management plans for specific areas of concern to meet environmental goals for life of the Project, including: Methods for the implementation of mitigation measures; Methods for the monitoring of mitigation effectiveness; Reporting mechanism on goals; and Incorporation of plans identified by the Developer in the EIS as being required and other plans deemed necessary.	4.2, 4.3, 6.0, 7.0, Appendix E

TABLE E: CONDORDANCE TABLE

ToR Section	Information Requested	EIS Location
13.4	**Socio-economic and Cultural Effects Management, Policies, and Commitments**	
	Management plans, policies, commitments, and arrangements directed at promoting beneficial or mitigating negative impacts to social, cultural, or economic conditions where they have been presented as a form of mitigation. Discuss any requirements for contractors and sub-contractors to comply with these policies.	4.0, 4.3.2, 6.0, 7.2
	Recruitment, training, hiring, pay equity and employment policies, including those policies specifically for Aboriginal and local candidates, and those promoting participation.	1.3, 1.6.2, 4.2.7, 4.3.2, 4.3.3, 7.2
	Contracting and procurement policies, including those which promote local sourcing, and participation of local businesses and how this will be accomplished.	1.3, 1.6.2, 2.2.4, 2.2.6, 4.3.2
	Employment policies, including policies on alcohol and drugs on the job site, harassment policies, firearms policies, work and pay schedules, and any policies related to worker access to harvesting areas.	4.3.8, 7.2
	Commuting and work rotation of workers and contractors.	2.6.9, 4.3
	Policies to managing hunting, fishing and gathering on, or from, the work site by non-Inuvialuit employees and contractors, while respecting the harvest rights of Aboriginal employees and contractors.	3.1.9, 3.2.8, 3.2.9, 4.2.7, 4.3.7, 4.3.8, 6.0
	Occupational health and safety and related training, and emergency response plans for workplace accidents.	4.2, 4.4 Appendix E
	Scheduling of construction activities to accommodate needs of Aboriginal harvesters (employees, contractors, and non-employees).	4.3.8
	Scheduling of work activities to accommodate needs of Aboriginal employees and contractors to pursue other traditional activities.	4.3.8
	Promoting activities and programs that increase community stability and wellness.	1.6, 3.2.6, 4.3
14	**References**	
	Information used to prepare the EIS, including: primary, peer-reviewed literature, government and consultant reports, personal communications, guidelines and best practices.	References

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
SOCIO-ECONOMIC	
The Developer is committed to observing the relevant economic measures of the Inuvialuit Final Agreement (IFA).	Design, Construction, Operations
The Developer is committed to preferential employment opportunities for qualified local residents and contractors.	Construction, Operations
The IFA guidelines for business operation will apply to this Project, giving priority hiring to companies included on the Inuvialuit Business List.	Construction, Operations
The Developer and on-site Project contractors will be responsible for the implementation of focused socio-economic measures, including recruitment and skills training.	Construction
The Developer will install educational signage related to harvesting, fishing, hunting, and responsible use of the Highway at appropriate and highly visible locations.	Operations
The Developer will require that its Project contractor(s) ensure that all heavy equipment operators are suitably trained in proper machinery maintenance and operation; that equipment is regularly inspected and serviced; and that contractor staff obey posted Highway rules (e.g., speed limits, hunting/fishing restrictions).	Construction
The Developer will require that its contractor(s) educate their staff on the prevention of accidents and malfunctions. The training received will be outlined for the Developer, including emergency spill response.	Construction
The Developer commits to ensuring that its contractor(s) have Health, Safety and Environment (HSE) manuals; work procedures documents; and site-specific health and safety plans.	Design, Construction
PLANNING AND DESIGN	
The Developer is responsible for the design and construction of the Highway, including field studies and data collection during Highway design and construction, and future operations funding, similar to other NWT highways.	Design, Construction, Operations
The Developer will conform to the IFA and the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans (CCPs) and will integrate the goals of these documents into the Project's environmental management.	Design, Construction
The Developer will undertake further engineering, environmental and archaeological studies in areas scheduled for construction during that same year.	Design
The Developer is committed to addressing the performance criteria and management goals identified in the ILA's draft Husky Lakes Special Cultural Area Criteria, pending approval.	Design
On approval of the Highway, the Developer commits to further consider Alternative 3 (2010 Minor Realignment) as the final alignment for the Highway.	Design
The Developer commits to using, as a guideline, the design parameters and construction techniques in the Transportation Association of Canada (TAC 2010) *Development and Management of Transportation Infrastructure in Permafrost Regions*. This will include mitigation strategies such as: -Accessing and hauling from borrow sources during the winter months; -Constructing embankments during the winter months;	Design, Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
-Conducting summer construction activities (such as grading and compacting the embankment, and placing of surfacing materials) only when the Highway can be accessed over the embankment; -Stockpiling surfacing material along the embankment during the winter for use in the summer; -Minimizing the surface area of open cut; -Grading slopes to minimize slumping; -Grading material storage and working areas to promote drainage ; -Reclaiming borrow sources when construction is complete by grading slopes to blend with the natural topography and drainage of the surrounding area; -Designing and constructing thick or high embankments to create an insulative layer that promotes the development of a frozen embankment core; -Designing the alignment to avoid unfavorable terrain, such as areas with thick organic deposits and ice-rich polygonal or patterned ground; -Installing culverts to manage seasonal overland flows; -Installing sufficient cross drainage during construction to prevent or minimize potential water ponding; and -Inspecting and maintaining culverts, as needed, in the spring and fall.	Design, Construction
CONSTRUCTION	
The Developer and its contractors will adhere to all applicable legislation, regulations, guidelines, and terms and conditions.	Construction
The Developer and on-site Project contractors will implement the mitigation measures identified in this EIS.	Construction
The Developer is committed to constructing the proposed Inuvik to Tuktoyaktuk Highway, borrow sources, and associated winter access roads in a safe and environmentally responsible manner.	Design, Construction
The Developers and their contractors will meet the standards required for a safe work environment.	Design
The Developer commits to working towards achieving the Environmental Impact Review Board's goal statements for all phases of the proposed development.	Design, Construction, Operations
Blasting, if required, will occur only during winter borrow source development.	Construction
The Developer is committed to building the roadway with 3:1 side slopes.	Construction
The Developer will use winter roads to access borrow sources; permanent all-weather access roads will not be required.	Construction
The Developer is committed to performing the majority of the construction activities during the winter months.	Construction
BORROW SOURCES	
The Developer is committed to limiting the footprint of each borrow source and minimizing the number of borrow sources developed.	Construction.
Borrow pits will be closed as soon as they are no longer required and reclaimed in a progressive manner, as described in the Pit Development Plan.	Construction, Operations, Reclamation
Pit Development Plans will conform to the approving authority's regulations and permitting requirements.	Design, Construction, Operations

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
Pit Development Plans will include mitigation measures to address potential environmental concerns, and operational and reclamation plans. Mitigation measures include: -Developing borrow sources only during winter periods; -Maintaining an appropriate amount of undisturbed land between borrow source locations and any waterbody; and -Applying appropriate erosion and sediment control BMPs for the construction of ditches and cross drainage channels.	Construction
The Developer commits to ensuring that borrow source development is monitored by environmental monitors.	Construction
OPERATIONS	
The Developer, using local contractors, will be responsible for ongoing operation, maintenance, and safety of the Highway.	Operations
The Developer will construct and operate the Highway to GNWT DOT standards and guidelines for public highways.	Construction, Operations
Should the Mackenzie Gas Project proceed, the Developer will work with the Mackenzie Gas Developers to ensure that increasing traffic on the Highway is effectively managed.	Operations
MANAGEMENT PLANS	
An Environmental Management Plan (EMP) will be prepared prior to construction, and will be submitted for regulatory approval prior to use. The EMP will clearly define expectations for compliance monitoring, responsibilities, requirements for training, and reporting.	Construction
The EMP will contain the following types of plans: -Environmental management; -Spill contingency; -Erosion and sediment control; -Pit development for borrow sources; -Fish and fish habitat protection; -Wildlife management; -Health and safety; -Waste management; -Hazardous waste management; and -Archaeological site(s) protection. Where necessary, the Developer and its contractor(s) will seek approval for the plans prior to use.	Design, Construction
SPILL CONTINGENCY PLAN	
The Developer will require that Project contractors prepare spill contingency plans, outlining spill reporting, containment, and clean-up, in accordance with INAC's *Guidelines for Spill Contingency Planning* (1987).	Design, Construction
The Developer will ensure that the Project contractor has appropriate spill response equipment on-site.	Construction
The Developer's contractors will report all spills greater than 5 litres to the GNWT Spill Line and other appropriate agencies.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
In the event of a spill, the Developer's contractors will respond according to the site-specific spill contingency plan and the contractor's HSE manual and procedures.	Construction
The Developer will develop and implement an erosion and sedimentation control plan as part of the EMP. The plan will comply with appropriate erosion and sediment control guidelines, GNWT best management practices (currently being prepared in coordination with DFO), and measures outlined in the DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat*. Some measures that will be followed include: -Limiting the use of construction equipment to the immediate footprint of the Highway or borrow source; -Minimizing vegetation removal and conducting progressive reclamation at the clear-span abutments, culvert installations and borrow sources; -Keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out by vehicles; -Avoiding the use of heavy equipment in streams or on stream banks during summer months, and the adherence to the DFO *Operational Statement for Temporary Stream Crossings* (DFO 2008), where this is deemed necessary; -Installing silt fencing and/or checking dams, and cross drainage culverts as necessary to minimize siltation in runoff near waterbodies; and -Appropriately sizing and installing culverts, based on hydrological assessments and local experience, to avoid backwatering and washouts.	Design, Construction
The Developer commits to ensuring that any exposed areas will be suitably stabilized prior to the spring thaw period.	Construction
The Developer is committed to using heavy equipment during Highway embankment construction through the winter months when all watercourse crossing locations are frozen.	Construction
FISH AND FISH HABITAT	
No instream work will occur in fish bearing streams during critical time periods.	Construction
Where critical fish habitat cannot be avoided, mitigation will be incorporated into the design.	Construction
Individual site-specific circumstances might preclude complete adherence to DFO Operational statements. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize effects.	Construction
In accordance with DFO (2009a), the installation of culverts in fish bearing streams will not permitted between April 1 and July 15 for watercourses that provide habitat for spring/summer spawners.	Construction
The Developer will consider, at a minimum, stream category when determining the type of structure to be placed at stream crossings.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
The Developer will develop and implement a fish and fish habitat protection plan in consultation with DFO that will include mitigation measures such as: -Designing appropriate crossing structures based on site conditions; -Completing primary construction activities during winter months; -Applying erosion and sediment control measures and best practices -Minimizing riparian disturbance (footprint); -Following the DFO *Operational Statement for Clear-span Bridges* (DFO 2009b) where appropriate; -Placing abutments at a sufficient distance from active stream channels; -Employing best management practices for culvert installation; -Annually monitoring for culvert subsidence or lifting; -Constructing in non-fish bearing streams during winter; -Sizing culverts appropriately based on hydrological assessments and local experience; -Maintaining equipment away from waterbodies; -Having on-site spill containment equipment and operators trained to handle spills; -Reported spills will be contained by trained maintenance crews; -Maintaining a sufficient buffer of undisturbed land between borrow sources and waterbodies; -Following DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998); -Following DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories*; -Allowing filtration by natural vegetation; -Installing silt fences at each road-stream intersection; -Building regularly spaced cross-drainage culverts; -Following the DFO *Operational Statement for Culvert Maintenance* (DFO 2009b) where applicable; -Applying spill response measures according to an approved spill contingency plan -Creating and enforcing Regulations or guidelines on fish harvest by FJMC with input from DFO, local fisherman and Hunters and Trappers Committees; -Posting signage at regular, visible intervals on Highway; -Constructing or installing stream crossing structures to avoid the impingement of active stream channels; -Effectively suppressing dust (i.e., through the use of water trucks) during the dry season; and -Following the recommendations of the Water License (once approved)	Design, Construction, Operation
WILDLIFE AND WILDLIFE HABITAT	
General	
The Developer will develop and implement species specific Wildlife Management Plans (WMP) that will include specific mitigation measures for Species at Risk, caribou, grizzly bears, moose, furbearers, and birds.	Design, Construction
The Developer or its contractor(s) will develop Bear Safety Guidelines and will educate staff accordingly.	Design, Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
The Developer's contractor(s) will be responsible for eduating and training staff on applicable practices contained within the Wildlife Management Plans and the Bear Safety Guidelines, including the proper use of non-lethal wildlife deterrent materials (e.g., bear spray).	Construction
-Camps and associated infrastructure will be designed to incorporate features that ensure safety for both personnel and wildlife, including installing adequate lighting, implementing proper waste management, cleaning and maintaining the kitchen and dining area, and implementing appropriate wildlife detection and deterrent strategies.	Design, Construction
Pre-disturbance surveys for critical habitat features (e.g., dens, nests) will be conducted prior to construction, in cooperation with GNWT ENR, as required.	Design, Construction
All wildlife encounters and mortalities will be reported to the environmental monitor, Safety Advisor, and GNWT ENR	Design, Construction, Operations
The Developer will implement general wildlife protection measures along the proposed Highway as follows: -Minimizing loss of habitat and the reduction of habitat effectiveness through Project design; -Educating users of the Highway that wildlife have the right-of-way at all times; -Posting signage along the Highway, emphasizing areas of high wildlife use; -Implementing a policy whereby Project personnel and contractors will not disturb any wildlife or critical habitat features such as dens or nests; -Implementing a system during the construction phase that serves to notify workers of wildlife presence in or near construction areas; -Hiring environmental monitors to during construction to watch for wildlife; -Adhering to spill contingency plans, as required, in a timely manner; -Conducting follow-up monitoring of spill sites to verify effectiveness; -Utilizing clean equipment, particulalry when deployed in or near water; -Implementing appropriate dust control measures to minimize effects to habitat and forage quality; -Adhering to waste management plans and procedures to avoid attracting wildlife; -Timing construction activities to avoid critical periods; -Applying and conforming with pre-determined setback distances from key wildlife habitat features; -Implementing a "no hunting" policy for Highway construction and maintenance workers; and -Working with agencies such as the HTCs, WMAC and GNWT ENR to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.	Design, Construction, Operations

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
Types of Mitigation for Caribou	
Types of mitigation measures that the Developer will integrate into the Project design, construction, and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on caribou are: -Limiting blasting activities, if required, to borrow sites and will only occur when caribou are >500 m from the blast site; -Working with agencies such as the HTCs, WMAC, and GNWT ENR to develop guidelines for periodic Highway closures, if required, as a way of minimizing the disruption of migration patterns to barren-ground caribou; -All sightings of caribou will be reported to environmental staff on-site; -Maintaining a minimum distance of 500 m between field operations and caribou for the duration of construction; -Caribou sightings will be recorded (including a GPS location if possible) and be submitted to the GNWT DOT Planning, Policy and Environmental Division and GNWT ENR upon completion of construction; and -Caribou crossing signs will be placed along the Highway, as needed.	Design, Construction, Operation
Types of Mitigation Measures for Grizzly Bears and Furbearers	
Types of mitigation measures that the Developer will integrate into the Project design, construction, and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on grizzly bears and furbearers include: -Freshly dug dens will be mapped such that construction activities will avoid active dens during the hibernation period; -If possible, no activities will occur within 500 m of an active den during the denning period (October to April); and -No blasting will occur if active bear dens are confirmed within 500 m of a proposed blasting area.	Construction
-Maintaining a minimum distance of 500 m between identified grizzly bear/wolverine den sites and personnel during construction; -Dens (grizzly bear, wolverine) discovered within 500 m of the Highway after the pre-construction survey will be reported immediately to GNWT ENR to determine the appropriate course of action; -Providing the wildlife monitor and designated, trained staff access to non-lethal deterrent materials (e.g., bear spray). The use of any deterrent method on wildlife will be reported to GNWT ENR;	Construction
-Minimizing and properly disposing of wildlife attractants such as garbage, food wastes, and other edible and aromatic substances; -Storing all food, grease, oils, fuels, and garbage in bear/wolverine-proof containers and/or areas; -No waste will be incinerated on- or off-site; and -Transporting waste to Tuktoyaktuk and/or Inuvik municipal solid waste facilities for disposal. Disposal of wastes at these facilities will follow the specified terms and conditions for use.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS

COMMITMENTS	PROJECT PHASE
Types of Mitigation Measures for Birds	
Types of mitigation measures that the Developer will integrate into the Project design, construction, and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on birds include: -Conducting pre-disturbance bird nest surveys in June-July to document use by nesting birds; -Avoiding conducting Project activities within 500 m of an active raptor nest during nesting season; -Designing structures in a way that limits or prevents their potential use as nesting structures; and -Allowing nesting birds who have utilized structures to remain in place.	Design, Construction
Types of Mitigation Measures for Peregrine Falcons	
The Developer will incorporate the following mitigation measures for Peregrine Falcons including: -Lights will be positioned to shine down or will be fixed with shielding to direct light downward on buildings and other infrastructure sites, wherever possible; -Lighting will be switched off, whenever possible (i.e., when camps and facilities are not in use); -Conducting an aerial survey of the final alignment and borrow sources to identify areas where Peregrine Falcons could be nesting that may require mitigation; and -Appropriate federal (CWS) and territorial (GNWT ENR) authorities will be contacted immediately before continuing work if a Peregrine Falcon nest is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).	Design, Construction
Types of Mitigation Measures for Bird Species At Risk	
The Developer will incorporate additional mitigation measures for bird Species at Risk including: -Immediately contacting appropriate federal (CWS) and territorial (GNWT ENR) authorities if a nest of a key bird species is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).	Construction
WASTE MANAGEMENT	
The Developer will develop a waste management plan for all wastes associated with pre-construction and construction activities. The waste management plan will apply to the Developer and all associated Project contractors involved in the generation, treatment, transferring, receiving, and disposal of waste materials for the Project.	Design, Construction
The Developer commits to the following steps prior to disposal of waste: -Obtaining approval from the Town of Inuvik and Hamlet of Tuktoyaktuk to use their sewage lagoon and solid waste disposal facilities; -Providing an estimate of the amount and type of domestic waste generated by the Project compared to the facility's available capacity; -Following all applicable Licence, Permits, and/or municipal bylaws regarding the use of the facility in Inuvik and Tuktoyaktuk; and -Recording the amount of domestic waste shipped to the landfills.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
The Developer will develop and implement a hazardous waste management plan (HWMP). The HWMP will encompass all pre-construction and construction phases of the Project and will apply to the Developer and all Project contractors involved in receiving, transferring, and transporting hazardous waste for the Developer's activities on land, water, and air.	Construction
FUEL MANAGEMENT	
The Developer commits to storing fuel used for borrow source and Highway construction activities in double-walled fuel storage tanks, and in accordance with CCME guidelines.	Construction
All vehicles and equipment will be refueled at least 100 m from water bodies following INAC (DIAND) fuel storage guidelines.	Construction
WATER QUALITY AND QUANTITY	
The Developer will ensure that the DFO water withdrawal protocol criteria are followed.	Construction
The Developer is committed to carrying out bathymetric surveys on all lakes proposed for water extraction.	Construction
The Developer will minimize effects to water quality and quantity as a result of Highway design through the design and use of crossing structures that are appropriate for site-specific flow conditions; by employing erosion and sediment control best management practices and DFO *Operational Statements* (where possible) as per approved Environmental Management Plans; installing appropriately sized culverts to divert and manage Highway and surface drainage flows; and undertaking primary Highway embankment construction activities during the winter months.	Design, Construction
The Developer is committed to completing hydrological assessments prior to bridge design to determine suitable span widths and abutment placement.	Design, Construction
During the bridge design of the Project, should individual site-specific circumstances preclude complete adherence to the DFO *Operational Statements*, the Developer will consult with DFO in advance to discuss and approve of proposed plans.	Design
Some of the mitigation measures for water quality and quantity effects the Developer will follow include: -Limiting the use of construction equipment to the immediate footprint of the Highway or borrow source; -Minimizing vegetation removal and conducting progressive reclamation at the clear-span abutments, culvert installations, and borrow sources; -Keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out by vehicles; -Avoiding the use of heavy equipment in streams or on stream banks during summer months, and the adherence to the DFO *Operational Statement for Temporary Stream Crossings* (DFO 2008), where this is deemed necessary; -Implementing the erosion and sediment control plan to be developed as part of the overall EMP; -Appropriately sizing and installing culverts based on hydrological assessments and local experience, to avoid backwatering and washouts.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
-Completing Highway embankment construction during winter months; -Adhering to the DFO *Operational Statement for Clear-Span Bridges* for all applicable activities; -Implementing appropriate dust control measures to minimize effects to waterbodies and aquatic habitat; -Following the DFO *Operational Statement for Culvert Maintenance* (DFO 2010) where necessary; -Maintaining equipment away from waterbodies; and -Adhering to spill contingency plans, as required, in a timely manner	Construction
STREAM CROSSINGS	
The Developer (under appropriate seasonal conditions), will conduct further assessments of the proposed water crossing locations and will provide information about watercourse characteristics and proposed crossing structure designs sufficient to meet the requirements of the Northwest Territories Waters Regulations.	Design, Construction
The Developer is committed to working closely with DFO to design appropriate crossing structures for each stream and to obtain Fisheries Authorizations, if determined to be required.	Design, Construction
The Developer will install culverts according to established guidelines and will follow culvert installation guidelines such as those contained within the DFO Land Development Guidelines (1993) and the INAC Northern Land Use Guidelines for Roads and Trails (INAC 2010).	Construction
The Developer will install appropriately sized culverts to minimize changes in water flow pattern and timing.	Construction
The Developer will not install culverts in critical aquatic habitats.	Construction
The Developer will carry out routine monitoring and inspections at watercourse crossings and culverts, including reporting on culvert performance and maintenance requirements.	Construction, Operations
The Developer will ensure that maintenance requirements for culverts will adhere to the DFO Culvert Maintenance Operational Statement.	Operations
The Developer will ensure that when crossings are completed, disturbed materials will be replaced with similar-sized substrates and the bed and banks of the watercourse are stabilized and restored.	Construction
VEGETATION	
The Developer commits to surveying borrow sources prior to construction for the presence of Yukon stitchwort and other rare plant species. Should rare plants be identified, they will be avoided where possible. If avoidance is not an option specimens will be collected, transferred to another suitable location, and/or donated to local herbaria for educational purposes.	Design, Construction
The Developer commits to minimize direct effects to vegetation cover by limiting construction activities, to the extent possible, to the planned footprint of the Highway.	Construction
Surveys ahead of construction in the vicinity of Holmes Creek and Hans Creek will be carried out to verify the location of the road alignment and stream crossings with respect to the unique Riparian Black Spruce/Shrub vegetation type.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
Controlling the effects of dust during construction and operation of the Highway will include applying water as needed, as per the *GNWT Guideline for Dust Suppression* (GNWT 1998).	Construction
The Developer commits to using appropriate northern, native plant species for any deliberate re-vegetation efforts of borrow sources.	Construction, Operations
The Developer or contractor(s) will apply strategies for mitigating potential effects to the vegetation types in the vicinity of the Highway and associated borrow operations such as: -Restricting off-site activities (e.g., ATV use) to the footprint area; -Ensuring machinery and equipment is clean prior to use on site; -Periodically monitoring roadsides for invasive species establishment; -Designing and engineering roadbed and drainage structures appropriately to accommodate unique environmental conditions; and -Containing and cleaning-up spills immediately in accordance with the spill contingency plans.	Design, Construction
AIR QUALITY	
The Developer will conform with applicable ambient air quality objectives by using pollution prevention measures and best management practices.	Construction
Mitigation measures for air quality during the construction phase will include: -Applying water as per the GNWT's *Guideline for Dust Suppression* (GNWT 1998) during summer months; -To the extent possible, aggregate stockpiling activities will be conducted well downwind of potentially sensitive receptors (based on prevailing winds); -Closing and progressively reclaiming borrow pits as soon as they are no longer required to reduce potential fugitive dust; -Ensuring proper maintenance of heavy equipment to minimize air emissions; and -Restricting speed limits along the access roads and Highway during construction to minimize dust production.	Construction
The Developer will be responsible for the ongoing maintenance of the Highway during the operations phase and will conform to the GNWT's *Guideline for Dust Suppression* (GNWT 1998).	Operations
LAND USE	
The Developer will implement mitigation measures to minimize potential land use effects such as: -Ensuring that construction vehicles stay on access roads or the construction site at all times; and -Prohibiting the recreational use of the Highway by Project staff during construction, including the use of ATVs and snowmachines.	Construction
During the operations phase, the Developer will work with appropriate parties to install signage and/or develop educational materials to encourage users to stay on the Highway and not adjacent areas.	Operations
NOISE	
The Developer will consult with wildlife experts to minimize noise effects on wildlife, particularly blasting activities.	Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
The Developer will use appropriate design, scheduling, logistics, and maintenance measures to reduce the effects of noise.	Design, Construction
Project contractors will be directed to apply reasonable mitigation measures to reduce possible effects associated with construction noise, including adequate maintenance of construction equipment and provision of appropriate mufflers for all internal combustion engines.	Construction
Blasting activities, if required, will be timed to avoid periods when sensitive wildlife species are in the area.	Construction
ARCHAEOLOGY	
The Developer will hire a qualified archaeologist to perform a final Archaeological Impact Assessment within a 100 m wide corridor along the alignment and all associated components such as borrow sources, work staging areas, and construction camps. All types of terrain will be sampled, including those with limited archaeological potential.	Design, Construction
Mitigation measures will be designed on an individual basis, and require prior approval by the Prince of Wales Northern Heritage Centre.	Construction
The Developer will, on recommendation from the contract archaeologist or Prince of Wales Northern Heritage Centre, implement avoidance or mitigation measures to protect archaeological sites or to salvage the information they contain through excavation, analysis, and report writing.	Construction
The Developer will prepare an archaeological site(s) protection plan to facilitate the continued protection and management of archaeological resources during the construction phase of the Project.	Construction
The Developer and its Project contractors will make every effort to avoid and protect recorded and unrecorded archaeological and heritage resources in accordance with the terms and conditions of the Northwest Territories archaeological regulations during the Project.	Construction
MONITORING	
The Developer requires that Project contractors employ an adaptive management approach to ensuring sensitive species/ species at risk are adequately protected during all phases of construction.	Construction
The Developer is committed to hiring environmental monitors to ensure the application of prescribed mitigation, identify unforeseen and potential erosion sites that could lead to the discharge of sediment to surface or groundwater, and prevent erosion and subsequent sedimentation.	Construction
Compliance and effects monitoring activities will be conducted to ensure the terms and conditions set out in regulatory approvals, licences and permits, the EMP, and in the commitments are met, and to check the effectiveness of mitigation measures in avoiding or minimizing potential effects.	Construction, Operations
The Developer will prepare an effects monitoring table and an inspection table prior to construction. The effects monitoring table will describe the indicators and parameters to be monitored and the target or management goal. The inspections table will describe the types of inspections required, the frequency of the inspections, and which phase of the Project the inspection will occur.	Design, Construction

TABLE F: SUMMARY OF DEVELOPER COMMITMENTS	
COMMITMENTS	**PROJECT PHASE**
Environmental and wildlife monitoring will be carried out by third party monitors supplied by the ILA (environmental monitors) and the HTC (wildlife monitors), and will be funded by the Developer and/or Developer's contractor(s).	Construction
The Developer will conduct post-construction monitoring according to the extent, frequency and duration required by regulators to evaluate the success of mitigation measures and to identify required modifications, repairs, or maintenance.	Operations
The Developer will require that Project contractors work closely with the environmental and wildlife monitors during construction.	Construction
The Developer is committed to participating with other parties in a cumulative effects monitoring program.	Construction, Operations

1.0 INTRODUCTION

1.1 THE DEVELOPER

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1.1.2 Environmental Performance

The Project Partnership, generally referred to collectively as the Developer or Project Team, for the proposed Inuvik to Tuktoyaktuk Highway are the Hamlet of Tuktoyaktuk, the Town of Inuvik and the GNWT Department of Transportation (DOT). However, the actual design and construction of the Highway will be the responsibility of the GNWT DOT and thus the following discussion focuses on GNWT DOT's environmental performance.

Care for the natural environment has been promoted as a core corporate value since the creation of the DOT in 1989. This value has been advocated in a variety of internal and external documents that commit the DOT to conducting its work in a way that will conserve the beauty and health of the natural environment, for the enjoyment and benefit of current and future generations.

Since 1989, the DOT has engaged a number of national organizations to develop best practices for transportation works, specifically aimed at protecting the environment. These initiatives have resulted in the DOT's adoption of the best and most innovative practices for mitigating impacts, from a wide range of activities related to the DOT's mandate, including construction in permafrost regions, construction management in riparian zones, protection of navigability in northern waters, management of glycol and salt use, research into alternative de-icing and dust control products, reduction of wildlife collisions, among others. The DOT has also worked hard to ensure that the potential impacts and proposed mitigations from large scale projects are discussed with regulators, well in advance of any permit and/or licence applications. As a recent example in the Inuvialuit Settlement Region (ISR), this practice was evident in the construction of the Tuktoyaktuk Access Road to Source 177 and contributed to the success of this project. It is important to note, however, that this kind of discussion has been undertaken on a routine basis prior to the formation of the DOT.

In 2009, the DOT presented their Environmental Strategy entitled *Green Light – Signalling the Department of Transportation's Commitment to the Environment* (Appendix A). The main goal of *Green Light* is to highlight existing environmental practices and to further foster a corporate culture of environmental excellence, within both the DOT and the northern transportation industry. *Green Light* lays the groundwork for improving operations and demonstrates the DOT's commitment to environmental performance and to lead by example. The development of an Environmental Management System is one of the medium-term goals of *Green Light*.

In 2010, a draft environmental policy was prepared to institutionalize environmental priorities as an integral part of the decision-making process in all operations. The goal of this policy is to foster a corporate culture of environmental excellence at DOT and throughout the northern transportation industry. This will be accomplished by highlighting and celebrating environmental achievements and by systematically improving the sustainability of DOT's approach to developing, operating, and maintaining the transportation system. The policy also lays out a number of actions to achieve and evaluate for continuous improvement.

The following text, extracted from the Draft Environmental Policy (2010), highlights the principles and actions to be taken:

Principles:

The following principles will guide us in achieving our environmental goals:

- *We will continue to support other Northwest Territories Government policies and initiatives related to environmental protection, pollution prevention and sustainability.*
- *We will continue to address environmental issues in the development of policies, plans, programs, procedures, practices, standards and guidelines.*
- *We will regularly monitor and review our work processes.*
- *We will encourage our staff and contractors operating on our behalf to identify opportunities for improving our environmental performance.*
- *We will remain knowledgeable and improve our expertise in environmental practices related to our core business.*

Continuous Improvement

- *We will regularly review our environmental management policies and procedures, including QA/QC and auditing documents, to maintain their effectiveness in meeting our environmental performance goals.*
- *We are committed to seeking opportunities to improve our environmental performance and recognize the central role of our staff, clients and contractors operating on our behalf in achieving improvements.*
- *We will support our staff and contractors working on our behalf in the training and development necessary to meet our collective responsibilities to the environment, as these responsibilities are defined by legislation, professional requirements, and our Environmental Management System (to be developed) (GNWT DOT 2010b).*

The DOT's focus on improving and strengthening its environmental standards and practices will ensure the current transportation system and future changes to it will maintain the quality of the environment.

Environmental Management System

The GNWT DOT is in the process of developing and implementing an Environmental Management System (EMS), based on the EMS guide developed by the Transportation Association of Canada for the public transportation sector. The program will be implemented by an EMS Coordinator in the Planning, Policy, and Environment Division.

The EMS will complement programs already underway which include the GNWT Sustainable Development Policy, the NWT Greenhouse Gas Strategy, the Climate Change Adaptation Strategy and DOT's Drive Smart Program.

Project-specific Environmental Performance

Since its establishment, DOT has successfully undertaken hundreds of projects across the NWT with little to no negative effect on the environment. Wherever even the potential for unacceptable effects have been identified by project personnel, regulators, or residents, DOT has moved quickly and effectively to address the issue of concern. DOT is an experienced and highly-engaged project delivery department, whose commitment to environmental stewardship is not only a mandated requirement, but also informs all phases of its activities, from planning to implementation and post-construction monitoring.

Recently the GNWT DOT facilitated the development of the all-weather Access Road from Tuktoyaktuk to Source 177, a precursor to the present Highway development proposal.

Overall the project was generally considered to be a success, with only a few concerns raised that were resolved during the construction period. DFO, for example, had expressed reservations about the installed elevation of some culverts but this issue was resolved at the beginning of the next construction season.

1.2 DEVELOPMENT OVERVIEW

Project Context

Currently, surface transportation access to the Hamlet of Tuktoyaktuk is by a 187 km ice road from Inuvik, built annually by the GNWT DOT on the frozen channels of the Mackenzie River Delta and Kugmallit Bay. The ice road is open for three to four months, depending upon the weather, from mid to late December to mid to late April. Tuktoyaktuk has year-round access by air from Inuvik and barge service from Hay River during the summer.

As part of the early 1960s "Northern Vision" of Prime Minister John Diefenbaker, the federal government of Canada implemented an ambitious program of all-weather road construction in the Western Arctic.

As an ultimate goal, the federal all-weather road program had envisaged the eventual extension of the Mackenzie Highway to Inuvik and onwards to Tuktoyaktuk. The first route surveys for an Inuvik to Tuktoyaktuk all-weather road were undertaken by Public Works Canada (PWC) in 1974, which resulted in a 140 km all-weather road route (PWC 1975). Preliminary engineering and environmental studies were undertaken on this route in 1975-76, which became known as the PWC 1977 route (PWC 1976, 1977, 1981a, 1981b, 1982a, 1982b). However, road construction did not proceed due to changes in government policy and the declining pace of industry activity in the region. In the late 1980s, the existing Northwest Territories highway system was transferred to GNWT DOT.

The need and rationale for new all-weather road corridors in the Western Arctic (namely, the Inuvik to Tuktoyaktuk Highway, the extension of the Mackenzie Highway to Inuvik, and the Slave Province corridor), and the necessity of federal funding assistance, have figured prominently in various GNWT DOT reports since 1990. Reports include:

- *Northwest Territories, Transportation Strategy* (GNWT DOT 1990);
- *Northwest Territories, Transportation Strategy Update, 1994* (GNWT DOT 1995);
- *Investing in Roads for People and the Economy: A Highway Strategy for the Northwest Territories* (GNWT DOT 2000);
- *Corridors for Canada: An Investment in Canada's Economic Future: A Proposal for Funding Under the Strategic Infrastructure Fund Government of Canada* (GNWT 2002);
- *Corridors for Canada-II: Building on Our Success. A Strategic Infrastructure Proposal for Investment in Transportation Infrastructure* (GNWT 2005a);

- *Connecting Canada Coast to Coast to Coast: A Proposal to Complete the Mackenzie Valley Highway to the Arctic Coast* (GNWT 2005b); and
- *Northern Connections: A Multi-Modal Transportation Blueprint for the North* (GNWT DOT 2008b).

Recently, the federal government has re-engaged with the idea of developing road and other infrastructure in the Arctic under the Building Canada Fund. The first significant new road project in the Northwest Territories under this program is the 19 km all-weather Access Road from Tuktoyaktuk south to Source 177, along a horizontal alignment that will become part of the future all-weather Inuvik to Tuktoyaktuk Highway. Construction on this road began in 2009 and was completed in 2010.

Development Overview

More detailed construction information and methodologies are found in Section 2.0 and an overview of the development is provided within the executive summary, under the headings of 'Route Alignment Alternatives', 'Highway Design Considerations', and 'Highway Construction and Schedule'. The following is a brief summary of this information.

The proposed development will involve the construction of a 137 km stretch of two-lane, all-weather highway between Inuvik and Tuktoyaktuk (Figure 1.5-1). There have been several design iterations since the Highway was first proposed in 1960, but the currently proposed alignment is the Primary 2009 Route (Figure 1.5-2). This route is an updated and refined version of the 1977 PWC alignment, but includes a minor encroachment on the Husky Lakes 1 km setback.

The other route alignment options in the vicinity of the Husky Lakes are also continuing to be considered: Alternative 1 (2009 Minor Realignment) to avoid the encroachment on the Husky Lakes setback; Alternative 2 (Upland Route); and Alternative 3 (2010 Minor Realignment) recommended by Inuvialuit interests. In particular, Alternative 3 (2010 Minor Realignment) will be further considered and likely adopted in the detailed design stage based on the additional field information that needs to be gathered.

This public Highway will be constructed and operated in conformance with applicable highway standards. Highway construction will involve:

- Construction of a two lane gravel roadway 8 to 9 m wide with 3:1 side-slopes;
- Installation of approximately eight short span single lane bridges and numerous culverts;
- Surveying and staking of the Highway, snow clearing, and material stockpiling at the borrow sources;
- Use of 'fill' techniques, rather than 'cut and fill', so that permafrost is preserved as much as practicable;
- Construction of temporary ice/winter roads to borrow sources and a winter road along the Highway alignment;

- Placement of frozen borrow material directly onto frozen ground (with geotextile separation layer);
- Use of excavators, tractor-trailers and articulated trucks to load and transfer material from the borrow pits to the construction site, where the material will be end-dumped and spread using bulldozers.

Phases and Schedule

The main Highway construction program is currently scheduled to start in fall/winter 2012 and last for four years, until summer 2016. However, subject to completion of the EIRB review process, regulatory approvals and funding, initial upgrading of the Tuktoyaktuk to Source 177 Access Road to highway standards will commence in spring 2012. The Developer proposes to build the Highway concurrently from the north and south ends.

Factors that have the potential to influence Project schedule include:

- The availability and proximity of appropriate borrow sources, as the development progresses; and
- The timing/location of construction resource placement, such as equipment and crew camps, so that work will proceed smoothly from season to season.

See Section 2.0 for more detail on specific construction methodologies, schedule, strategies proposed, and a detailed list of equipment.

Workforce and Cost

The total anticipated workforce during the four years of construction will be approximately 670 Full Time Equivalents (FTE).

The estimated capital cost of the Project is $230 million. This does not include royalties or administrative fees associated with construction materials from sources on Inuvialuit owned lands.

1.3 DEVELOPMENT PURPOSE AND JUSTIFICATION

The Inuvik to Tuktoyaktuk Highway will be the first all-weather road connection in Canada to the Arctic Ocean, and will generate substantial benefits at the local, regional, and national levels. Information on the effects of the proposed Inuvik to Tuktoyaktuk Highway is located in Section 4.3. The primary purpose and justification for the Highway are below.

Cost of Living

The Highway is expected to reduce the cost of living and doing business in Tuktoyaktuk because goods could be shipped overland year-round, on an as-needed basis.

Cost of Government Program Service Delivery

The Highway is expected to reduce the cost of providing and accessing government services and programs delivered in Tuktoyaktuk and throughout the Region. It is anticipated that there will be a reduction in travel costs, operation and maintenance costs for health, education, social and recreational services, capital programs, and local municipal services and programs.

Social Aspects

The all-weather Highway will provide Tuktoyaktuk residents with cheaper, easier and safer access to regional services, such as health care, education and recreational facilities. The Highway will promote family, community, and sporting interactions by providing year-round access between communities.

Business Opportunities and Competition

The Highway will allow Inuvik- and Tuktoyaktuk-based businesses to compete more effectively for resource-related and government business opportunities. The construction of the Inuvik to Tuktoyaktuk Highway will also create various spin-off business opportunities for Tuktoyaktuk, Inuvik and other regional businesses, such as fuel and gas service stations and Highway maintenance services. The increase in tourism and the creation of new business opportunities will provide important year-round employment and training opportunities for local Inuvik and Tuktoyaktuk residents. Enhanced competition between businesses may lead to higher quality and lower cost services for government, resource development, and other goods and services sectors.

Tourism Development

The Highway will promote the tourism and hospitality industries in Inuvik and Tuktoyaktuk. A tourism campaign could capitalize on Tuktoyaktuk, the terminus of the all-weather Highway, as the point closest to the Arctic Ocean that can be reached by road from anywhere in Canada, continental USA and Mexico – appreciably closer than northern Alaska which has the only other points in North America on the Arctic Ocean with road access.

Pollution Prevention and Spill Response in the Arctic Ocean

The all-weather Highway may reduce the costs of the Canadian Coast Guard's Tuktoyaktuk-based Arctic pollution prevention and spill response planning and operations by allowing ground transport of response personnel, equipment, and materials during the summer/fall Arctic shipping season.

National Sovereignty and Security in the Arctic

In the past few years the issue of protecting Canadian sovereignty in the Arctic has received prominent national attention. Furthermore, commercial and non-commercial shipping into and through the Northwest Passage is now being assessed for viability based on changes to open-water patterns. The Inuvik to Tuktoyaktuk Highway would allow easier and cheaper access for sovereignty and security related operations in the western Arctic Ocean, which could be based in Tuktoyaktuk and/or Inuvik.

Arctic Harbour and Port Development

With the potential increase in international marine traffic through the Northwest Passage and potential Beaufort Sea oil and gas development, there may be increased marine activity in the Arctic. At present, a deep water port is not available in the Western Arctic region (Canada or the United States) to support the existing and expected increase in marine traffic. The construction of the Inuvik to Tuktoyaktuk Highway would facilitate the efficient use of a new deep water port in terms of location and costs, which could have multiple economic benefits for the region.

Oil and Gas Exploration and Development

By providing all-weather access, the Highway can be expected to reduce the costs of onshore oil and gas exploration and development in the area. In addition, it could help reduce the cost of off-shore exploration and development in the Beaufort Sea, as equipment and supplies could be trucked to Tuktoyaktuk.

Quantification of Regional Economic Impacts

A study entitled Inuvik to Tuktoyaktuk All-Weather Road Economic Analysis was prepared for GNWT DOT in June 2010. The study concluded that the direct, indirect and induced effects in the NWT are:

- Constructing the Highway results in an estimated $135 million Gross Domestic Product (GDP), with 1,086 full time equivalent (FTE) positions being created and governments receiving $27 million in additional revenues;
- Operating the Highway results in an estimated $1.5 million GDP, with 19 FTE positions being created and governments receiving $250,000 in additional revenues;
- Not constructing the winter road results in $73,000 less in GDP, 0.6 less full FTE positions each year, and approximately $15,000 less in additional government revenues;
- Reducing the cost of living in Tuktoyaktuk is estimated to increase GDP by over $500,000, increases the number of positions by four FTE, and increases tax revenues by $100,000; and
- Increasing tourism spending to $2.7 million each year will generate an increase of over $1.2 million in GDP, create 22 FTE positions in the NWT, and increase government revenues by $200,000.

Overall, the Highway is anticipated to create the following effects in NWT and Canada: 2,000 one-time (i.e., construction-related) jobs, $270 million in GDP, and $47 million in government revenues.

1.4 THE DEVELOPMENT SETTING

This section of the EIS is intended to introduce the development setting and to provide a general overview of the geographic, social, economic and cultural setting in which the development is proposed to take place. This section also provides similar information for all considered alternatives.

1.4.1 Proposed Alignment

Geographic Setting

As indicated in Section 2.0 of this Environmental Impact Statement, the proposed Highway will be 137 km long and will be located entirely within the ISR (Figure 1.5-1 and 1.5-2). The corridor between Inuvik and Tuktoyaktuk is situated within the geographic coordinates 68°30' to 69°50'N latitude and 132°45' to 134°0'W longitude. Granular resource requirements for the Highway will be met using material from selected borrow sources located in the vicinity of the Highway alignment (Figure 1.5-2). For the phases of work conducted during the winter, temporary winter access/haul roads will be used during the construction phase of this Project to access and transport borrow materials. For work conducted during the summer months, access and transport will be along the constructed embankment.

Inuvik is located on the East Channel of the Mackenzie River Delta. It is accessible by land, via the Dempster Highway, which originates in Yukon Territory, by air from Yellowknife, Whitehorse, Calgary, Edmonton, and regional communities, and by water during the summer months.

Tuktoyaktuk is located on Kugmallit Bay near the Mackenzie River Delta and is approximately 126 km northeast of Inuvik. It is accessible by air from Inuvik year-round, by water during the summer months, and by ice road during the winter.

To the south of the proposed Highway corridor is the Town of Inuvik and the Gwich'in Settlement Area. To the north, the Highway corridor terminates at the Hamlet of Tuktoyaktuk and Kugmallit Bay in the Beaufort Sea. To the east, a portion of the corridor is located near the western shores of Husky Lakes. Ranging in distance between 20 and 50 km to the west of the proposed Highway corridor is the Mackenzie River. The Mackenzie River is the location of the 187 km Inuvik to Tuktoyaktuk Ice Road, which is part of the Mackenzie Delta Ice Roads (Inuvik Area) component of the overall Northwest Territories Public Highway System. The seasonal ice road connects Inuvik and Tuktoyaktuk for approximately three months per year.

Social and Cultural Setting

<u>Tuktoyaktuk</u>

The Hamlet of Tuktoyaktuk had a population of 916 in 2010. The majority of the population is Inuvialuit, and approximately 84% of Hamlet residents are Aboriginal. The main languages spoken in Tuktoyaktuk are Inuvialuktun and English (GNWT Bureau of Statistics 2009a).

The Hamlet has a health centre and social services (BDHSS 3010b). Hamlet recreational facilities include Kitti Hall (a community centre), school gym, playground and golf course. There is one grade school, an Adult Education Centre through Aurora College, an RCMP detachment, and a volunteer fire department.

The total labour force in the Hamlet of Tuktoyaktuk is 345 persons. Of the total Tuktoyaktuk labour force, sales and services (29.0%), trades transport and equipment operators (24.6%), and social science, education, government service and religion (14.5%) were the three most commonly held occupation types (Statistics Canada 2006a, 2006b). In 2009, 46.1% of the population were high school graduates. The average annual income in 2008 was $49,810 (GNWT Bureau of Statistics 2009a).

Inuvik

Inuvik was established in 1953 and became a town in 1970. Inuvik is the regional government centre, and transportation and recreation hub for the Canadian Western Arctic. Due to its strategic location, Inuvik is also the main headquarters for the oil and gas industry operating in the Beaufort Sea and Mackenzie Delta (Town of Inuvik 2009). The airport, government services, recreational programs and hospitality industry attract residents from neighbouring communities, those traveling from other communities and tourists.

Inuvik had a population of 3,552 in 2010. Aboriginal people (Inuvialuit and Gwich'in) comprise 64% of Inuvik's population; the balance of the population consists of non-Aboriginal residents. The main languages spoken in Inuvik are English, Inuvialuktun and Gwich'in (GNWT Bureau of Statistics 2009b).

There are several regional health care and social service facilities located in Inuvik, including a regional hospital (BDHSS 2010c). Town recreational facilities including the Midnight Sun Recreation Centre Ice Arena (that also includes an indoor pool and fitness centre), the Midnight Sun Complex and Conference Centre, and over 20 outdoor recreational spaces consisting of parks and playgrounds, trails, a boat launch, and more (Town of Inuvik 2010e). There are four child care centres, two schools, a campus of Aurora College, an RCMP detachment, and a volunteer fire department.

The total labour force in the Town of Inuvik is 2,020 persons. Of the total Inuvik labour force, sales and services (23.0%), business finance and administration (18.6%), and trades transport and equipment operators (17.8%) were the three most commonly held occupation types (Statistics Canada 2006a, 2006b). In 2009, 68.6% of the population graduated from high school. The average annual income in 2008 was $49,810 (GNWT Bureau of Statistics 2009b).

Economic Setting

The Beaufort-Delta region accounts for about 16% of the NWT's population and about 12% of personal income. Over the past decade, the region's population has declined by about 400 residents or around 6%.

The Dempster Highway provides an all-weather road link between Inuvik and communities in the Yukon Territory and represents an alternative attraction for tourists from the Alaska Highway. The Beaufort-Delta region benefits from the direct air travel connections between Whitehorse and international destinations during the summer months.

Currently, the Dempster Highway connection only serves communities south of Inuvik. The development of the Ikhil gas project has provided the community of Inuvik with access to gas for electrical generation and heating. The region has abundant gas resources. However, development is dependent upon access to markets. An application to develop the Mackenzie Gas Project was recently approved. Project lead Imperial Oil Resources Ventures Limited has until the end of 2013 to indicate whether the Mackenzie Gas Project will be constructed in the near term.

Tourism is increasing, and there have been large investments made in accommodation facilities and attraction development. Physical attractions include the Mackenzie Mountains, the Beaufort Sea and the Arctic Ocean, the Mackenzie Delta and the midnight sun during summer months.

The region's base industries include public administration, petroleum exploration, transportation, tourism and furs. Tuktoyaktuk continues to rely on traditional game harvesting from the Delta and fishing from the Beaufort Sea and regional lakes as a large part of its economy.

1.4.2 Alternative Alignment

Because the selected and alternative routes only differ slightly, the same communities will be affected; therefore, a separate assessment of the routes, with respect to social, cultural, and economic setting is not necessary. Further discussion comparing the route alignments is found in Section 2.0.

1.5 REGULATORY APPROVALS AND NON-REGULATORY REQUIREMENTS

Through the *Inuvialuit Final Agreement* (IFA), signed in 1984, the Inuvialuit received title to approximately 20% of surface lands in the Inuvialuit Settlement Region (ISR), some of which includes ownership of subsurface minerals.

The proposed Highway will be 137 kilometres (km) long and will be located entirely within the ISR. Approximately 71 km or 51.5% of the alignment will be located on Inuvialuit private lands, which are regulated and administered by the Inuvialuit Lands Administration (ILA). Approximately 67 km or 48.5% of the route will be located on Crown lands, which are regulated and administered by Indian and Northern Affairs Canada (INAC). Granular resource requirements for the Highway will be met using material from selected borrow sources located in the vicinity of the Highway alignment.

The IFA, and its enabling legislation, the *Western Arctic (Inuvialuit) Claims Settlement Act,* requires:

> *"…the screening of developments of consequence to the Inuvialuit Settlement Region… that are likely to have a negative impact on the environment, or on present or future wildlife harvesting. It provides for the establishment of the EISC to carry out the preliminary environmental screening of onshore developments."*
>
> (EISC 2004 p.2)

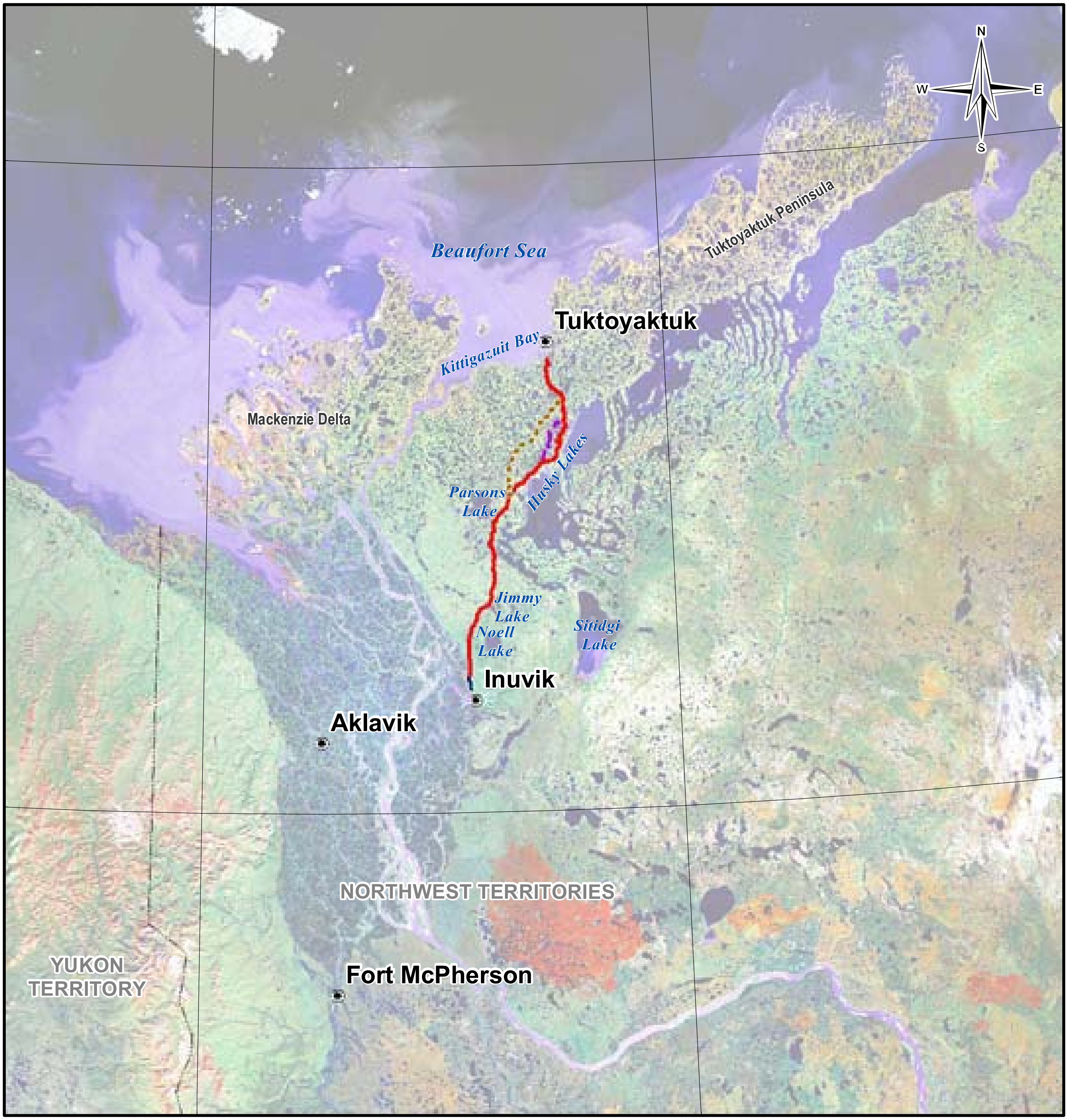
In the fall of 2009, the Project Team consulted the EISC, ILA, territorial and federal regulatory agencies with the goal of identifying key issues related to the proposed Highway. Regulatory and resource management agency representatives were asked to describe their organization's anticipated role in screening the proposed Project and to suggest other agencies and organizations that should be consulted. A Project Description Report was prepared in accordance with the *Environmental Impact Screening Committee – Operating Guidelines and Procedures* (EISC 2004).

After its review of the Project Description Report, with regard to IFA Subsections 11(17) and 11(18), the EISC determined that the proposed development could have a significant negative environmental impact and was, therefore, subject to further review by the Environmental Impact Review Board.

Upon review of this EIS, if the EIRB concludes that significant negative impacts can be mitigated to an acceptable level and, therefore, that the Project may proceed, then the ILA and other regulatory agencies can issue permits and licences and prepare accompanying terms and conditions. For the portion of the Highway traversing Inuvialuit lands, as part of the permitting process for access and use of Inuvialuit lands, a negotiated land tenure agreement will be required (Section 1.5.1.1).

Other Inuvialuit, territorial and federal agencies involved in the regulatory approval process will include, but may not be limited to the ILA, the Northwest Territories Water Board (NWTWB), Indian and Northern Affairs Canada (INAC), Fisheries and Oceans Canada (DFO), GNWT Environment and Natural Resources (ENR), Environment Canada (EC), Transport Canada, Aurora Research Institute, and the Prince of Wales Northern Heritage Centre (PWNHC).

Figures 1.5-1 and 1.5-2 show the location of the proposed Highway in the context of the Mackenzie Delta area. Figure 1.5-2 identifies the jurisdictional boundaries that indicate which agencies will screen, permit, licence, or otherwise issue decisions and authorizations for the construction of the Highway and associated activities. The location of the Project relative to the Inuvialuit Settlement Region, Inuvialuit 7(1)(a) and 7(1)(b) lands, and Crown Lands are of particular relevance to the assessment and regulatory discussion that follows.



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LEGEND

- ◉ Communities
- Territorial Boundary
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road

NOTES
Base imagery: ESRI Data and Maps

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Proposed Project Location

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:2,000,000

20 10 0 20 40 60
Kilometres

FILE NO.
V23201322_EIS_Map018_Intro_PrjLoc.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 1.5-1

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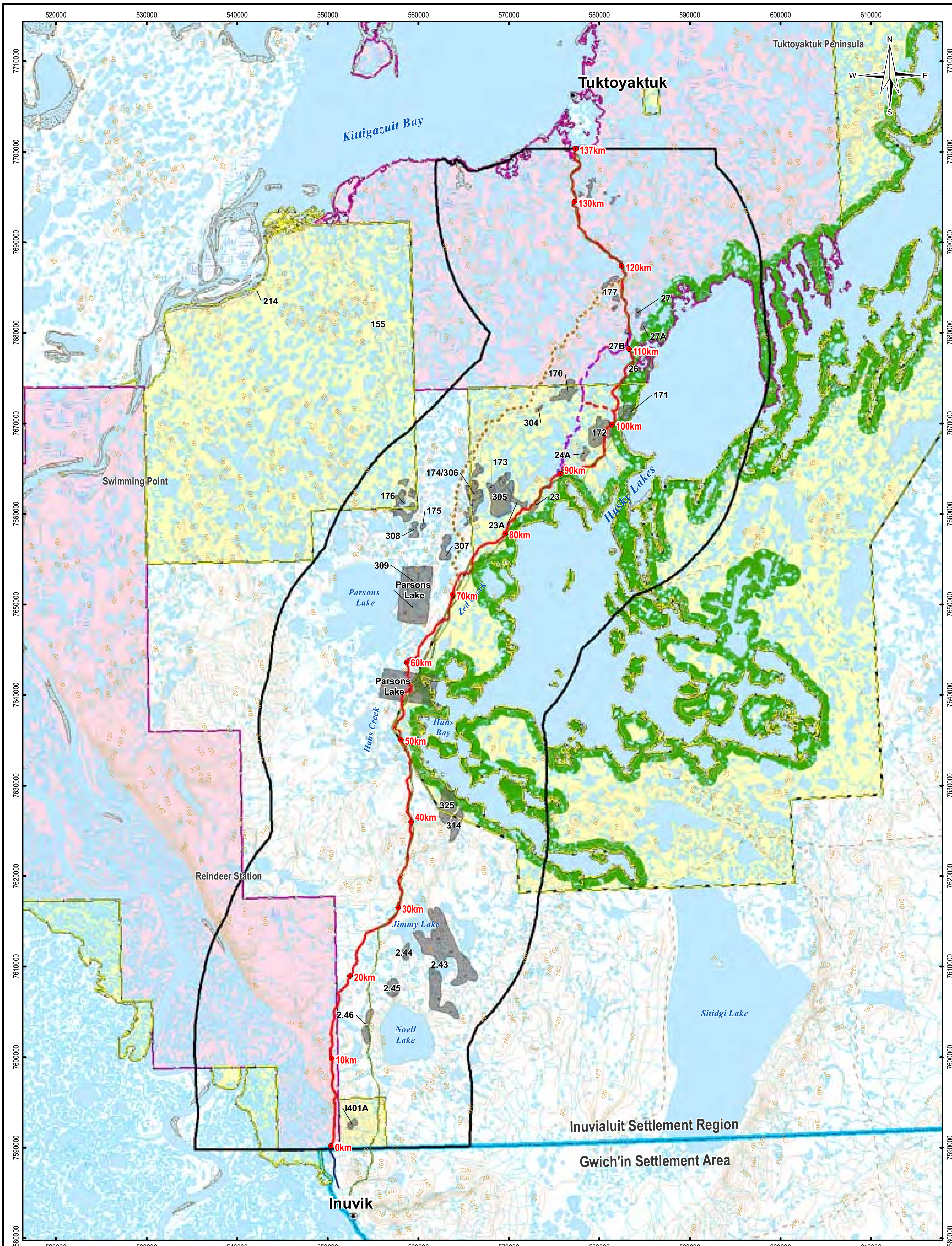

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Inuvik to Tuktoyaktuk Route Options and Potential Borrow Source Locations

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map004_Dev_GranProp.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 1.5-2

1.5.1 Previous Regulatory Approvals

Previous approvals known to have been obtained for road construction and/or quarrying in the Project area are described below.

In 2000, the ILA granted an approval to E. Gruben's Transport Ltd. (EGT) to remove approximately 30,000 m^3 of aggregate material from Source 177. Some of this material was placed on several kilometres of land in the vicinity of the proposed alignment, some of which is now part of the all-weather Tuktoyaktuk to Source 177 Access Road.

In 2009, the ILA granted approval to the Hamlet of Tuktoyaktuk and the GNWT Department of Transportation to construct the all-weather Tuktoyaktuk to Source 177 Access Road. This Access Road can be considered a pilot project for the currently proposed Inuvik to Tuktoyaktuk Highway in terms of environmental review and permitting, cost, schedule, logistics, construction methods, environmental protection, and effects mitigation. The Access Road was completed in 2010.

Other land use and quarry permits have been issued in the Inuvik to Tuktoyaktuk corridor, but they pre-date the IFA and the current environmental screening and regulatory regime. Notably, borrow sources were accessed by Gulf Canada Ltd. in the 1970s to create spring/summer well site leases at the Parsons Lake natural gas field east of the proposed Highway alignment. As well, Source 168 was quarried by E. Gruben's Transport Ltd. (EGT) in the 1980s for shoreline erosion protection for the community of Tuktoyaktuk.

1.5.1 Review and Approvals Processes

There are several aspects of the proposed Highway project that require regulatory authorizations. The proposed Highway traverses private Inuvialuit lands and Crown lands. It crosses over a number of watercourses. During some phases of construction, the project will require considerable volumes of water and the extraction of large quantities of material resources. Each of these activities may trigger a regulatory authorization.

1.5.1.1 Inuvialuit Land Administration Authorizations

Access to Inuvialuit lands, that is more than casual and individual in nature, requires permission from the ILA. Accordingly, the ILA issues rights to access both 7(1)(a) and 7(1)(b) lands (ILA 2009, IRC 1987). For the portions of the proposed development activities occurring on privately held parcels, the ILA will be the primary regulatory authority.

Consultations with the ILA have identified the required authorizations including: a Temporary Right-of-Way, a Land Use Permit, and combined Land Use Permit and Quarry Permits for borrow sources. Supplemental geotechnical and biophysical studies will be conducted to fulfill the requirements of the land use and quarry applications. The Developer anticipates securing multi-year authorizations from the ILA to accommodate the duration of Highway construction. The project schedule is discussed in Section 2.0.

The project will also require an Access Agreement. The Access Agreement will be negotiated as part of the ILA permitting process.

Upon regulatory approval, the Developer anticipates continuing dialogue with the ILA and other Inuvialuit organizations and authorities. These discussions will include interpretation of Project terms and conditions, and completion of negotiated agreements, including permanent land tenure.

The entire length of the Inuvik to Tuktoyaktuk Highway alignment is 137 km, of which 71 km, or 51.5%, will be located on Inuvialuit settlement lands which are regulated and administered by the Inuvialuit Lands Administration. As the goal is to have the Highway right-of-way (surface rights) under the authority of the GNWT as a public road, 71 km are to be transferred to the GNWT pursuant to the expropriation procedure as set out in the Inuvialuit Final Agreement in Section 7 "Inuvialuit and Crown Lands", Subsections 7(60) "Expropriation" and 7(64) "Public Road Right of Way," and Section 18 "Arbitration."

As the Highway project proceeds through regulatory approvals, funding, design, and construction, GNWT DOT will work with the ILA to affect the land transfer necessary for the right-of-way, pursuant to and subject to the provisions of the IFA.

1.5.1.2 Indian and Northern Affairs Canada Authorizations

Indian and Northern Affairs Canada (INAC), in the administration of the *Territorial Lands Act*, the *Territorial Lands Regulation*, the *Territorial Land Use Regulation*, and the *Territorial Quarrying Regulation,* holds jurisdiction over Crown lands in the Inuvialuit Settlement Region.

A land use permit will be required for the proposed Highway right-of-way, temporary borrow source access roads, and temporary camps occurring on Crown lands. Specifically, under the *Territorial Land Use Regulations*, a Class A Land Use Permit will be required to carry on any work or undertaking that involves the levelling, grading, clearing cutting or snowploughing of any line, trail or right-of-way exceeding 1.5 m in width and exceeding 4 ha in area.

The project will require quarry permits issued under the *Territorial Quarrying Regulation* for the extraction of borrow materials. INAC will consider requested volumes in the context of the resource requirements of other reasonably foreseeable community, industrial, and other demands for granular resources. At present, INAC permits borrow sources for a maximum duration of one year; therefore, successive annual permits may be required for some project sources.

Applicable application forms will be submitted for the Land Use Permits and Quarry Permits. Supplemental geotechnical and biophysical studies will be conducted as necessary to fulfill the requirements of the land use and quarry applications.

1.5.1.3 Northwest Territories Water Board Water Licensing

According to *Northwest Territories Waters Act* Section 12, the Northwest Territories Water Board (NWTWB) is responsible to provide for the conservation, development and utilization of waters in the Inuvialuit Settlement Region. The Developers will require Type A or Type B water licences for water crossings, construction camps and water use. There are different thresholds for Type A and Type B water licences under the *Northwest Territories Waters Regulations*.

A Type B Water Licence is required for the construction of a structure across a watercourse that is more than 5 metres wide at the ordinary high water mark at point of construction. The proposed Highway crosses more than one watercourse greater than five metres in width.

A Type B Water Licence will be required for camps of more than 50 persons. This project proposes a number of 15-20-person camps in the first year, and in the second year, at least one camp of greater than 50 persons may be added.

A Type A Water Licence is required for the direct use of 300 m^3 or more of water per day for industrial use. The construction of the proposed Highway is anticipated to use 1,000 m^3 or more of water per day during peak phases of construction, particularly when establishing temporary winter access roads and for dust control in summer months.

Under the *Northwest Territories Waters Act* Subsection 174(1), it is mandatory for the NWTWB to provide the opportunity for a public hearing for projects that require a Type A Water Licence. If, during the regulatory phase, the NWTWB determines the need for a Type A Water Licence for this project a public hearing will be held if an intervenor demonstrates an interest.

The EIS provides information about water crossings greater than five metres in width, identifies the need for crew accomodations, and provides a construction schedule and preliminary logistics plan. The detailed water requirement estimates, water source identification, construction camp siting, and the location of winter access and haul roads will be submitted in the regulatory applications.

The Project Team will conduct further assessment of the proposed water crossing locations and will provide information about watercourse characteristics and proposed crossing structure designs sufficient to meet the requirements of the *Northwest Territories Waters Regulations*. Furthermore, the DFO (2005) *Protocol for Winter Water Withdrawal in the Northwest Territories* will be followed. This will include identification of suitable water withdrawal sources (lakes and streams), assessment of allowable withdrawal quantities per sources, unique source identification, and water withdrawal volume tracking.

1.5.1.4 Fisheries and Oceans Canada Authorizations

Fisheries and Oceans Canada (DFO) administers the *Fisheries Act*, which includes provisions that potentially relate to aspects of the Highway Project. In particular, DFO will focus on the potential effects of construction activities on fish habitat, which is protected under Section 35 of the Act.

DFO may issue a Letter of Advice for components of the Project that are not expected to result in the harmful alteration, disruption or destruction (HADD) of fish habitat or an Authorization for HADD, under Sections 35(1) and 35(2), respectively. A Letter of Advice normally sets out or refers to guidelines and/or mitigation measures that, if followed, would prevent a HADD. An Authorization recognizes that a HADD is likely to occur, and therefore includes an agreement between the project proponent and DFO for compensation that will achieve No Net Loss (NNL) of fish habitat.

In addition, DFO has developed a series of Operational Statements that provide guidance to project proponents regarding specific types of projects. The intention of these Operational Statements is to relieve proponents of the need for an approval from DFO, provided that specified requirements and conditions are followed. In the Northwest Territories, DFO has published several Operational Statements that may be applicable to this project including clear-span bridges, culvert maintenance, ice bridges and snow fills, temporary stream crossings, and maintenance of riparian vegetation in existing rights-of-way.

The various stream crossings that will be necessary as part of the proposed Highway will be sited and designed to avoid or mitigate adverse effects on fish and fish habitat (i.e. HADD), wherever possible. As such, it is expected that most of the Project can be completed through the issuance of Letters of Advice by DFO, or by application of relevant Operational Statements. Where a HADD is unavoidable, DFO will be consulted to discuss and determine suitable compensation strategies so that the necessary application for Authorization pursuant to Section 35(2) of the *Fisheries Act* can be submitted. Such situations arise, for example, due to the installation of culverts in fish-bearing streams, where the culvert results in the direct loss of spawning or rearing habitat. Once the final route is determined, conceptual plans for each crossing will be provided to DFO (and other regulators), which will include assessments of habitat type, quality, and quantity. These assessments will form the basis for Authorizations and compensation plans.

Borrow sources will not be developed within 50 m of any watercourse and 1 km of the Husky Lakes. Where blasting is required, DFO guidelines for the use of explosives will be followed (Wright and Hopky 1998).

1.5.1.5 Permit for Construction within Navigable Waters

Under the *Navigable Waters Protection Act* and *Regulations*, the Project will require a permit for construction of bridges across navigable waterbodies. It is understood that some of the larger streams in the Husky Lakes area, in particular Hans Creek and Zed creek may constitute navigable waters. Transport Canada is responsible for permits under the *Navigable Waters Protection Act*. An application will be made once the applicable bridge design information becomes available.

1.5.1.6 Research Authorizations

Pre-construction studies will include additional environmental, engineering, and archaeological investigations. Scientific activities are administered under the *Scientists Act* and are permitted with the issuance of a Scientific Research Licence by the Aurora Research Institute. In addition, Wildlife Research Permits are issued by the GNWT Department of Environment and Natural Resources (ENR), and several permits will be required from the Department of Fisheries and Oceans (i.e., Scientific Collection Permit and Animal Use Permit).

Archaeological investigations are permitted under the *Northwest Territories Archaeological Sites Regulations* made under the *Northwest Territories Act*, and are issued by the Prince of Wales Northern Heritage Centre. Such authorizations will be obtained on an annual basis, as needed, prior to the conduct of seasonal field activities. Local Hunters and Trappers Committees and Community Corporations will be notified of proposed work activities.

1.5.1.7 Non-Regulatory Requirements

Non-regulatory requirements are typically requirements or conditions recommended by local organizations, such as the HTCs, Community Corporations, and the general public. These types of requirements are typically conveyed to the regulatory bodies (e.g., ILA, INAC, NWTWB, etc.) and commonly become conditions associated with the regulatory approvals. In addition, during the consultations that were completed, the Developer took note of comments and concerns, and to the extent possible, have incorporated some of these in the Highway planning process.

1.5.2 Inuvialuit Settlement Region Consultation and Communication

"A well established system of co-management of resources is in place throughout the ISR… The communities, Hunters and Trappers Committees, co-management bodies, and government agencies are key elements of this system" (EISC 2004 p.6).

As the Developer intends to minimize or avoid disturbance to ISR land, traditional land use, and harvesting activities, the Developer has initiated consultations with the noted organizations and residents and will continue to provide notice of studies and construction activities.

Examples of consultation and communication occurring since the inception of this Project include:

- September 2009 Inuvialuit Land Administration, Inuvik and Tuktoyaktuk Hunters and Trappers Committees – Notice of the September 14-18, 2009 Field Study and Consent Form for submission to the Prince of Wales Northern Heritage Centre (in support of Archaeological Permit Issuance);

- September 2009 Aurora Research Institute – Telephone inquiry about the need for authorization to conduct the September 14-18, 2009 Field Study;
- October 2009 Inuvik to Tuktoyaktuk Highway Backgrounder (2-page Project introduction and map) emailed or faxed to community organizations and regulatory agencies;
- October 2009 Inuvik to Tuktoyaktuk Highway Community and Regulatory Consultations for information gathering purposes;
- November 2009 Notice of Intent to Inuvialuit Regional Corporation (IRC) Board, November 13, 2009; and
- January 2010 Inuvik to Tuktoyaktuk Highway follow-up community consultations to respond to questions raised in October 2009, update organizations and residents on progress made during Project Description Report preparations and to receive further input before finalizing the Project Description Report.

Input was also received during the EISC screening process and agency review of the Project Description Report. These comments have been reviewed and where possible, suggestions incorporated into this Environmental Impact Statement. Further discussion on consultation is located in Section 1.6.2.

1.6 STUDY STRATEGY AND METHODOLOGY

The following are the primary steps involved in the preparation of the EIS and the corresponding report Sections where more detailed information for each step is provided - many of these steps overlap temporally and some are ongoing (i.e. field studies and community consultations):

- Regulatory and Background Review (Section 1.5 and 3.0): Researched and reviewed applicable regulations; Compiled and reviewed available historical reports and data; Consulted regulators.
- Community Consultation (Section 1.6.2): Arranged meetings to obtain feedback from the public and affected communities about the development proposal.
- Environmental field work and studies (Section 2.7.7): Analyzed information gaps in existing data; prepared and conducted studies to supplement existing information.
- Route Design and Refinement (Section 2.0): Incorporated information from historical and new studies, regulatory requirements, and community feedback into designs; modified design to address regulatory, functional, environmental, and community concerns.
- Impact Effects Assessment (Section 4.0): Identified potential effects of the development proposal in relation to biophysical and human environmental components.

- Mitigation Planning (Sections 4.0 and 6.0): Developed strategies, using development standards, guidance documents, best management practices, regulatory feedback and professional experience, to design and deliver the Project in a manner that most adequately preserves biophysical and human environmental components.
- Cumulative Effects Assessment (Section 5.0): Assessed the potential cumulative effects of the Project in relation to other past, present and future projects in the region on biophysical and human environmental components.

All EIS steps were conducted in accordance with accepted EIRB standards and methodologies, as outlined in the EIRB's ToR.

Project goals, as specified by the EIRB ToR, are the basis for the EIS methodology and have been incorporated throughout this document. EIRB Project goals and the report sections where they are addressed are listed in Table 6-1 (Section 6.0).

1.6.1 Respect for and Use of Traditional Knowledge

The Developer acknowledges that traditional knowledge has been passed on between generations for centuries through a variety of means, including legends, stories, songs, dances and experience (ICC et al. 2006). The knowledge continues to be relevant today as the traditions and activities (such as hunting, trapping, and fishing) are still practiced. The Developer has incorporated traditional knowledge throughout the environmental assessment to ensure that the assessment is fair to resource users, by documenting the potential ways in which development location itself and associated activities may affect those who use the land for cultural or subsistence purposes.

Extensive traditional knowledge studies have been prepared in the Inuvialuit Settlement Region in the past decade. Traditional knowledge obtained during public consultation sessions and from the following studies has been incorporated into the Project design, construction and operational plans:

- Tuktoyaktuk Community Conservation Plan (TCCP) (Community of Tuktoyaktuk et al. 2000 and 2008);
- Inuvik Inuvialuit Community Conservation Plan (IICCP) (Community of Inuvik et al. 2000 and 2008); and
- Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al. 2006).

Traditional knowledge was obtained during open discussions and mapping exercises, as part of public consultation. The authors of the traditional knowledge studies that were used in this document include the Communities of Tuktoyaktuk and Inuvik, the Wildlife Management Advisory Council (NWT), The Joint Secretariat, and the Inuvik, Tuktoyaktuk and Aklavik Community Corporations. The methods used to gather and verify knowledge for these studies is outlined within each document.

Traditional knowledge was used in this environmental review process to:

- Contribute to biophysical and socio-economic understanding of the region;
- Contribute to overall Project design decisions;
- Improve the confidence in predicted biophysical and socio-economic impacts;
- Contribute to the development of mitigation strategies, and follow-up and monitoring programs;
- Assist in the ability to meet regulatory requirements; and
- Design a more culturally-acceptable development.

Traditional knowledge was incorporated during the assessment to:

- Identify potential concerns, issues and recommendations during the Highway design period;
- Provide baseline information on many topics, such as harvesting seasons and locations, wildlife migration patterns, camp locations, burial sites, traditional land use, and other resource use;
- Identify potential effects from various types of construction activities, such as increased employment, in-migration of workers, and the effect of the Highway on traditional harvesting; and
- Identify potential mitigation measures to the various effects described.

In the TK Studies, several values, issues and concerns are stated, many of which are relevant to the proposed Highway. Several themes that are discussed including:

- Protection of traditional land use and harvesting activities;
- Protection of resources;
- Protection of cultural sites and traditional activities;
- Protection of the environment; and
- Protection of culture.

These issues and concerns are addressed in more detail in the human environment baseline section of the report (Section 3.2), and the potential effects and proposed mitigation measures are identified in the human environment effects section (Section 4.3).

1.6.2 Involvement of Potentially Affected Communities and the Public

Public and regulatory meetings and consultation sessions for the proposed Highway were held in Inuvik and Tuktoyaktuk in October 2009 and January 2010. These meetings were an important opportunity to share information about the Project with the communities and to hear directly from residents about their interests, questions, and concerns. The October consultations provided insights that the Project Team incorporated into Project planning and the development of the Project Description Report and Environmental Impact Statement. The following section provides a brief description of the meeting content and outcomes. Detail about the parties consulted, meeting dates, discussion highlights, questions asked, and responses provided appear in Appendix B.

1.6.2.1 October 2009 Consultations

Planning and scheduling for the October 26-30, 2009 consultations began in September 2009. Community organizations (e.g., Elders Committee and Hunter and Trapper Committees) were contacted to establish availability and to open communication about any questions or comments on the prospect of the Highway that needed to be considered during the upcoming gatherings. Once meeting dates were scheduled and confirmed, organizations were sent a Backgrounder that provided a preliminary overview of the proposed Project (see Appendix B).

The community meetings in Inuvik and Tuktoyaktuk were publicized using notices on bulletin boards and television advertising. The community meetings allowed approximately 1-2 hours before the presentation, and as much time as needed afterward for residents to view maps and posters and engage in discussion with the GNWT Department of Transportation and consultant representatives. Markers and maps were available to note harvesting areas; locations where traditional land use activities take place; heritage values; camps and cabin sites; recreation areas; route preferences; and any areas of concern. Usually, groups of three to five residents gathered around the maps and discussed areas and activities that are familiar and important to them. The presentation sessions lasted approximately two and three hours in Inuvik and Tuktoyaktuk, respectively. Questions and answers were encouraged throughout.

The first round of meetings and consultations were intended to provide the communities, organizations, and regulatory agencies with an introduction to the proposed Inuvik to Tuktoyaktuk Highway, to identify the Developer, to establish Project status, anticipated study and review schedule, answer preliminary questions, and receive advice, input and recommendations. The second round of meetings and consultations served to respond to questions from the October 2009 consultations, solicit community feedback on the updated Project information, and gauge acceptability of the 2009 preferred route to put forward for EISC screening and subsequent regulatory review.

Photo 1.6.2-1
Tuktoyaktuk Community Meeting, October 27, 2009

Photo 1.6.2-2
Tuktoyaktuk Community Meeting, October 27, 2009

Photo 1.6.2-3
Inuvik Community Meeting, October 28, 2009

Photo 1.6.2-4
Tuktoyaktuk Community Meeting, October 27, 2009

Photo 1.6.2-5
Inuvik Community Meeting, October 28, 2009

Photo 1.6.2-6
Project Team meeting with ILA in Tuktoyaktuk, October 27, 2009

In the summary provided in Appendix B, the main areas of interest discussed during community and regulatory consultations are broadly categorized as follows:

- Application of the *Inuvialuit Final Agreement* to the proposed Highway;
- Protection of special areas, in particular, the Husky Lakes area;
- Project-specific regulatory review and decision-making process;
- Possible subsequent developments;
- Route and route alternatives;
- Traditional land use and related cultural considerations;
- Project Partnership/ Developer;
- Project economics;
- Granular resource / borrows;
- Project schedule;
- Community social, economic, and cultural considerations;
- Associated infrastructure maintenance and allocation of responsibilities;
- Public safety;
- Reference to the Tuktoyaktuk to Source 177 Access Road;
- Consultation approach;
- Areas for further investigation;
- Land tenure;
- Protection of wildlife, birds, and fisheries resources and habitat;
- Environmental and socio-economic mitigation and management planning;
- Construction specifications; and
- Items for discussion in January 2010.

The October 2009 consultations expanded views held by the Developer's regarding various alignment options. The prospect of development near the Husky Lakes met with approval from some residents and concern from others. For the Project Team's consideration, the communities, organizations, and agencies brought forward specific references and data to help assess the proposed Project:

- The *Inuvialuit Final Agreement*, Sections 8, 13, and 14;
- The EIRB (2002; 2009) Husky Lakes Management Plan / Husky Lakes Criteria;
- Mapping data from the Inuvialuit Land Administration, including the 1 km Husky Lakes setback, granular resources data, and the location of registered cabins.

The follow-up items identified during the October 2009 sessions included the following:

- An invitation to the EISC to come to the January 2010 Highway meetings in Tuktoyaktuk;
- A report on further investigation into the volumes, cost, and construction considerations for Alternative 2 (Upland Route) alternative to enable reasonable comparison to the Primary 2009 Route. This work was completed in November and December 2009 to support the January 2010 consultations;
- Additional elaboration in the Project Description Report regarding the history of Inuvik to Tuktoyaktuk Highway proposals and studies;
- The provision of October 2009 consultation notes to the communities of Inuvik and Tuktoyaktuk prior to the January 2010 meetings;
- A video conference presentation to a joint meeting of the EISC and EIRB in November 2009, and teleconference presentation to WMAC (NWT) in December 2009; and
- A commitment for ongoing discussion with Inuvialuit and Federal regulatory agencies to establish the regulatory path for the Project review.

1.6.2.2 January 2010 Consultations

On December 18, 2009, community organizations were emailed advance notification that meetings would be held in Inuvik and Tuktoyaktuk during the week of January 11-15, 2010. On January 5, 2010, the dates were announced as concurrent evening meetings on Thursday, January 14, 2010. Bulletin board notices, television advertising and email notifications were sent out on January 5, 2010. As an additional awareness-raising measure, the meetings were advertised on CBC Radio and CKLB FM on the Tuesday, Wednesday, and Thursday prior to the meetings.

The second round of meetings and consultations served several functions: to respond to questions and issues raised in the October 2009 consultations, to solicit community feedback on the updated Project information, and to gauge acceptability of the Primary 2009 Route to put forward for EISC screening and subsequent regulatory review.

On January 13, 2010, Indian and Northern Affairs Canada (INAC) hosted a meeting between a group of federal regulatory agencies and the Project Team. The agencies represented were Indian and Northern Affairs Canada, Fisheries and Oceans Canada, the NWT Water Board, and the Inuvialuit Land Administration. At the beginning of the meeting, Mr. Russell Newmark provided a statement about the 30 year history of the proposed Inuvik to Tuktoyaktuk Highway. The Project Team presented a Project update and then responded to questions. The discussion addressed topics including sources of funding, water crossings, potential fisheries authorizations, the preferred and alternative alignments, the Project cost estimate, proposed borrow sources (volumes, quality, and ice content), the proposed use of geotextile fabric to help maintain the integrity of the Highway embankment, Highway construction standards, a request for construction and maintenance phase sediment and erosion control plans, recommended additional studies, and a request for borrow source pit management plans.

The Developer was invited to meet with the Inuvik and Tuktoyaktuk Community Corporations, and the Inuvik and Tuktoyaktuk Hunters and Trappers Committees on January 13, 2010. The meeting provided an opportunity to discuss a variety of topics including the anticipated regulatory process, the alternative alignments, fisheries and water crossing concerns, the ban on caribou hunting, additional baseline information sources (e.g., fisheries data, potentially sensitive cultural sites), water sources, social concerns, existing camps and cabins at Husky Lakes, and traditional use.

Positive effects of the Project were also discussed. Community Corporation representatives identified contracts, employment, and training benefits that would spread over several years. Mayor Gruben reported that the Tuktoyaktuk to Source 177 Access Road is regarded as "The Happy Road" because people are happy to be working on it and excited to see it becoming a reality. The meeting ended with final comments from each participant. There was an expression of support for the Project to move forward to EISC screening and a commitment to on-going Project Team consultations with the Community Corporations and Hunters and Trappers Committees.

The two community meetings, held concurrently on January 14, 2010, were well attended and participants from both meetings were generally supportive of the Primary 2009 Route (Photo 1.6.2-7). Discussion points from the January meetings are presented in Appendix B. The outcomes of the meetings are summarized below.

Photo 1.6.2-7
Tuktoyaktuk Community Meeting, January 14, 2010

Tuktoyaktuk residents expressed general satisfaction that the new presentation materials incorporated and addressed the concerns raised at previous meetings by the community members. Residents of Tuktoyaktuk and Inuvik were generally supportive with the Project Team's efforts to keep the proposed Highway alignment beyond the 1 km setback (with one minor encroachment of less than 2 km) in accordance with ILA recommendations and the latest version of the Husky Lakes Management Plan. They also expressed a general confidence in the ability of the Inuvialuit co-management bodies and other agencies to protect their interests in relation to future implementation of the Highway. An Elder also highlighted a number of benefits if the Highway is constructed including increased safety, cheaper costs for Tuktoyaktuk residents, increased opportunities for the youth, and ability to travel year-round.

Inuvik residents generally indicated great interest in seeing the Project move forward. However, it must be noted that a few of the community members continued to favour Alternative 2 (Upland Route). Participants that stated a preference for Alternative 2 (Upland Route) spoke from two perspectives. One perspective was that Alternative 2 (Upland Route) would be several kilometres farther from Husky Lakes than the Primary 2009 Route and, with that separation, may pose less risk to Husky Lakes. The other perspective preferred Alternative 2 (Upland Route) because it would be a bigger project, it would employ more people, it might take longer to build, and it would require more borrow material.

The technical, economic, construction and maintenance advantages of the Primary 2009 Route were discussed as rationale for presenting the Primary 2009 Route for funding and regulatory screening. The discussion then turned to land use issues, environmental protection, Husky Lakes access, the regulatory review process, and management planning. Those present at the meeting expressed a strong interest in seeing an efficient regulatory process, encouraging one another to identify any concerns or possible issues now, rather than at the 'last minute', so as to avoid delaying approvals.

1.6.2.3 ILA Consultations – November 2010

The ILA held two public hearings on the proposed Inuvik-Tuktoyaktuk Highway in November 2010. Hearings were held in Inuvik on November 10, 2010 and Tuktoyaktuk on November 15, 2010. The meetings were attended by 30 people in Inuvik and 98 people in Tuktoyaktuk. A summary of the meetings is provided in Appendix B.

According to the consultation summary, the "vast majority of the Tuktoyaktuk beneficiaries who shared their opinion on the Highway were strong supporters of the Highway, in principle." However, it was noted that beneficiaries who opposed the Highway were not comfortable expressing their opinions in front of the assembly, but stated their opinion in one-on-one conversations with ILA staff. While some were concerned with the routing, environmental, and wildlife effects, the beneficiaries "overwhelmingly supported" the concept of a highway between Inuvik and Tuktoyaktuk (ILA 2010, p. 1).

The degree of support for the Highway was less evident in Inuvik, although it was clear that most beneficiaries who offered comments or questions were in support of the Highway. There were also a minority of Inuvik beneficiaries that felt the Highway would have too severe an impact and therefore should not be constructed.

Support for Alternative 2 (Upland Route) was almost unanimous in Tuktoyaktuk. The reason most commonly given for supporting Alternative 2 (Upland Route) was that it is the route most distant from the Husky Lakes. Keeping the Highway away from Husky Lakes was considered important for the following reasons: maintaining the traditional lifestyle and purposes for which Husky Lakes have been used for generations, preventing harvest loss at Husky Lakes (wildlife and fisheries), and protecting the Husky Lakes environment (water quality, vegetation, permafrost, tidiness). According to beneficiaries in Tuktoyaktuk, Alternative 1 (2009 Minor Realignment) in this EIS) and the proposed Primary 2009 Route are too close to the shores of Husky Lakes and would permanently and negatively affect the way Husky Lakes is used.

The Inuvik beneficiaries voiced less concern and spent less time discussing the routes as those in Tuktoyaktuk, and did not support one route over the other routes. A few beneficiaries in Inuvik stated their support for Alternative 1 (2009 Minor Realignment) as a good compromise between the Upland and the Primary 2009 Route (proposed route).

A few beneficiaries expressed concern that potential granular borrow sources were located too close to the Husky Lakes, potentially affecting the area's environment and tranquility.

Most Inuvialuit who expressed support for the Highway stated that it would not only reduce the cost of living in Tuktoyaktuk, but would provide many jobs and training opportunities for Inuvialuit. Ensuring that Inuvialuit are the primary benefactors of Highway construction jobs was also a common request.

If the Highway is constructed, beneficiaries stated that Highway inspections and management would be required to mitigate its effects. Some felt that cooperative management of the Highway will be required and should be enacted as early as possible, assuming the Highway is approved. Beneficiaries felt that the HTCs, DFO, FJMC, and ILA should be working together to the greatest extent possible. Questions were raised about the extent that the ILA and beneficiaries could control the use of the Highway, specifically related to tolls, speed limits, and periods of closure.

1.6.2.4 Consultations Summary

Most Inuvik and Tuktoyaktuk residents identified long-held community sentiments that a year-round road connection between Inuvik and Tuktoyaktuk would be beneficial to people from both communities, would provide construction and maintenance jobs, and would create business and employment opportunities between the communities. Residents expressed an urgency to build the Highway now because it sounds like the right time to apply for and obtain the funding. They also stated that local workers are available to construct the Highway now because there is currently very little other industrial activity.

The input received during the consultation meetings (see detailed summary of consultations in Appendix B) and subsequent discussions were considered during the development of the Project and route alternatives. The desire and interests brought forward by the communities, and the additional information that they provided, has been integrated into the Project plan and the preparation of the Environmental Impact Statement.

1.6.3 Recognition of the *Inuvialuit Final Agreement* and Community Conservation Plans

As discussed previously, the Developer acknowledges that the Project will be conducted in conformance with the *Inuvialuit Final Agreement* (IFA) and take into consideration the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans (CCPs), as outlined in the following sections.

In addition to the IFA and the CCPs, the Inuvialuit Settlement Region Traditional Knowledge Report, prepared by the Inuvik, Tuktoyaktuk and Aklavik Community Corporations in 2006, was used to supplement information from the CCPs.

Goals of the IFA and CCPs

The IFA is comprehensive land use agreement, between the Inuvialuit and the government of Canada. The guiding goals of the IFA are to:

- Preserve Inuvialuit cultural identity and values within a changing northern society.
- Enable Inuvialuit to be equal and meaningful participants in the northern and national economy and society.
- Protect and preserve the Arctic wildlife, environment and biological productivity.

CCPs reflect each community's values and strategies for achieving conservation and management of renewable resources within the community's planning area. Five goals were used to develop the 2000 and 2008 CCPs:

- Identify and Protect Important Habitats and Harvesting Areas - To identify important wildlife habitat, seasonal harvesting areas and cultural sites (for example, cabin sites) and make recommendations for their management.
- Develop Land Use Decisions - To describe the community process for making land use decisions and managing cumulative impacts which will help protect community values and conserve the resources on which priority lifestyles depend.
- Promote Education - To identify educational initiatives for the Inuvialuit and others interested in the area which will promote conservation, understanding and appreciation.
- Define Species Management - To describe a general system for wildlife management and conservation and identify population goals and conservation measures appropriate for each species of concern in the planning area. This will be done using the knowledge of the community and others with expertise.

- Enhance Economy - To enhance the local economy by adopting a cooperative and consistent approach to community decision making and resource management. This approach will help ensure economic stability and maintenance of all components of the Arctic ecosystem (Community of Tuktoyaktuk et al. 2008, Community of Inuvik et al. 2008).

In designating land management categories, the Inuvialuit have recognized priority land uses and activities, as well as areas of special ecological and cultural importance (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). These areas are discussed primarily in the land use section (Section 3.2.9).

Review of IFA and CCPs with Communities

The IFA and the CCPs were discussed with community members during consultations. A brief summary of the IFA and CCP-related topics discussed include:

- Application of the *Inuvialuit Final Agreement* to the proposed Highway;
- Protection of special areas, in particular, the Husky Lakes area;
- Project-specific regulatory review and decision-making process;
- Traditional land use and related cultural considerations;
- Community social, economic, and cultural considerations;
- Consultation approach;
- Land tenure;
- Protection of wildlife, birds, and fisheries resources and habitat; and
- Environmental and socio-economic mitigation and management planning.

As previously discussed in Section 1.6.2, the communities, organizations, and agencies brought forward specific references and data during the October 2009 consultations to help assess the Highway Project, including:

- The *Inuvialuit Final Agreement*, Sections 8, 13, and 14;
- The EIRB (2002, 2009) Husky Lakes Management Plan/ Husky Lakes Criteria; and
- Mapping data from the Inuvialuit Land Administration, including the 1 km Husky Lakes setback, granular resources data, and the location of registered cabins.

Detailed information regarding the consultation proceedings is located in Section 1.6.2 and Appendix B.

Applying IFA and CPP's to the Development

Using the IFA and the CCPs, the Developer has identified mitigation measures and commitments to eliminate potential damage, destruction, and other effects to identified lands and waters (Section 6.0). In particular, the baseline and effects sections (Section 3.0

and 4.0, respectively) identify existing guidelines and plans with which the Development will comply.

The Developer has used the IFA and CPPs as a foundation for Project planning and environmental management.

1.6.4 Consideration of Sustainability Goals

This EIS reflects consideration of local, regional, territorial and national goals for sustainable development, and discusses the Project's ability to meet these goals.

The EIS demonstrates the Developer's consideration of sustainable development, through recognition and incorporation of the following sustainability indicators:

- The capacity of natural systems to maintain their structure and functions and to support indigenous biological diversity and productivity.
- Protection and conservation of wildlife and the environment, for present and future generations.
- The capacity of the social and economic systems of the human environment to achieve, maintain or enhance conditions of self-reliance and diversity.
- The capacity of human environments, including local and regional institutions, to respond to and manage externally induced change.
- The potential environmental effects of the development.
- The attainment and distribution of lasting and equitable social and economic benefits from projects.
- The rights of future generations to the sustainable use of renewable resources (EIRB 2010).

The EIS, as guided by the EIRB's Terms of Reference, is structured to report the extent to which the Developer has considered and can achieve the stated sustainability goals for the Project. In particular, the baseline section (Section 3.0) of the document identifies the current understanding of the biophysical and human environments, using accepted indicators.

Using the baseline conditions as part of the assessment, the capacity of the biophysical systems and human environment to maintain their structure, functions, self-reliance and diversity was assessed in relation to the Project planning and design components to identify potential effects. To mitigate potential negative effects, mitigation measures have been fully incorporated into the overall Project design.

The baseline, effects, mitigation and monitoring sections of the EIS document identify the methodology and list of indicators used in the assessment.

In particular, the Developer has considered the following during preparation of the EIS:

- How the public and communities have been given opportunity to participate in and contribute to the planning and design of the development and the degree to which their views have been considered in the review process.
- How the planning and design of the development affects the achievement of sustainable development.
- How monitoring, management and reporting systems have incorporated indicators of sustainability.
- The extent to which the development makes a positive overall contribution towards environmental, social, cultural and economic sustainability – locally, regionally, territorially, and nationally.

As discussed, in Section 1.6.2, the public, communities, and regulatory agencies were provided opportunity to participate in and contribute to the planning and design of the development. Specific information collected during this process is identified in Sections 1.6.2 and Appendix B. Incorporation of consultation-generated information, such as the minimum 1 km setback from Husky Lakes, is discussed in relevant sections of the document.

Through consultation and research, much effort has been put toward identifying and meeting the present needs of the biophysical and human environment. This EIS examines the potential effect of the proposed development on the ability of future generations to meet their needs. For example, a common theme expressed by community meeting attendees is the need to protect traditional harvesting activities, and therefore, wildlife populations and access to the land. The EIS examines and describes if/how the proposed Highway could affect traditional harvesting activities through potential effects on wildlife, their habitat, or on harvester's access to the land. Should effects be identified, mitigation measures are examined to determine if these effects can be mitigated, and, where they cannot be mitigated, residual effects are identified.

As previously mentioned, data from various indicators are reported in the baseline section. These indicators not only provide current information on the status of the component, but also provide a method to measure future change. Through evaluation of the changes over time, adaptive management may be used to further mitigate negative effects or to enhance positive effects. Further information regarding follow-up and monitoring are found in Section 7.0.

The effects and cumulative effects sections (Section 4.0 and 5.0) identify whether the Project makes a positive overall contribution towards environmental, social, cultural and economic sustainability. Effects are described as local, regional, territorial or national effects.

1.6.5 Precautionary Principle

According to the *Canadian Environmental Protection Act, 1999* (CEPA) the precautionary principle is defined as:

"where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

The precautionary principle, therefore, is an approach to risk management that reflects the need to take prudent action in the face of potentially serious risk without having to await the completion of further scientific research. This principle implies that there is a social responsibility to protect the public and the environment from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.

A precautionary approach may be relevant in circumstances where it is identified that a Project activity could cause serious or irreversible adverse effects on the environment and the cause and effect relationships cannot be clearly established.

The available research, including scientific and traditional knowledge, has been incorporated into the baseline and effects sections of this EIS to determine the potential effects from the proposed Highway on the biophysical and human environment.

Cause and effect relationships have been established for the biophysical aspects of this Project, but are more challenging to determine for the human environment. Several concerns were raised during the consultations regarding the public's use of the Highway and the potential for increased harvesting activities or access to harvesting areas. Although the Developer is sensitive to these issues, and has proposed mitigation measures to minimize such induced effects, ultimately, the responsibility for managing these issues rests with other agencies in the community, and with the residents of the ISR themselves.

During consultation, the overall response to the proposed Highway, and people's capacity to accept the changes that the Highway would bring, was positive. Details of the consultation results are found in Sections 1.6.2 and in Appendix B.

Based on the results of the effects assessment, found in Section 4.0 of this EIS report, the precautionary principle will be exercised by applying best management practices and exercising due diligence in the delivery of this Project. These principles are part of the Developer's operational practices and environmental policy.

2.0 PROJECT DESCRIPTION

2.1 ROUTE ALIGNMENT ALTERNATIVES

2.1.1 Brief History of Alternative Alignments Considered

During the 1980s, interest in the proposed Highway varied in relation to economic and political factors and two other possible highway alignments were considered as alternatives to the original PWC 1977 surveyed route alignment which is discussed in greater detail in the next section.

In 1985, the Inuvialuit Land Administration expressed its opposition to the PWC 1977 route partly because of its proximity to the Husky Lakes; and in 1986 suggested to Department of Indian and Northern Affairs (DIAND) a longer route which involved a major shift of the alignment to the west, towards Reindeer Station through the Caribou Hills, and along the East Channel of the Mackenzie River. This highway alignment would be located almost entirely within Inuvialuit lands, and was approximately 173 km long, or 33 km longer than the PWC 1977 route. Public Works Canada did not support this proposed alignment because of economic and geometric reasons, but put forward an alternative route that was 27 km longer than the original PWC 1977 route. However, this route was located without field data, and would have required completely new preliminary engineering studies, and because of its longer length, would have been considerably more costly to construct than the original PWC 1977 route.

As part of its Highway Strategy, GNWT Department of Transportation launched a $2 million initiative in May 1998 under which it conducted various planning, environmental, pre-engineering and related studies for each of the three new highway corridors that the Department had been promoting for federal funding: Slave Geological Province Transportation Corridor; Mackenzie Highway Extension from Wrigley to Inuvik; and Inuvik to Tuktoyaktuk Highway. The results of the studies were published in the "Summary Report of the Highway Strategy, October 1999, GNWT Department of Transportation".

Two of the several studies carried out for the Inuvik to Tuktoyaktuk Highway, as part of the Highway Strategy, dealt with the route alignment issues.

First, the route location was an important question posed and discussed at community consultation meetings held in January 1999 in Inuvik, Tuktoyaktuk, Aklavik, Fort McPherson, and Tsiigehtchic. In terms of the route alignment for the Inuvik to Tuktoyaktuk Highway, there was general agreement by the public with the PWC 1977 route, except that some residents, particularly from Tuktoyaktuk, expressed concern about the proximity of the proposed alignment to the shore of Husky Lakes. Three critical sites were identified where a preference was expressed to relocate the route 2.5 km or more from Husky Lakes (Rescan 1999a).

Second, the "Inuvik to Tuktoyaktuk Road Pre-Engineering Update, March 1999, prepared by Highways and Engineering Division, GNWT Department of Transportation" endorsed the PWC 1977 alignment as the most logical route for an all-weather highway link between the two communities. This study also provided an update regarding design standards and costs for the Highway.

The move of the proposed route (Primary 2009 Route) farther from Husky Lakes, as suggested in the 1999 community meetings, and in the 2009 and 2010 community consultations, has been considered.

2.1.2 Alignments Considered in the Current Stage of Project Development

The specific evaluation and further development of alignments is based on historical studies, a better understanding of the development of transportation infrastructure in permafrost regions, and the management of risk that is associated with climatic warming or climate change. In addition, the first hand understanding gained during the September 2009 field work of the physical terrain, and the recent stakeholder and regulatory input, has been accounted for in the further development of alignments or alignment segments for comparison.

The alignments considered in the current stage of Project development are shown in Figure 2.1.2-1. The alignments include:

- **Primary Alignment** - the Primary 2009 Route, which is an updated and refined version of the 1977 Public Works Canada (PWC) alignment, with a minor encroachment on the Husky Lakes 1 km setback;
- **Alternative 1** - the 2009 Minor Realignment of the Primary 2009 Route to fully achieve the Husky Lakes 1 km setback requirements;
- **Alternative 2** - the Upland Route, which diverts west from the Primary 2009 Route about 70 km north of Inuvik and re-joins the alignment near Source 177. This route has been considered in response to requests in the 2009 consultations to consider a suitable alignment that is substantially further than 1 km away from the Husky Lakes; and
- **Alternative 3** - the 2010 Minor Realignment, recommended by Inuvialuit interests to modify Alternative 1 (2009 Minor Realignment) and to provide a more direct route. This information was presented to the Developer just prior to submission of the Project Description Report, and is identified as an option in this EIS.

  The Developer considers this alternative alignment in the Husky Lakes area to be a promising route option, but the engineering considerations related to this option in the field have yet to be assessed. However, the Developer feels that subject to Project approval, Alternative 3 would be further considered and likely adopted in the detailed design stage based on the additional field information that needs to be gathered.

A brief description and comparison of these alignments is described in the following subsections.

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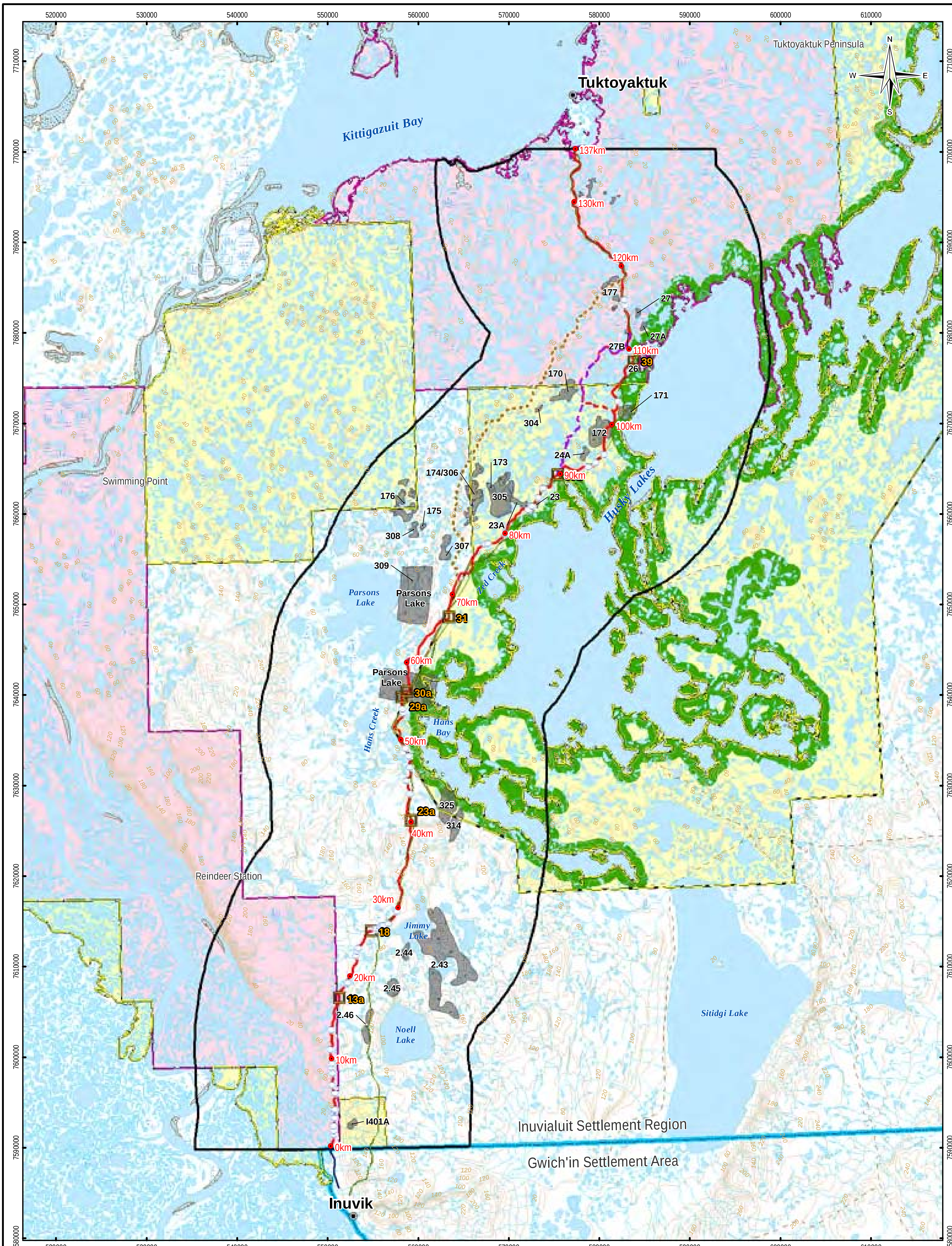

LEGEND

- Stream Crossing
- 18 Stream Crossing - Potential Bridge
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Primary 2009 Route and
Other Alternative Alignments Considered

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map054_Alignment.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 2.1.2-1

2.1.2.1 PWC 1977

The PWC 1977 alignment has been the starting point for further development and comparison of alignments at this stage in the Project development. Originally developed to a conceptual level by Public Works Canada in 1977, it has been the subject of further minor investigation and comparison with other more westerly alignment concepts through the Mackenzie Delta. The southern limit of the alignment is the northeast quadrant of the Town of Inuvik and the northern limit is the existing hamlet road network in Tuktoyaktuk. The original PWC alignment follows the shores of Husky Lakes and the design/construction approach at the time, considered a balance of cuts and fills. Today, this alignment would not be directly suitable as it encroaches on the 1 km setback as recommended by the ILA adjacent to Husky Lakes, traverses lakeshores which are generally softer, less stable ground, and relies on an undesirable approach of cutting into the permafrost to gain an advantage for vertical geometry (Photo 2.1.2-1).

Photo 2.1.2-1
Looking west from Husky Lakes to area where PWC 1977 alignment was considered

2.1.2.2 Primary 2009 Route

The Primary 2009 Route builds and improves on the original PWC 1977 alignment. Extending from the north end of Navy Road in the Town of Inuvik to the Hamlet of Tuktoyaktuk, it follows a similar alignment to that of PWC 1977 but has been developed to a conceptual design level - one to two iterations of vertical and horizontal alignment design based on:

- Minimum/desirable design parameters using a digital elevation model developed from available 1:30,000, 2 m resolution colour air photos);
- 1 km setback from Husky Lakes;
- Optimum stream crossing locations based on initial field work;
- Potential areas of wildlife and vegetation sensitivity;
- Areas of archaeological potential;
- Sensitive permafrost and ice-rich terrain;
- Location of potential borrow sources; and
- Topography suitable to meet minimum vertical and horizontal geometric requirements with a "fill only" construction approach.

There are two locations where the Primary 2009 Route does not fully meet the 1 km Husky Lakes setback. The first encroachment is from KM 105+340 to 105+600 where, for a road length of approximately 260 m, the Primary 2009 Route runs just along the 1 km setback boundary or has a slight encroachment of 14 m. The second encroachment is from KM 107+580 to 109+400, where the 1 km setback boundary runs through the east end of a large lake that is just west of the Husky Lakes system. The Primary 2009 Route encroaches on the setback for a road length of approximately 1,820 m. Through this 1,820 m, the encroachment on the setback ranges from 0 m to 600 m east of the setback boundary. This is illustrated in Figure 2.1.2-2.

At the south end, the Primary 2009 Route takes advantage of more suitable terrain north of Navy Road than the previous PWC 1977 alignment (Photo 2.1.2-2). At the north end, the Primary 2009 Route takes advantage of the horizontal alignment of the 19.5 km access road that is currently under construction from Source 177 to Tuktoyaktuk (Photo 2.1.2-3). The horizontal alignment for this access road meets or exceeds the minimum design parameters for the future Highway. Only the access road cross section (i.e., width of driving surface) and the vertical profile will need to be upgraded to meet the requirements for the future Highway. Minimum and desirable design parameters are discussed in further detail in the next section of this Environmental Impact Statement.

Photo 2.1.2-2
Looking south along Primary 2009 Route near Hans Creek

2.1.2.3 Alternative 1 (2009 Minor Realignment)

To avoid the minor encroachments of the Primary 2009 Route on the Husky Lakes setback, Alternative 1 (2009 Minor Realignment) was developed inland, to the west of a large lake, starting at KM 101+200 of the Primary 2009 Route and re-joins the Primary 2009 Route at KM 111+700. This minor realignment traverses more upland terrain that the Primary 2009 Route, but was considered feasible by the Developer. More direct comparisons of the alignments are presented in further sections of the EIS. Alternative 1 (2009 Minor Realignment) is shown in Figure 2.1.2-2.

LEGEND

- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Husky Lakes 1000m Setback

NOTES

Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Route Alternatives

PROJECTION UTM Zone 8		DATUM NAD83	
Scale: 1:100,000 1 0.5 0 1 2 3 Kilometres			
FILE NO. V23201322_EIS_Map021_Dev_Realign.mxd			
PROJECT NO. V23201322	DWN SL	CKD TS	REV 0
OFFICE EBA-VANC	DATE May 2, 2011		

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 2.1.2-2

Q:\Vancouver\GIS\ENVIRONMENTAL\V232\V23201322_TukRoad_EIS\Maps\EIS\V23201322_EIS_Map021_Dev_Realign.mxd modified 5/2/2011 by sleusink

Photo 2.1.2-3
Partially complete access road from Tuktoyaktuk to Source 177

2.1.2.4 Alternative 2 (Upland Route)

Alternative 2 (Upland Route) diverts northwest from the Primary 2009 Route at KM 71 and re-joins the Primary 2009 Route at KM 118, near Source 177. The route has been considered in response to requests to find a suitable alignment that is substantially further than 1 km away from Husky Lakes. Initial review of Alternative 2 (Upland Route) was based on the historical power line alignment and input from community members who frequently travel the route by snowmachine for recreational and harvesting activities. As a result of the consultations, Alternative 2 (Upland Route) has been developed to the same conceptual design level as the Primary 2009 Route.

Alternative 2 (Upland Route) is found to be through more rugged terrain than the Primary 2009 Route. This poses challenges for constructability, resulting in an increase in material quantities to meet the minimum design parameters, and requires higher fills that could result in maintenance and operational issues (Photos 2.1.2-4 and 2.1.2-5). More direct comparison of the alignments is presented in further sections of this Environmental Impact Statement.

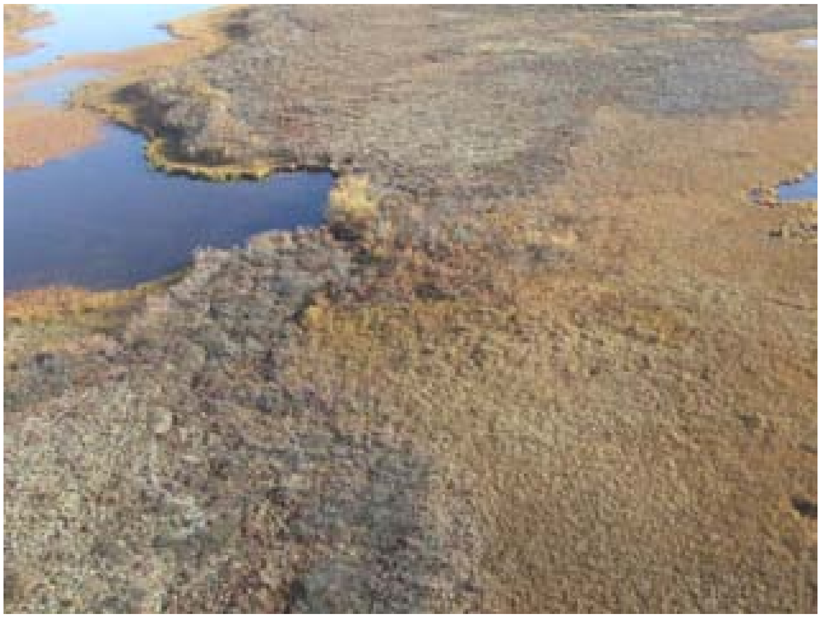

Photo 2.1.2-4
Looking south along Alternative 2 (Upland Route) at typical terrain

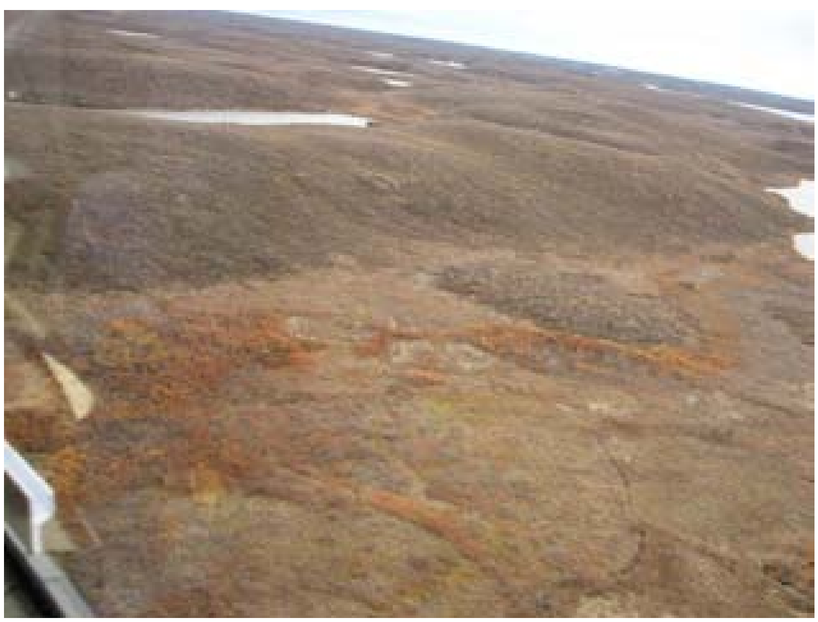

Photo 2.1.2-5
Looking south along Alternative 2 (Upland Route) at typical terrain

2.1.2.5 Alternative 3 (2010 Minor Realignment)

Inuvialuit interests recommended Alternative 3 (2010 Minor Realignment) as a proposed modification of Alternative 1 (2009 Minor Realignment)(Section 2.1.2.3). This modification creates a more direct route through suitable terrain, along a four to five kilometre segment. The entire route alignment is located outside of the 1 km Husky Lakes setback. Alternative 3 (2010 Minor Realignment) starts at approximately KM 90 of the Primary 2009 Route and re-joins the Primary 2009 Route at KM 111+700. Alternative 3 (2010 Minor Realignment) is shown in Figure 2.1.2-2.

2.2 COMPARISON OF ALIGNMENT OPTIONS

Of the four route alignments presented in this assessment, three alignment options have been considered in the conceptual design for the Inuvik to Tuktoyaktuk Highway. The alignments include:

- Primary 2009 Route (with encroachment on Husky Lakes setback);
- Alternative 1 (2009 Minor Realignment) to the Primary 2009 Route (to meet Husky Lakes setback); and
- Alternative 2 (Upland Route).

Alternative 3 (2010 Minor Realignment), recommended by Inuvialuit interests, is considered a viable route option, but has not yet been assessed in the field; therefore, modeling to identify accurate geometric design factors is not yet available. However, Alternative 3 (2010 Minor Realignment) is similar to Alternative 1 (2009 Minor Realignment), in that it does not encroach on the Husky Lakes setback, and it is shorter in length, at approximately 135 km. However, as stated previously, the Developer feels that subject to Project approval, Alternative 3 would be further considered and likely adopted in the detailed design stage based on the additional field information that needs to be gathered.

Table 2.2-1 presents a summary of the quantity and cost estimates for each alignment. The summaries are based on the full length of alignment (including common segments) from Inuvik to Tuktoyaktuk.

TABLE 2.2-1: COMPARISON OF ESTIMATED QUANTITY OF GRANULAR MATERIALS AND COSTS PER ROUTE OPTION

Element	Primary 2009 Route	Alternative 1 (2009 Minor Realignment)	Alternative 2 (Upland Route)
Estimated Highway Length	137 km	142 km	134 km
Estimated Embankment Quantity	4.5 million m^3	4.8 million m^3	5.4 million m^3
Estimated Surfacing Gravel Quantity	250,000 m^3	259,000 m^3	242,000 m^3
Estimated Capital Construction Cost	$221,000,000	$233,000,000	$258,000,000

The three options share a common alignment from KM 0 (North end of Navy Road, near Inuvik) to KM 71, and again from KM 118 to KM 137 (near Granular Source 177, by Tuktoyaktuk).

2.2.1 Evaluation Process

Each option was evaluated for environmental, economic, social, and technical factors that are further divided into sub-indicators. In some cases (i.e., cost) these factors are specifically quantified, but it should be noted that when quantified differences between options are small (say within 5 to 6%), then for that factor the options could be considered equal.

Scientific and economic factors are only part of the development decision. The technical teams who assessed the options maintained an awareness of the values, particularly for the Husky Lakes, held by the communities. These values and interests were discussed in the October 2009 and January 2010 consultation meetings, and were also provided during the initial EISC assessment process. The intent has been to integrate those values, while delivering key technical information to decision makers and stakeholders to review and to draw their own conclusions about the acceptability of the proposed Highway.

2.2.2 Environmental Factor

Sub-indicators for the Environmental Factor are described in the following subsections.

Footprint Area

An effective design and a well planned construction approach will minimize the footprint area of the Highway development. Minimizing the footprint area is desirable and the alignment option with the least footprint area is favoured. Footprint area is a function of highway length and the volume of material required for construction. Volume of material is a good representation of embankment width, as well as number and size of material sources required for construction.

As previously discussed, Table 2.2-1 shows the estimated quantity of granular materials and costs based on the Highway route. When considering length, the three options are considered equal; however, when considering volume of material, Alternative 2 (Upland Route) is considered to have a larger footprint and is therefore less favourable. Alternative 2 (Upland Route) requires a larger volume of embankment material and, therefore, greater borrow source/ quarry development, due to the more rugged terrain traversed.

Potential Effects on Fish and Fish Habitat

Potential effects to fish can be minimized in all three options by considering appropriate structures at stream crossings to avoid net loss of fish habitat and respecting the Husky Lakes setback. The Primary 2009 Route (with encroachment on the Husky Lakes setback) is least favourable even though the encroachment is very minor. Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) are considered to be more favourable than the Primary 2009 Route as both alignment options meet the Husky Lakes setback. However, Alternative 2 (Upland Route) is considered to be most favourable with respect to fish and fish habitat issues because of its increased distance from the Husky Lakes.

Potential Effects on Wildlife and Vegetation

At this stage in the development of the Highway, the footprint area is the most effective measure of potential effects on wildlife, and vegetation. Overall, development of the Highway is expected to have minimal effects on wildlife, and vegetation. As noted above, Alternative 2 (Upland Route) is considered to have a larger footprint and is therefore less favourable.

Potential for Dust Generation during Operation

Dust control measures will be implemented as necessary to minimize dust generation. An alignment option that has a lesser potential to generate dust is a more favourable option. The amount of dust generated is a function of traffic volume, travel speed and length of highway. Since all three alignment options are estimated to have the same traffic volume and travel speed (on average), length of highway is the factor considered in the potential for dust generation. The Highway length for each of the three options is within 5 to 6%; therefore, they are considered equal relative to the potential for dust generation during operation.

2.2.3 Economic Factor

Sub-indicators for the Economic Factor are:

- Estimated cost of design and construction; and
- Estimated cost of maintenance and operations.

Estimated Cost of Design and Construction

The estimated cost of design and construction for each of the three options is provided in Table 2.2-1. The Primary 2009 Route is the lowest cost option and is most favourable in terms of estimated cost of design and construction. Alternative 2 (Upland Route), although shorter, requires a greater volume of fill material to meet the minimum design requirements and is, therefore, the highest cost of the three options. Alternative 2 (Upland Route) is the least favourable in terms of estimated cost of design and construction.

The difference in cost between the Primary 2009 Route and Alternative 1 (2009 Minor Realignment) is between 5 and 6%; therefore, these two options are rated equally with respect to estimated cost of design and construction.

Estimated Cost of Maintenance and Operations

Quantitative annual costs of maintenance and operations for the future Highway have not been estimated. However, qualitatively, Alternative 2 (Upland Route) is expected to have a higher level of blowing snow, drifting and white-out conditions based on the topography and the vertical alignment, than the Primary 2009 Route. This is expected to result in a higher frequency of winter Highway patrols, greater efforts in ploughing and snow removal, and higher frequency of Highway closures due to poor weather. The maintenance and operations costs for Alternative 2 (Upland Route) are expected to be higher than the other routes, therefore making it the least favourable in terms of estimated cost of maintenance and operations.

2.2.4 Social Factor

Sub-indicators for the Social Factor are:

- Public safety;
- Economic advantages to the local communities;
- Local job creation and diversity;
- Quality of life; and
- Cultural heritage.

Public Safety

The potential adverse effects on public safety are specifically defined by the risk of collision. The design incorporates minimum requirements for vertical and horizontal curvature (i.e., how steep the grades can be, how tight the curves can be and how far ahead a driver must be able to see, etc.). All three routes meet or exceed the minimum design criteria or requirements established based on the future operation of the Highway. However, a designer's job is to balance risk with economics and, where economically practical, the designer will provide a highway that is better than the minimum requirements to reduce the risk of collisions in the future.

All highways have a potential for collisions. Specific geometric features of alignment options can be compared to identify which might have a higher potential for collisions and therefore a higher potential for negative or adverse effects on public safety. Information on specific geometric elements for each alignment option from KM 71 to KM 118 is presented in the Table 2.2.4-1.

TABLE 2.2.4-1: COMPARISON OF GEOMETRIC FEATURES PER ROUTE OPTION

Geometric Feature	Primary 2009 Route	Alternative 1 (2009 Minor Realignment)	Alternative 2 (Upland Route)
Number of horizontal curves with radius less than 350 m	27	32	89
Number of segments with vertical grades greater than 4%	39	44	55
Total length of segments with vertical grades greater than 4%	5.39 km	5.95 km	7.59 km
Maximum Grade	8%	8%	8%

For each geometric feature presented, a lower number represents a highway alignment that exceeds the minimum safety requirements more often and by a greater degree, and therefore, has a lower risk of collision. A higher number for each feature represents a highway alignment that just meets the minimum requirements, and therefore, has a higher risk of collision. A lower risk of collision is more favourable when it comes to public safety.

The Primary 2009 Route is the most favourable of the three alignment options relative to geometric design requirements.

Economic Advantages to the Local Communities

Economic benefits to the local communities are realized through an increase in trade and local business, such as supply of materials, expediting and transport of persons and goods during both construction and the future operation of the Highway. There is little difference between the three operations relative to the opportunities for local businesses and the development of new businesses. The three alignment options are considered equal for this sub-indicator.

Local Job Creation and Diversity

Job creation and diversity includes creation of training and employment opportunities. Employment opportunities are available during the construction and operation phases of the Highway, including support services and businesses and spin-off opportunities such as access management and tourism. The three alignment options are considered equal for this sub-indicator.

Quality of Life

Quality of life includes both benefits and adverse effects on the daily life of community members. Examples of expected benefits include new infrastructure, and better access to healthcare, education and training. Examples of potential adverse effects include increases in vehicular accidents, noise, dust, traffic, or Highway closures. All three alignment options provide equal benefits relative to use of the new infrastructure, employment opportunities, and improved access to healthcare, education and training. Most adverse effects to quality of life are equal across the three alignment options with the exception of the potential to generate dust, the potential for Highway closures and the risks to public safety.

As described previously, the potential to generate dust is a function of the length of a highway; therefore, since Alternative 2 (Upland Route) is shortest in length, it is more favourable. However, Alternative 2 (Upland Route) has a higher potential for Highway closures due to poor weather conditions and has a higher risk of collisions given the design challenges presented by the topography. Alternative 2 (Upland Route) is, therefore, the least favourable when considering quality of life.

Cultural Heritage

Cultural Heritage includes overall effects of the option on the cultural attributes of the alignment and the surrounding land (i.e., historical, preservation, archaeological, access for hunting and fishing, etc.). All three highway alignment options consider and avoid known locations of heritage or archaeological significance.

Husky Lakes is a very important area. The concern expressed during consultation is that this is an area of traditional use that calls for minimizing potential effects (i.e., restricting development, access and use); however, it is also considered a valuable fishery and recreational area that is difficult to access.

As a sub-indicator, Cultural Heritage can be viewed from two perspectives. One that minimizes or eliminates the potential for access to Husky Lakes through physical distance and one that may improve access but still does not provide direct access to Husky Lakes. In considering these two perspectives, Alternative 1 (2009 Minor Realignment) and Alternative 2 (Upland Route) are considered equal because they both fully respect the 1 km Husky Lakes setback.

2.2.5 Technical Factor

The sub-indicators for Technical Factor are:

- Footprint area;
- Geometric design requirements;
- Potential for geotechnical challenges;
- Permitting risk; and
- Construction risk.

Footprint Area

The sub-indicator of Footprint has been discussed and evaluated under the Environmental Factor above. The same information is considered when viewing footprint as a technical sub-indicator and Alternative 2 (Upland Route) is considered the least favourable.

Geometric Design Requirements;

The geometric design requirements have been discussed in the sub-indicator of public safety previously. When viewed as a sub-indicator of the Technical Factor, the same discussion prevails. An alignment option that exceeds the minimum design requirements for the operation of the Highway more often is more favourable. The Primary 2009 Route is the most favourable of the three alignment options relative to geometric design requirements.

Potential for Geotechnical Challenges

The potential for geotechnical challenges is based on the limited terrain assessment. The routing for each Highway alignment option has been largely developed based on terrain observations in an effort to select reasonable topography and avoid ice rich and other sensitive soils that are likely to result in geotechnical challenges. Such challenges can be mitigated through modification of horizontal alignment to avoid ice rich terrain and considering an overall embankment fill design (rather than balancing cut and fill) with minimum embankment height defined based on the nature of the terrain type. For example, fill over bedrock could be as little as 0.5 m whereas fill over ice-rich permafrost would be 1.8 m or greater to provide an insulating layer and prevent thaw of the permafrost below the active layer.

There is a greater potential for ice-rich terrain along the Primary 2009 Route than Alternative 2 (Upland Route), although mitigative measures during the design and construction will be incorporated such that it is anticipated that both would perform in a similar manner. Subsequent to completion of this initial evaluation of route alternatives, INAC (2010) reported that approximately 10% (or 14 km of 137 km) of the Primary 2009 Route was determined to be located on confirmed or suspected ice-rich terrain and approximately 8% (or 4 km of 45 km) of the Alternative 2 (Upland Route) was located on similar terrain.

Permitting Risk

All three alignment options carry a risk of not receiving the appropriate permits and approvals to proceed with construction and operation. An alignment option that does not meet currently established development guidelines will carry a higher risk of not receiving approval. Any alignment option that encroaches on the 1 km Husky Lakes setback does not meet the currently established development guidelines. Therefore, the Primary 2009 Route (with encroachment on the Husky Lakes setback) is less favourable than the other two options.

Construction Risk

Although there are risks in construction relative to safety of workers and preservation of the environment, there is also risk associated with unforeseen circumstances that will increase costs and delay completion. Such circumstances include lack of borrow material that is of sufficient quality and type suitable for Highway construction, increased number of bridges rather than culvert crossings and unforeseen geotechnical conditions along the Highway alignment that require thicker embankment fills, modification of the Highway alignment, and longer/more complex bridge structures and foundations.

The three alignment options (i.e., Primary 2009 Route, Alternatives 1 and 2) have been developed to the same level of conceptual or preliminary design and quantity estimates and any of the three will require further environmental surveys and geotechnical investigations in potential borrow sources and along the alignment to support detailed design and construction. However, the available information upon which the conceptual designs and quantity estimates were based is different for each of these three alignment options, particularly with respect to the stream crossings, the geotechnical conditions and the available material sources. There is less of this type of information available for Alternative 2 (Upland Route) than for the other two alignment options. Where there is less information available, there is greater risk of unforeseen circumstances during design and construction, increasing the potential for increased costs and longer construction time.

During the initial development of the conceptual designs, the Primary 2009 Route had the most reliable information available and is therefore most favourable when considering construction risk in this manner. Alternative 1 (2009 Minor Realignment) has a similar level of information as the Primary 2009 Route, but could benefit from additional high level review relative to the specific routing. Virtually no information exists at this time about the availability of suitable material sources along Alternative 2 (Upland Route). Therefore, Alternative 2 (Upland Route) has the greatest risk of encountering circumstances that are unforeseen at the present time, and is thus the least favourable when considering construction risk.

2.2.6 Summary of Evaluation

Table 2.2.6-1 presents a summary of the evaluation based on factors and sub-indicators discussed above.

TABLE 2.2.6-1: SUMMARY OF EVALUATION

Factor	Sub-indicator	Primary 2009 Route	Alternative 1 (2009 Minor Realignment)	Alternative 2 (Upland Route)
Environment	Footprint Area	Most favourable	Most favourable	Least favourable
	Wildlife and vegetation effects	Most favourable	Most favourable	Least favourable
	Fish and fish habitat effects	Least favourable	Favourable	Most favourable
	Potential for dust generation during operation	Equal	Equal	Equal
Economic	Estimated cost of design and construction	Most favourable	Most favourable	Least favourable
	Estimated cost of maintenance and operations	Most favourable	Most favourable	Least favourable
Social	Public Safety	Most favourable	Favourable	Least favourable
	Economic Advantages to the Local Communities	Equal	Equal	Equal
	Local Job Creation and Diversity	Equal	Equal	Equal
	Quality of Life	Favourable	Favourable	Least Favourable
	Cultural Heritage	Favourable	Most Favourable	Favourable
Technical	Footprint Area	Most favourable	Most favourable	Least favourable
	Geometric Design Requirements	Most favourable	Favourable	Least favourable
	Potential for geotechnical hazards	Equal	Equal	Equal
	Permitting Risk	Least favourable	Favourable	Favourable
	Construction Risk	Most favourable	Favourable	Least favourable

Of the 16 sub-indicators presented, the three alignment options were considered equal for four of the sub-indicators.

This evaluation presents a simplified multiple accounts analysis where all sub-indicators are considered with equal weight or importance. The summary of favourability for each of the three alignment options is presented in Table 2.2.6-2.

TABLE 2.2.6-2: SUMMARY OF FAVOURABILITY

	Primary 2009 Route	Alternative 1 (2009 Minor Realignment)	Alternative 2 (Upland Route)
Most Favourable	8	6	1
Favourable	2	6	2
Least Favourable	2	0	9
Equal	4	4	4

2.2.7 Conclusion on Preferred Alignment

The Project Team has reviewed the previous Project studies, the 2009-2010 assessment, the current opportunities to fund and construct the Highway, the route evaluations, and the community views presented during the October 2009 and January 2010 consultation proceedings. After considering these factors, the Primary 2009 Route was reconfirmed as the preferred primary alignment.

In the vicinity of the Husky Lakes, the Project Team recognized that other minor realignments needed to be considered to fully respect the Husky Lakes setback. As a result, Alternative 1 (2009 Minor Realignment) was proposed and considered along with Alternative 2 (Upland Route). Subsequent to the initial evaluation, Alternative 3 (2010 Minor Realignment) was recommended by Inuvialuit interests in an effort to provide a more direct route through suitable terrain.

The Project Team considers this alternative alignment in the Husky Lakes area to be a promising route realignment, but has not yet assessed the engineering considerations related to this option in the field. However, the Project Team feels that subject to Project approval, Alternative 3 would be further considered and likely adopted in the detailed design stage based on the additional field information that needs to be gathered.

2.3 TERRAIN CONDITIONS ALONG PREFERRED ALIGNMENT

Terrain conditions observed along the Primary 2009 Route, beginning at the north terminus of Navy Road (KM 0) and traveling north to Source 177 (KM 118) are described in Table 2.3-1 below. A detailed discussion of the surficial geology landforms is presented in Section 3.1.1. Construction of the access road from Tuktoyaktuk to Source 177 commenced in 2009 and was completed in the summer of 2010.

The surficial geology and landforms along the proposed Highway corridor are primarily the result of glacial activity in the region. The main glacial deposits along the corridor are glacial moraine, glaciofluvial and lacustrine in origin. Fluvial, colluvial, organic and aeolian units are the result of ongoing and sometimes active processes subsequent to deposition by glaciers.

The proposed alignment crosses two distinct physiographic regions between Inuvik and Tuktoyaktuk. From Inuvik to south of Husky Lakes, the alignment crosses the eastern extension of the Caribou Hills on the edge of the Anderson Plain, consisting of mostly unconsolidated materials with varying amounts of ground ice overlying relatively shallow bedrock. Much of the topographic relief is a direct reflection of the bedrock surface, but bedrock is rarely exposed. North of this area to Tuktoyaktuk, the alignment enters onto the Pleistocene Coastal Plain, consisting of thick unconsolidated sediments, moraines, ice-contact, glaciofluvial and organic lacustrine deposits (Rampton 1987; Rampton 1979). The area also contains varying quantities of ground ice and massive ice layers. Bedrock is not near surface in the Pleistocene Plain.

The terrain conditions presented in the Table 2.3-1 are specific to the Primary 2009 Route (with minor encroachments on the Husky Lakes setback). When the Project is approved, further terrain and geotechnical investigation will be undertaken as part of the detailed design steps. At that time, the specific terrain conditions of Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) will be investigated and documented to support the detailed design. The ultimate alignment will respect the 1 km Husky Lakes setback. In the meantime, there is sufficient preliminary information available to anticipate that the terrain conditions along Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) are similar to those conditions described in Table 2.3-1.

TABLE 2.3-1: TERRAIN CONDITIONS ALONG PRIMARY 2009 ROUTE

Kilometre		Description of Terrain Conditions
0	4	The proposed route departs Inuvik from the terminus of Navy Road traveling north along subtle coalescing alluvial fans that slope toward the Mackenzie River. The route crosses several drainage channels supporting fish habitat that will require culverts.
4	10	The route ascends onto an elevated rolling moraine plain (late Wisconsinan stage) and crosses a series of drainage channels that will require culverts, but do not appear to support fish habitat (Kiggiak-EBA 2010b).
10	27	The route crosses onto a morainal blanket (early Wisconsinan stage), travels along a narrow strip of ice-rich polygonal patterned ground between two lakes and parallels along the east side of a chain of lakes from KM 13 to KM 19, about 2 km to 3 km east of Douglas Creek. The soils appear to be clayey/silty tills. At about KM 25, the route descends in elevation toward the lowlands adjacent to Jimmy Lake and crosses several drainage channels along the way.
27		At about KM 27 the alignment crosses the abandoned NCPC (Northern Canadian Power Commission) power transmission line and an overland winter road cutline.
27	34	The alignment travels 1 to 2 km west of Jimmy Lake for 1 to 2 km crossing wet, polygonal ground and numerous drainage channels that drain to the lake. The route then begins ascending in elevation onto relatively dry terrain from about KM 29 to KM 34, and further climbs a section of steep terrain from KM 32 to KM 34.

TABLE 2.3-1: TERRAIN CONDITIONS ALONG PRIMARY 2009 ROUTE

Kilometre		Description of Terrain Conditions
34	39	The alignment continues along a section of irregular, hummocky ground on a morainal blanket for about 1 km, and then from KM 35 to KM 38 the route crosses a relatively smooth moraine veneer, before approaching the first major stream crossing at KM 39 (unnamed Crossing 23A in the field map book). The crossing is incised and mapped as having colluvial slopes along its banks.
39	52	Surficial mapping shows the alignment to transition away from the unnamed creek and associated colluvial materials at KM 40 and back onto a rolling moraine plain with patterned polygonal ground to KM 52. From about KM 40 to KM 46, the route descends the east extension of the Caribou Hills toward the south end of Husky Lakes. Between KM 46 and KM 51, the alignment crosses ice-contact transitional terrain between the moraine plain to the west and Husky Lakes to the east. The ice contact terrain is irregular and hummocky with kame and kettle complexes and thermokarst modified outwash plains. The route crosses drainage channels through this section and ice-rich polygonal patterned ground. There are signs of thermokarst activity and associated slumping.
52	56	The route leaves the hummocky ice-contact terrain and crosses a glaciofluvial outwash plain with little relief for a few kilometres before approaching Hans Creek at about KM 56.
56		Hans Creek is a major stream on the route containing extensive deposits of alluvial outwash sands and gravels along the south-facing (north) terrace. This material source has been investigated and reported by others (RKL 1972). Hans Creek discharges water from East Hans Lake and associated tributaries into Husky Lakes. The terraces have historically slumped, particularly the north facing terrace, and are clearly sensitive to disturbance, but there are no signs of recent instability.
57	67	North of Hans Creek the route climbs onto a north-east trending ice-contact deposits and crosses through an area of higher ground with lakes on either side. The Highway parallels a series of thermokarst lake beds and, on a geologic time scale, pingos are developing in the area.
67		The route crosses Zed Creek which is the outlet to Parson Lake discharging into Husky Lakes. The local area is characterized by thermokarst lakebeds and evidence of sensitive terrain.
67	90	North of Zed Creek the route climbs onto a north-east trending glaciofluvial outwash plain that appears reasonably well-drained and at about KM 76 crosses a wet, ice-rich, lowland area at the north end of Zed Lake. Along this section, the route skirts the eastern limits of an ice contact deposit and alternates between the ice contact deposit and a glaciofluvial outwash deposit to the east. The terrain is irregular and hummocky at times. The route crosses areas of ice-rich polygonal patterned ground and overall the terrain is characterized as poorly drained.
90	95	The route crosses a complex geologic intersection of ice-contact, glacial outwash, moraine and lacustrine deposits. Overall the area is characterized as being wet and ice-rich containing numerous lakes and occasional pingos. A description of deposits along this section based on the mapping by Rampton (1987) is as follows: KM 87 to KM 90 ice contact deposit, KM 90 to KM 91 lacustrine, KM 91 to KM 92 moraine, KM 92 to KM 93 lacustrine, KM 93 to KM 95 moraine.
95	114	At KM 95 the route moves onto lowland lacustrine deposits along Husky Lakes. The terrain is smooth, but wet and ice-rich. This section of the alignment comprises lacustrine sediments most likely deposited in a proglacial or glacially dammed basin environment. There are sections of relatively good terrain to cross, but for the most part the terrain is wet and ice-rich polygonal terrain is common.

TABLE 2.3-1: TERRAIN CONDITIONS ALONG PRIMARY 2009 ROUTE		
Kilometre		Description of Terrain Conditions
114	118	Near KM 114 the alignment moves off the abandoned lake-bed of Husky Lakes onto thermokarst modified ice-contact and moraine terrain to KM 118 (Source 177). The landscape is marked by pot-hole lakes and abrupt elevation changes. The till subsoil generally contains extensive and erratic massive ground ice.
118	137	The route from Source 177 to Tuktoyaktuk continues on outwash hills and ridges. Northward of Source 177 the terrain becomes more subdued. The area has many thermokarst lakes and pingos. The route in this section meanders around the frequent lakes following favourable terrain.

Morainal materials generally provide suitable foundation conditions to construct a road. These materials are typically moderately well drained and comprise a fraction of sand, gravels and cobbles. They present few limitations to road construction except in areas with steep slopes or where drainage is poor and ice-rich.

Most glacial outwash materials provide a suitable foundation for roads as drainage is generally considered to be good. In addition, some outwash deposits provide good construction material sources. Ice-contact deposits also provide suitable foundation conditions for roads but the irregular and hummocky terrain can be a challenge and require higher fill volumes to construct a road.

Lacustrine sediments present limitations for road construction and maintenance due to their fine-textured nature; these sediment types are generally found in lowland adjacent to existing lakes such as Husky Lakes. Their limitations are due to their wetness and high settlement potential. Thick organic deposits and ice-rich patterned ground was avoided as much as possible as disturbance to these accumulations can result in significant rutting, compaction and alterations to hydrologic conditions.

Alluvial and colluvial deposits comprise a small percentage of the materials that will be encountered along route. These materials are transported and deposited by streams and gravity and are found along water courses and steeper slopes. From an engineering perspective, alluvial deposits represent potential borrow sources, however, these materials are often located in sensitive areas near waterbodies, are variable and of small/limited volume, and are mostly unmapped, so they will not be relied upon as significant material sources.

2.4 KEY HIGHWAY GEOTECHNICAL ISSUES

2.4.1 Permafrost

Permafrost is continuous throughout the Project area. Melting of ice-rich permafrost can result in substantial thaw settlement, the loss of the soil structural integrity, and potentially affect the Highway foundation. Minimizing disturbance to permafrost is important. Common permafrost-related features in the Project area include ice-rich polygonal ground, thaw-flow slides, thermokarst and peatland.

The term "permafrost" describes a ground thermal condition where the soil or rock remains below 0˚C for two or more years, without consideration of material type, ground ice distribution, or thermal stability. The Inuvik to Tuktoyaktuk corridor is located entirely within the continuous permafrost zone of the Northwest Territories. Ground temperatures are within the range of minus 2 to 5.

Frozen ground can contain excess ice, where the amount of water contained in the soil matrix in a frozen state is higher than would be retained in the soil in an unfrozen state. The excess ice can be found mixed (disseminated, non-visible) within the soil matrix, or can be in the form of pure ice, ice lenses or ice wedges. These ice-rich soils are sensitive to thermal disturbance, which can result in thaw settlement and instability.

2.4.2 Sensitive Terrain

The majority of the proposed alignment is located in the Mackenzie Delta of the Pleistocene Plain, a region of limited topographic relief. The southern portion of the route is located on the Caribou Hills, with rolling terrain and steeper slopes. There are various landforms and specific areas along the alignment identified that would be sensitive to construction activities along the Primary 2009 Route and the Alternative 2 (Upland Route). A major routing design consideration was to avoid problematic or sensitive areas and to design accordingly to mitigate impact. Also, construction over ice rich permafrost terrain requires substantial quantities of materials to maintain a grade with continuous thick fill over thaw sensitive terrain.

The following subsections describe the landforms identified as being sensitive to construction activities and disturbance.

2.4.2.1 Polygons

Polygons are recognizable as a type of patterned ground, which are characteristically ice-rich and found primarily in low-lying poorly drained areas (i.e. drained lakebeds). These features are commonly classified as high- or low-centered polygons. Low-centered polygons consist of central flat terrain enclosed by relatively dry ridges. Ice wedges grow progressively and ice wedge growth pushes up the surface soil to form linear ridges. Intersecting ridges give the surface of the ground a polygonal appearance. Over time low-centered polygons can become high-centered polygons. This ice-rich patterned ground was avoided when possible.

2.4.2.2 Thick Organics (Peatlands)

Generally these deposits occur as peat or fen, peat-fen complexes, usually as cover over the underlying mineral soil, typically on flat terrain. Peatlands are wetlands with massive deposits of peat that are typically greater than 0.5 m thick and may be several metres thick. There are many classes of peatland, but most in the Mackenzie Valley are bogs and fens. Bogs are a form of peatland, having a water table at or near the surface, where the waters are virtually unaffected by nutrient rich groundwater from the surrounding terrain. Most bogs are affected by permafrost and take the form of peat plateaus, polygonal peat plateaus and plazas (Tarnocai et al. 2003). Fens support nutrient rich waters (flowing water) that originate from mineral soil. Thick organic terrain identified during the field reconnaissance and from orthophotos has been avoided in route planning.

2.4.2.3 Thermokarst

Thermokarst refers to surface subsidence and expression resulting from the melting of ice rich permafrost, particularly massive ice lenses. Thermokarst is a slow natural process that can be aggravated and accelerated by land use activities if not cautious. As ground ice thaws and the resulting water cannot drain away, it contributes to degradation of permafrost. The result is the creation of small ponds and lakes, as expressed in the numerous lakes observed along the route. Old thermokarst lake beds occur where fine-grained clay, silt, peat, and local sand deposited in low, flat areas previously occupied by lakes/ponds become exposed. These lake beds often support an organic cover and the areas tend to be very wet and ice-rich. Ice content is generally high is these fine-grained, organic materials. These areas often exhibit thermokarst subsidence with erosion along ice wedge cracks and pingos. These areas have been avoided when possible.

2.4.2.4 Thaw Flow Slides

Thaw flow slides are characterized by landslides that occur only in ice-rich soils in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and hundreds of these features line the river banks and tundra lakes in the Project area. These landslides are typically relatively small, but over time can retreat some distance back from the rim and from the escarpment. These slides would have a significant impact on a road if one were to occur. The likelihood of a retrogressive thaw slide impacting the Highway has been reduced by carefully avoiding existing slides and steeper slopes that would be susceptible to failure.

The class and types of landslides characteristic to the regions are identified by Aylsworth et al. (2000) in *The Physical Environment of the Mackenzie Valley, Northwest Territories: A Base Line for the Assessment of Environmental Change*. In addition, an inventory of 3400 landslides has been compiled for the Mackenzie Delta and Tuktoyaktuk Peninsula, Mackenzie Valley and adjacent mountainous regions and is presented in Figure 3.1.1-4 (Aylsworth et al. 2001).

2.4.2.5 Pingos

Pingos are ice-cored hills that are forced up by the hydrostatic pressure in a wet area underlain by permafrost. Pingos may be up to 50 m high and have a base of up to 600 m in diameter. Mackay (1963) reported the existence of some 1,400 pingos in the Mackenzie Delta Area. Several large pingos are located near Tuktoyaktuk and to the west of the proposed Highway alignment near the Beaufort coastline. Pingos are cultural and heritage resources that have been avoided entirely. It is also understood that INAC generally recommends a 150 m setback for any activities near a pingo, which will be respected during final route alignment optimization prior to construction.

The drainages of Hans Creek and Zed Creek, and the wetland north of Zed Lake have been identified as being particularly sensitive to disturbance and construction activities given their environmental settings. Careful design and construction will be undertaken in these areas.

2.5 DETAILED QUANTITY ESTIMATES FOR THE PREFERRED ALIGNMENT

Fill quantity estimates have been developed for the Primary 2009 Route based on the conceptual design. The estimated fill quantities by topography and terrain are presented in Table 2.5-1.

The quantity estimates presented in the Table 2.5-1 are specific to the Primary 2009 Route (with minor encroachments on the Husky Lakes setback). When the Project is approved, further terrain and geotechnical investigation will be undertaken as part of the detailed design steps. At that time, the specific conditions of Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) will be investigated and documented to support the detailed design. The ultimate alignment will respect the 1 km Husky Lakes setback. In the meantime, there is sufficient preliminary information available to anticipate that the quantity estimates along Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) are similar to those conditions described in Table 2.5-1.

TABLE 2.5-1: ESTIMATED FILL QUANTITY BY TOPOGRAPHY AND TERRAIN

Alignment Segment	Length	Surfacing Gravel (m^3)	Embankment (m^3)	Average Embankment Fill Estimated per km (m^3)	Remarks on Topography and Terrain
KM 0 - KM 10	10	19,000	391,000	37,767	Elevation climb out of Inuvik
KM 10 - KM 44	34	62,000	969,000	28,416	Higher ground with drops to creeks
KM 44 - KM 90	46	82,200	1,801,000	39,275	Lower ground twisting around Husky Lakes
KM 90 - KM 118	28	52,300	863,000	30,648	Flatter terrain
KM 118 – KM 137 (Tuktoyaktuk)	19	33,800	476,000	25,677	Upgrade access road to the Highway

There are many stream crossings identified along the Primary 2009 Route. It is anticipated that most will be served by culverts and select locations will be crossed using bridges. The specific design of drainage structure (i.e., bridge or culverts) will be confirmed in future field investigations and during detailed design.

Based on preliminary engineering considerations and input from fisheries field investigations, a minimum of eight bridge crossings will likely be needed. The estimated lengths for these eight potential bridge crossings are presented in Table 2.5-2, and locations are illustrated in Figure 2.5-1.

TABLE 2.5-2: ESTIMATED LENGTHS FOR POTENTIAL SINGLE SPAN, PRE-FABRICATED BRIDGES			
Location	**Stream Crossing No.**	**Estimated Length (m)**	**Remarks**
KM 17	13a	15	Potential Bridge Crossing, Fish Habitat to be Confirmed
KM 26	18	20	Jimmy Creek
KM 40	23a	20	Trail Valley Creek, Potential Bridge Crossing, Fish Habitat to be Confirmed
KM 55.5	29a	20	Hans Creek tributary, Potential Bridge Crossing, Fish Habitat to be Confirmed
KM 56.5	30a	25	Hans Creek
KM 67.5	31	25	Zed Creek
KM 89.5	35a	10	Potential Bridge Crossing, Fish Habitat to be Confirmed
KM 109	39	10	Potential Bridge Crossing, Fish Habitat to be Confirmed

Culverts will be required at numerous locations along the Primary 2009 Route. Specific sites and estimated lengths based on the conceptual design have been identified where ephemeral creeks were identified in the 2009 field work (see Sections 3.1.7 and 4.2.5). Additional nominal quantities of culvert length have been included in the construction cost estimates to account for culverts that may be incorporated in the detailed design to equalize surface flow from one side of the Highway to the other, and including proposed culvert extensions for the Tuktoyaktuk to Source 177 Access Road upgrade.

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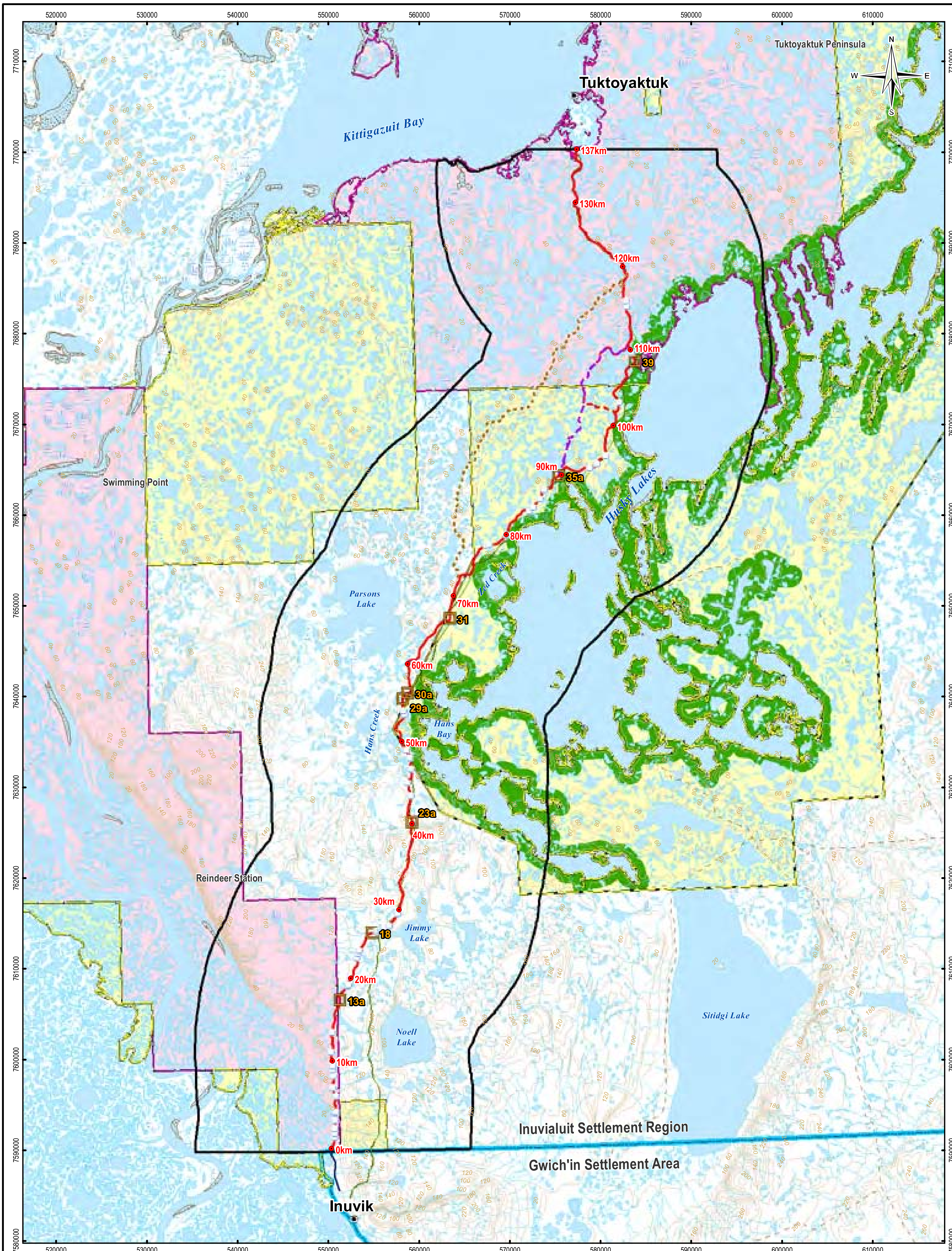


LEGEND

- Stream Crossing
- Stream Crossing - Potential Bridge
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Potential Bridge Locations

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map026_BridgeX.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 2.5-1

2.6 PROJECT COMPONENTS AND ACTIVITIES

The proposed Project is an all-weather highway between Inuvik and Tuktoyaktuk, NWT. This section of the EIS will discuss the Project activities and components necessary for construction and operation of the proposed Inuvik to Tuktoyaktuk Highway.

The Highway will be a public, all-weather highway under the management and operation of the Government of Northwest Territories Department of Transportation. This will allow year-round use by haul trucks and passenger vehicles according to the size and weight limitations as defined in the Northwest Territories *Public Highways Act*. The posted speed limit on the Highway will be 80 km/hr.

The Highway will be a two lane gravel roadway (8 to 9 m wide with 3:1 sideslopes) with short span single lane bridges at major stream crossings. Culverts will be used to cross most smaller streams and to accommodate seasonal overland surface flows.

The stability of permafrost and the infrastructure built on it depend on maintaining ground temperatures that can minimize the thickness of the active layer, and impede thaw. Climate change or more specifically, climate warming is changing the air/surface temperature relationship in the Mackenzie Delta and this is having a negative impact on permafrost.

A risk-based approach for incorporating climate change into design of highway infrastructure on permafrost is now recommended practice. This approach is documented in the national guidelines entitled *Development and Management of Transportation Infrastructure in Permafrost Regions* published by the Transportation Association of Canada (TAC) in May 2010. The challenge for design and construction over thaw-sensitive permafrost terrain is to balance the capital cost of constructing the Highway, against the long term maintenance implications. The design parameters and construction techniques noted above are based on experience in the area and the case studies and lessons learned as presented in the TAC guideline. These parameters and techniques take the inherent risks into account and provide mitigative approaches in the Highway design. The most significant elements of the design are the use of non-woven geotextile fabric between the existing ground surface and the placed Highway embankment material, and maintaining a minimum thickness in the material placed based on terrain type, to insulate the permafrost. In addition, pit development and best management practices for the borrow sources will also be incorporated. The elements of the risk-based approach to design and construction are described in the following sections.

2.6.1 Construction Overview

Construction will proceed in stages over a four year period, using a model similar to that for construction of the Tuktoyaktuk to Source 177 Access Road. Most construction will take place in the winter, with some activities such as grading and compaction on the new Highway, adjustment of culverts or installation of certain culverts (to protect fish habitat) occurring in the summer and fall. Summer and fall activities will only be undertaken where access is provided by the newly constructed Highway. Construction phases include:

- Mobilizing crew (surveyers and drillers) to construction staging points;
- Surveying and staking the initial several kilometres of the Highway;
- Constructing a temporary winter access road parallel to the permanent alignment;
- Placing geotextile fabric from toe to toe along the Highway alignment embankment and material being directly dumped and spread onto the geotextile;
- Placing an initial lift of approximately 300 mm to 400 mm is placed, followed by smaller lifts, with the embankment being left some 150 to 200 mm higher than design to accommodate settlements;
- Surveying the next few kilometres of route alignment; and
- Ground-truthing the original ground surveys for the design team to adjust the design to match the actual ground elevations.

These phases will be repeated each winter season until completion of the entire Highway. Further information regarding construction phasing is found in Section 2.7.1 and further discussion of the sequencing and construction approach is presented in the following sections.

2.6.2 Winter Season Construction

A fundamental tenet of the construction methodology is to complete most of the construction activities during the winter months rather than more typical summer construction, as used in southern Canada.

The advantages of winter construction are:

- Allows the use of temporary ice/winter access to borrow sources, without the need to construct all-weather access roads.
- Allows the placement of construction material directly onto frozen ground. This approach enables the establishment of a frozen core for the Highway and helps protect sensitive and ice-rich terrain.
- Minimizes potential effects on vegetation and soils from construction equipment that might occur if working under snow-free or wet conditions.
- Promotes initial Highway stability through the placement of frozen borrow material directly onto frozen ground (with geotextile separation layer). Following each year of witner construction, it is anticipated that the majority of embankment settlement will occur in the top layers of the emplaced borrow material as it thaws, dries and consolidates. Little to no thaw is expected in the lower layers of the embankment, leading to greater Highway stability and less maintenance.

- Allows for an ice crossing component of the temporary winter road near the bridge installation site. Prefabricated bridge structures will be shipped to the individual bridge sites by truck along the constructed embankment or temporary winter road. Bridges will be installed with typical construction equipment that is in general use for the Highway construction.

The disadvantages of winter construction are:

- The work is difficult, with temperatures of -35˚C or colder common at the beginning of construction in late December and early January. This is challenging for both personnel and equipment.
- There is little daylight.
- The excavation of frozen material in borrow sources may require the use of drill-and-blast methods to achieve the required volumes.
- The excavation and placement of frozen material makes it more difficult to achieve the desired compaction of the embankment layers.
- The available construction season from December to the beginning of May is short.

2.6.3 Construction Activities

Construction activities will be limited, to the extent possible, to the planned footprint of the Highway, with the exception of the temporary winter road that will parallel the alignment, and the temporary winter roads providing access to borrow sources. Prior to the commencement of construction, the route will be surveyed and staked, and temporary winter roads will be constructed to select borrow sources (Photo 2.6.3-1). Initially snow cats and small dozers will be used to clear snow from the staked footprint (Photos 2.6.3-1 and 2.6.3-2). Dozers used for snow clearing will be equipped with mushroom pads to avoid or minimize effects to the vegetative layer. After the route is staked, the snow is cleared, and adequate material is stockpiled at the borrow source, the construction activities will commence. The aggregate will be placed by end-dumping directly onto the existing ground surface without removal of the vegetative ground cover.

Photo 2.6.3-1
An example of winter road access constructed parallel to the road (Tuktoyaktuk to Source 177 Access Road, 2009)

Photo 2.6.3-2
The winter construction approach; note the grader in the distance clearing snow from the embankment footprint. (Tuktoyaktuk to Source 177 Access Road, 2009)

Geotextile will be placed between the existing ground and the embankment (fill) material (Photo 2.6.3-3). This is a common design technique in permafrost regions to assist in maintaining the integrity of the permafrost terrain beneath the Highway embankment. Workers will spread out rolls of non-woven geotextile fabric onto the cleared Highway footprint ahead of the placement of embankment materials.

Photo 2.6.3-3
An example of geotextile placement and the proposed end-dumping method of construction.
(Tuktoyaktuk to Source 177 Access Road, 2009)

Material will be loaded at the borrow sources using excavators and hauled along the temporary winter roads using both tractor-trailer units and articulated trucks. Material will be placed by end dump and spread with D6 and/or D7 Cats. An initial lift of approximately 300 mm to 400 mm is placed, followed by smaller lifts, with the embankment being left some 150 to 200 mm higher than design to accommodate settlements.

Culvert and bridge installation will proceed concurrently with the construction of the embankment. Since the bridge structures will be prefabricated single-span bridges, on binwall abutments, it is anticipated that access to bridge sites in advance of the embankment construction will not be necessary even if piling is required to supplement the binwall abutment foundations. Design, ordering and fabrication of bridges will need to be undertaken months in advance of the scheduled installation to ensure that shipping schedules are achieved, and that structures and binwall materials arrive on site in time for installation.

Access to both sides of the stream crossings will be required for binwall assembly prior to installation of the bridge structures. This will be accommodated with an ice crossing. Prefabricated bridge structures will be shipped to the individual bridge sites by truck along the constructed embankment or temporary winter road. Bridges will be installed with typical construction equipment that is in general use for the Highway construction.

Highway construction and drainage structure installation will be carried out each year in a similar manner. Final embankment compaction, adjustment of grade due to settlements and placement of surfacing gravel will be undertaken in the following summer.

Temporary winter roads that parallel the Highway or are used to access borrow sources will naturally decommission during the summer months, when the ice and snow melt.

2.6.4 Design Embankment

The embankment is the main component of the Highway to be constructed. Figure 2.6.5-1 shows a typical cross section of the Highway. Although the original work by PWC considered a balance of cuts and fills in the Highway design and construction (PWC 1981a), the Developer recognizes that, for this type of terrain, sufficient volumes of suitable material are not available. In addition, traditional cut-and-fill methods could result in future stability concerns for both the Highway and the cut slopes.

Using a method similar to that chosen for the access road recently constructed from Tuktoyaktuk to Source 177, the approach for the Highway will focus on using fills to build the Highway on existing ground.

When the Highway traverses drier, ice-poor upland terrain, then the minimum embankment height of 1.4 m will provide sufficient structural strength to carry the anticipated traffic loading. Increased embankment heights will be required through low lying, wet areas and areas of ice-rich polygonal patterned ground (Photo 2.6.4-1) that cannot be avoided and would most likely be in the 1.8 m to 2.0 m range. Table 2.6.4-1 summarizes the design parameters for fill embankment thickness.

Photo 2.6.4-1
Ice-rich polygonal patterned ground along the Primary 2009 Route

Some sensitive, slide prone locations were identified during the September 2009 field work along the alignments considered. The slides identified were described as retrogressive thaw flow slides. These occur in regions of high ice content soil, particularly where the active layer is thickening and slopes are over steepened. In this region the over-steepened slopes develop around expanding thermokarst lakes, along hummocky terrain and along stream channels and terraces (Photo 2.6.4-2).

Photo 2.6.4-2
Thermokarst lakes and hummocky terrain along the Primary 2009 Route

Table 2.6.4-1 provides the design parameters for embankment fill thickness by terrain type for the alignments considered.

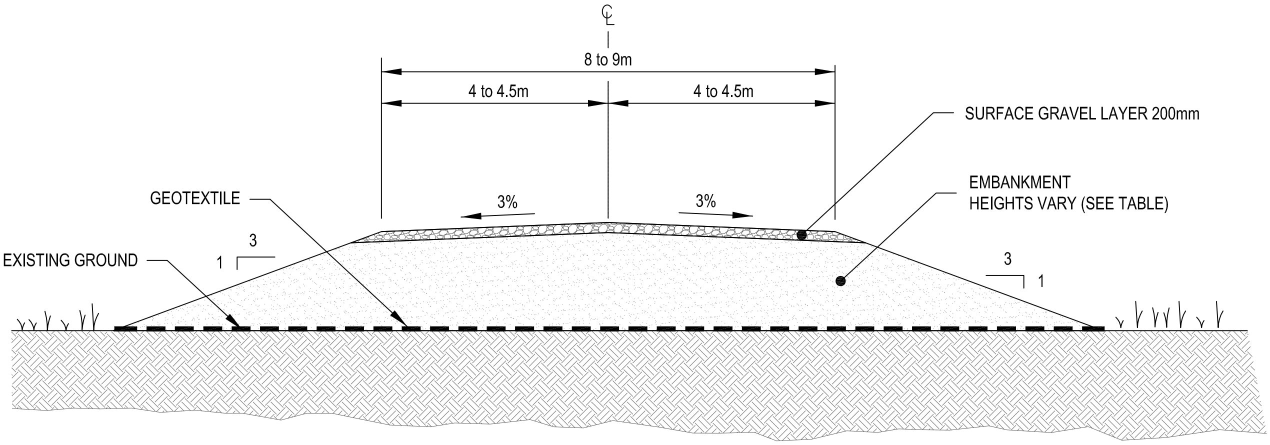
TABLE 2.6.4-1: DESIGN PARAMETERS FOR EMBANKMENT FILL THICKNESS

Terrain Type	Terrain Description	Embankment Fill Thickness
1	Dry (Ice-poor) Till & Outwash Deposits (relatively dry, stable, upland till and outwash deposits, overlain by a thin organic cover)	1.4 m
2	Wet (Ice-medium to Ice-rich) Till & Outwash Deposits (relatively wet, with some expression of ice-rich permafrost conditions, overlain by a thin to moderate organic cover)	1.4 m - 1.6 m
3	Wet Silts & Clays (Ice-rich) (lacustrine, silt and clay, deposits with distinct expressions of ice-rich permafrost conditions, moderate organic cover)	1.6 m - 1.8 m
4	Thick Organic Peatlands & Ice-Rich Permafrost	1.8 m

2.6.5 Geometric Design

The desired and minimum geometric design parameters for this Highway have been developed based on appropriate guidelines for public highways in the Northwest Territories. These parameters are presented in Table 2.6.5-1 and Figure 2.6.5-1 illustrates the design parameters in a typical highway cross section. The figure also shows the geotextile fabric to be installed between the existing ground and the Highway embankment. This is a feature that will be included along the entire alignment.

TABLE 2.6.5-1: GEOMETRIC DESIGN PARAMETERS FOR THE INUVIK TO TUKTOYAKTUK HIGHWAY	
Design Parameters	
Desired Design Speed	90 km/hr
Minimum Design Speed	80 km/hr
Horizontal Alignment	
Desired Curve Radius	440 m
Minimum Curve Radius	250 m
Desired Sight Distance	500 m
Minimum Sight Distance	180 m
Length of Spiral	160 m
Vertical Alignment	
Minimum Passing Sight Distance	605 m
Minimum Stopping Sight Distance	150 m
Minimum Sag K Value	40
Minimum Crest K Value	50
Minimum Distance between PVI	90 m
Desired Maximum Slope	3%
Maximum Slope Full Speed	6%
Cross-Section	
Desired Finish Top Shoulder Rounding to Shoulder Rounding	9 m
Minimum Finish Top Shoulder Rounding to Shoulder Rounding	7 m
Lane Cross Fall	3%
Superelevation	6%
Side Slopes - All Sections	3:1
Embankment Height	
Dry (ice poor) Till and Outwash Deposits	1.4 m
Wet (ice medium to ice rich) Till and Outwash Deposits	1.4 m to 1.6 m
Wet Silts and Clays (ice rich)	1.6 m to 1.8 m
Thick Organic Peatlands and Ice Rich Permafrost	1.8 m
Thickness of Surfacing Gravel	200 mm



TYPICAL HIGHWAY CROSS SECTION

TERRAIN TYPE	DESCRIPTION	EMBANKMENT HEIGHTS
1	DRY (ICE POOR) TILL AND OUTWASH DEPOSITS	1.4 m
2	WET (ICE-MEDIUM TO ICE-RICH) TILL AND OUTWASH DEPOSITS	1.4 to 1.6 m
3	WET SILTS AND CLAYS (ICE-RICH)	1.6 to 1.8 m
4	THICK ORGANIC PEATLANDS AND ICE-RICH PERMAFROST	1.8 m

LEGEND

PROPOSED INUVIK - TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

TYPICAL HIGHWAY CROSS SECTION

PROJECTION

DATUM

Scale 1:150

1 0 1 3m

FILE NO.
V23201322 TYPICAL SECTIONS.dwg

PROJECT NO.	DWN	CKD	REV
V23201322	SM	RM	0

OFFICE
EBA-VANC

DATE
March 16, 2011

Figure 2.6.5-1

Q:\Vancouver\Drafting\Environmental\V232\V23201098\Conceptual Design\Typical Sections\Environmental Impact Statement\V23201322 TYPICAL SECTIONS.dwg [FIGURE 2.6.5-1] March 31, 2011 - 9:10am adeepwell

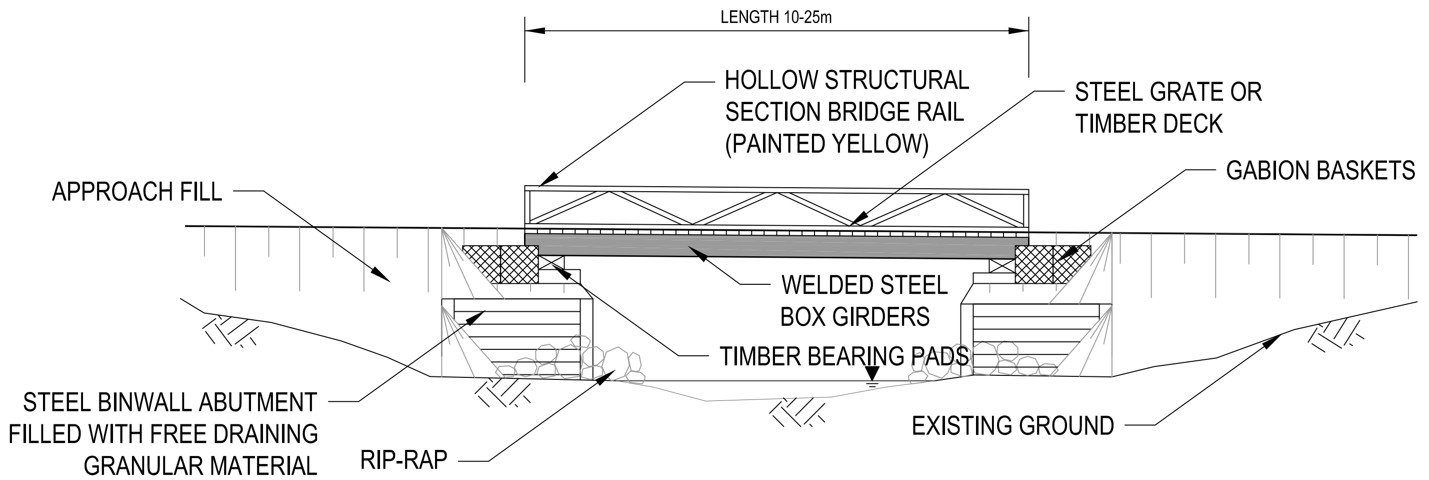
2.6.6 Stream Crossing Design Considerations

The drainage paths crossed by the Primary 2009 Route are typically minor, diffuse and/or ephemeral (seasonally dry). Defined but still minor stream crossings that do not comprise fish habitat will be accommodated using appropriately sized culverts. The major fish-bearing streams will be crossed using, simple prefabricated bridges.

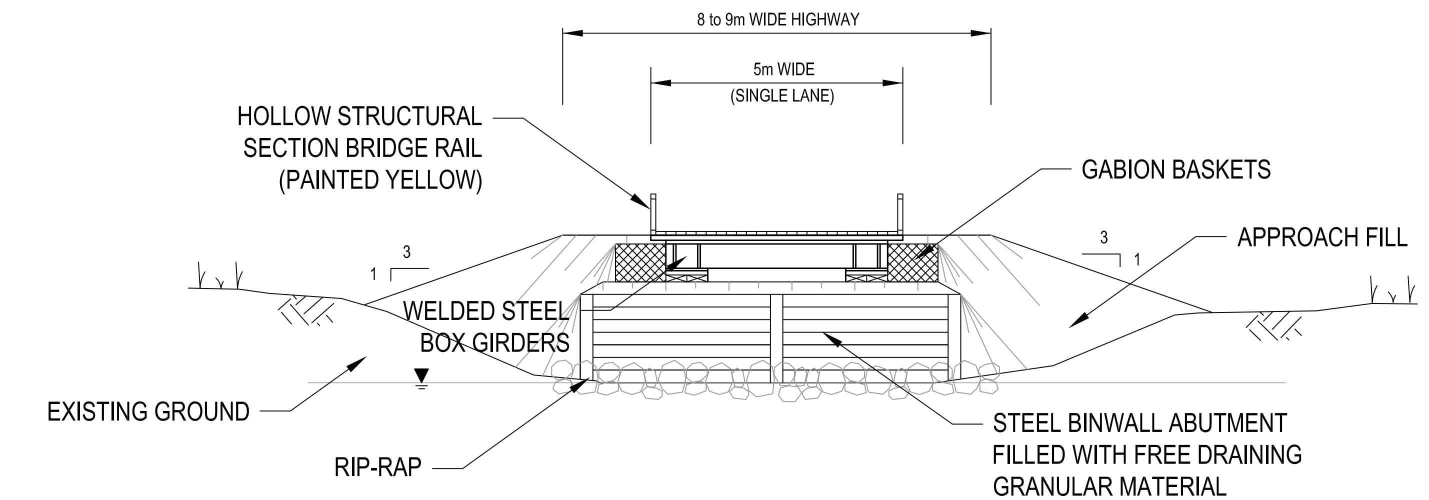
The concept for culvert installation is similar to that currently used on the Tuktoyaktuk to Source 177 Access Road. Culverts of appropriate size (typically 800 mm -900 mm) are laid in place with limited disturbance to the existing ground, at locations where drainage paths have been identified in the detailed design. Fill material is then placed around and over the culverts. In some cases, multiple smaller diameter culverts may be used instead of single large diameter culverts to avoid having to cut into the existing ground to maintain the vertical grade or creating a crest curve in the roadway where the embankment is constructed over the culvert. In addition, based on experience gained with construction of the Tuktoyaktuk to Source 177 access road, certain culverts (to protect fish habitat) may be installed during the summer season. Appropriate culvert sizing and location will be confirmed in the detailed design stages of the work.

The concept for the bridges, ranging from 10 to 25 m in length, is illustrated in Figure 2.6.6-1 and Photo 2.6.6-1.

Photo 2.6.6-1
Single span, prefabricated bridge on gravel filled binwall abutments



BRIDGE ELEVATION



ABUTMENT ELEVATION

LEGEND

PROPOSED INUVIK - TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

GENERAL ARRANGEMENT
PRE-FABRICATED STEEL BOX GIRDER BRIDGE

PROJECTION	DATUM

Scale: NTS

FILE NO.
V23201322 TYPICAL SECTIONS.dwg

PROJECT NO.	DWN	CKD	REV
V23201322	SM	RM	0

OFFICE	DATE
EBA-VANC	March 16, 2011

Figure 2.6.6-1

Q:\Vancouver\Drafting\Environmental\V232\V23201098\Conceptual Design\Typical Sections\Environmental Impact Statement\V23201322 TYPICAL SECTIONS.dwg [FIGURE 2.6.6-1] March 16, 2011 - 10:15am adeepwell

Such bridges are used extensively throughout the Northwest Territories and Nunavut for both permanent and temporary installation. Each single lane bridge is approximately 5-6 m wide, made of prefabricated welded steel box girder with timber or steel grade deck. The prefabricated bridges will be:

- Placed on timber bearing pads on gravel filled corrugated steel binwall abutments (with addition of piling to supplement the foundation if required by the soil conditions);
- Shipped by road to Inuvik or by barge to Inuvik or Tuktoyaktuk then transported by truck or even dragged (on skids) to site; and
- Installed using typical construction equipment and local labour.

The bridges will be designed to span stream widths, but for some crossings may encroach on the floodplain (to minimize length) with approach fill construction.

Section 4.2.5 of this Environmental Impact Statement discusses the fish and fish habitat issues that have and will continue to be considered to ensure that the appropriate stream crossing structures are selected for each of the streams to be crossed by the Highway. Section 4.2.4 discusses potential erosion and sediment effects and the proposed mitigation measures.

To minimize risk of travel over single lane bridges, site selection and approach grades will be managed to assure appropriate site distance requirements.

2.6.7 Drainage and Thermal Erosion Considerations

Design parameters for the Highway were developed based on the operational needs of the Highway and the need to protect the permafrost layer below the Highway surface. In southern areas of the Northwest Territories it is common for road designs to incorporate both ‘cuts and fills’ to level terrain along the road alignment. However, in permafrost areas, cutting into the surface vegetation can disturb the permafrost regime, resulting in thaw and unstable ground. Therefore, the design includes only fills with heights based on terrain type. This will be sufficient to protect the permafrost layer below the Highway surface.

As stated previously, the embankment design also mitigates several potential effects related to permafrost, terrain and drainage. A minimum embankment (or fill) height of 1.4 m will be required to construct the Highway using ice-poor granular materials. Granular materials which are low in fine particles, less than 0.02 mm, will be used to reduce the potential for frost heave or seasonal thaw settlement.

The Highway will be constructed with sufficient cross drainage to prevent or minimize potential water ponding. Ponding conditions, if unmitigated, could lead to permafrost thaw which could cause ground disturbance, changes to existing drainage conditions and slope instability.

2.6.8 Borrow Sources

2.6.8.1 General Information on Borrow Sources in the Area

The early work in the investigation and evaluation of granular material resources in the Mackenzie Delta Region was carried out by Roger Brown and Hank Johnston of the National Research Council (NRC) during the planning, development and construction of the new town of Inuvik and its related infrastructure in the 1950s (Fujino 1993). The following description draws heavily upon the work reported by Fujino (1993).

Beginning in the 1960s, generic sources of granular materials were identified in the Mackenzie Delta Region as part of the surficial geology and terrain mapping activities by the Geological Survey of Canada (GSC). This mapping work served as a foundation for future studies and investigations for granular materials conducted by industry and government agencies. The most recent surficial geology mapping of the Project study area, and the one used to perform this work, was prepared by Rampton (1987).

In the 1970s and early 1980s, numerous, extensive granular material investigations were undertaken by private industry resource development groups and government agencies, primarily under the direction of the Department of Indian and Northern Affairs. Many industry groups had significant interests in the development of energy resources in the Mackenzie Delta Region with parallel demands for granular materials.

Granular material investigations carried out by Ripley Klohn Leonoff International Ltd. (RKL) in 1972-73 for Indian and Northern Affairs Canada (INAC) has served as a comprehensive data base for more recent granular material investigations by numerous groups (RKL 1972a, 1972b). Subsequent investigations by EBA Engineering Consultants Ltd. (EBA) (1976, 1983a, 1983b), Hardy Associates (1978) Ltd.(1979, 1980), Terrain Analysis and Mapping Services Ltd. (1975), Northern Engineering Services Company Ltd.(1974, 1977), Public Works Canada (1975, 1976, 1977, 1981a, 1981b, 1982a, 1982b), and Hardy BBT (1986, 1987a, 1987b, 1988a, 1988b, 1988c, 1989a,1989b, 1990a, 1990b, 1990c) have provided further ground-truthing and confirmation of selected granular material sources and quarry sites in the Mackenzie Delta Region.

During the 1980s and early 1990s, the focus of the various studies and investigations of granular materials was directed to issues dealing with Aboriginal land claims. In this regard, the work in the Mackenzie Delta Region was primarily directed to the *Inuvialuit Final Agreement* (IFA) (IRC 1987). The granular materials inventory work completed by EBA (1987a, 1987b) in 1987 for INAC formed part of the IFA. The comprehensive granular materials inventory was assembled for resources within the Inuvialuit Settlement Region (ISR) using the available information collected over the years.

Under the *IFA*, signed between the Government of Canada and the Inuvialuit in 1984, ownership of most of the accessible granular deposits in the Western Arctic Region was transferred to the Inuvialuit (IRC 1987). Management of this resource is now the responsibility of the ILA in consultation with local groups such as the Community Corporations and Hunters and Trappers Committees. Several studies of granular resources in the Inuvialuit Settlement Region have been conducted over the years to refine the database/inventory of the resource.

The comprehensive inventory of granular materials for the Inuvialuit Settlement Region (ISR) was provided to the Developer by the ILA. The inventory includes granular resources in the settlement region including areas outside of the Project area and the Mackenzie Delta Region. The material sources within proximity to the Project area are summarized in figures and tables herein and form the basis of the borrow areas identified for construction of the proposed Highway.

2.6.8.2 Available Information on Borrow Sources in the Area

Figure 2.6.8-1 shows all known borrow sources in the general area between Inuvik and Tuktoyaktuk based on information from the ILA, INAC, Geological Survey of Canada, and Public Works Canada.

The borrow sources shown on Figure 2.6.8-1 along the Primary 2009 Route could be selected as potential borrow areas for constructing the Highway along the current preferred alignment. These borrow sources were previously assessed by PWC (1981a; 1981b) and were deemed to be suitable and available. The materials identified for embankment construction were judged to be of generally fair to poor quality. Most of the materials contain high ice content that might be above the liquid limit of the soil, and could require select harvesting to obtain the best available material for use in construction. Thirty years later, these sources have not been further investigated. Except for a few sources in close proximity to Husky Lakes (which are not available for use), the borrow sources identified by PWC are assumed to still be acceptable.

The 2009 field program did not include further examination of the proposed borrow source areas that PWC had identified, but fly-overs were completed to confirm that the areas appeared to be viable borrow sources.

Table 2.6.8-1 summarizes available information on borrow sources along the Primary 2009 Route. Materials at prospective borrow sources have been graded into one of the five following classes:

- Class 1 – Excellent quality material consisting of clean, well-graded, structurally-sound sands and gravels suitable for use as high quality surfacing materials.
- Class 2 – Good quality material generally consisting of well-graded sands and gravels with limited quantities of silt. This material will provide good quality base and surface course aggregates or structure-supporting fill.
- Class 3 – Fair quality material consisting generally of poorly-graded sands and gravels with or without substantial silt content. This material will provide fair quality general fill for roads, foundation pads or laydown yards.

- Class 4 – Poor quality material generally consisting of silty, poorly-graded, fie-grained sand with minor gravel. These deposits may also contain weak particles and deleterious materials. These materials are considered suitable for marginal general (non-structural) fill.
- Class 5 – Bedrock of fair to good quality, felsenmeer or talus. Potentially excellent sources of construction material, ranging from general fill to concrete aggregate or building stone if quarried and processed. Also includes erosion control materials such as rip-rap or amour stone.

The calculated volumes of the various types of granular materials available at the examined sources have been divided into proven, probably and prospective certainty levels, as described below.

A 'proven' volume is one whose occurrence, distribution, thickness and quality is supported by ground truth information such as geotechnical drilling, test pitting and/or exposed stratigraphic sections. Usually the thickness of material encountered in a borehole is extrapolated to a radius not exceeding 50 m around the hole.

A 'probable' volume is one whose existence and extent is inferred on the basis of direct and indirect evidence, including topography, landform characteristics, airphoto interpretation, extrapolation of stratigraphy, geophysical data and/or limited sampling.

A 'prospective' volume is one whose existence is suspected on the basis of limited direct evidence, such as airphoto interpretation and/or general geological considerations.

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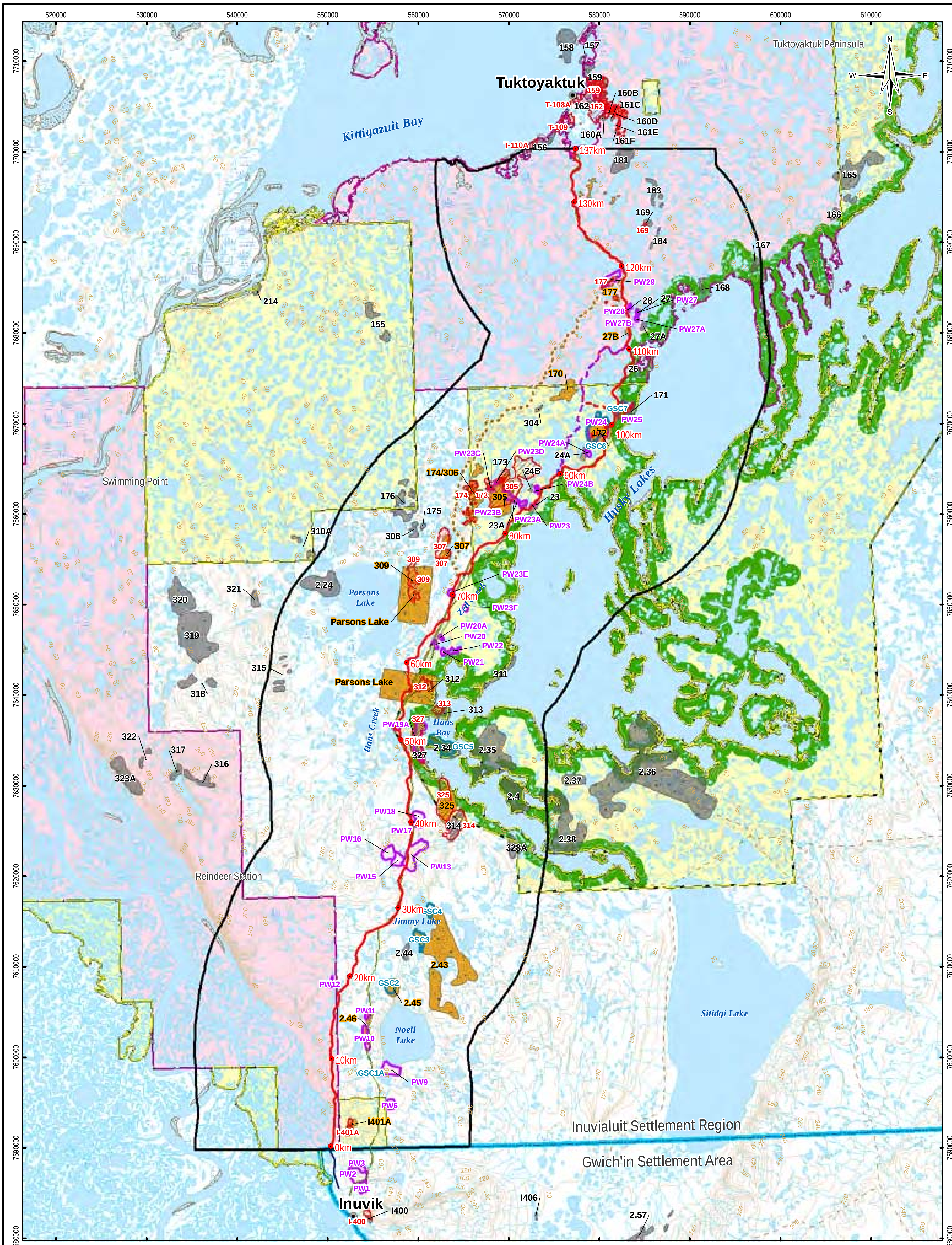

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- INAC Borrow Sources
- Geological Survey Borrow Sources
- Public Works Borrow Sources
- Potential Highway Borrow Sources
- Borrow Sources
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources: ILA, Public Works, GSC, INAC

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Available and Potential Borrow Sources Along the Proposed Route

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
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PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 2.6.8-1

TABLE 2.6.8-1: INFORMATION ON BORROW SOURCES ALONG THE PRIMARY 2009 ROUTE

Source Name	Land Owner	Location	Geo-morphologic Setting	Landform	Approx. Area (km²)	Recoverable Volume (m³)[1]	Quality/ Volume[2] (Proven)	Quality/ Volume[2] (Probable)	Quality/ Volume[2] (Prospective)
2.43	Crown	28 km NE of Inuvik	Unknown	Outwash plain	12	180,000,000	Class 3 – 900,000 Class 4 – 900,000	Class 3 – 9,000,000 Class 4 – 9,000,000	Class 3 – 90,000,000 Class 4 – 90,000,000
2.44	Crown	30 km NE of Inuvik	Unknown	Glaciofluvial outwash	0.17	0	Class 3 – 25,000	Class 3 – 250,000	Class 3 – 1,000,000
2.45	Crown	25 km NE of Inuvik	Unknown	Glaciofluvial outwash	2	0	Class 2 – 800,000	Class 2 – 8,000,000	Class 2 – 25,000,000
2.46	Crown	20 km NE if Inuvik	Unknown	Kames/ crevasse filling	0.0125	0	Class 3 – 5,000 Class 4 – 5,000	Class 3 – 10,000 Class 4 – 10,000	Class 3 – 12,500 Class 4 – 12,500
I401A	Crown	10 km N of Inuvik	Hillblocks bisected by streams	Kame field	1.1	1,020,000	Class 4 – 20,000	Class 4 – 250,000	Class 4 – 750,000
170	Inuvialuit	32 km S of Tuktoyaktuk	Hummocky, thermokarst	Glaciofluvial outwash plain	2	4,580,000	NA	Class 3 – 4,560,000	NA
171	Inuvialuit	35 km S of Tuktoyaktuk	Hummocky, near Husky Lake	Glaciofluvial outwash/ kames	2	1,520,000	NA	Class 2 – 1,520,000	NA
172	Inuvialuit	37 km S of Tuktoyaktuk	Hummocky, near Husky Lake	Glaciofluvial outwash/ kames	2	918,000	NA	Class 4 – 912,000	NA
173	Inuvialuit	45 km S of Tuktoyaktuk	Hummocky plain	Kame complex	2	688,000	NA	Class 1 – 684,000	NA
174	Inuvialuit	48 km S of Tuktoyaktuk	Hummocky, rough terrain	Kame complex/ outwash	2	3,280,000	NA	Class 2 – 3,268,000	NA
175	Inuvialuit	50 km SW of Tuktoyaktuk	Hummocky, rolling terrain	Glaciofluvial outwash	1	1,530,000	NA	Class 2-3 – 1,500,000[3]	NA
176	Inuvialuit	50 km SW of Tuktoyaktuk	Thermokarst plain	Glaciofluvial outwash plain	2	6,100,000	NA	Class 1 – 1,525,000	Class 1 – 3,050,000
177	Inuvialuit	22 km S of	Hummocky	Glaciofluvial	1	1,902,000	NA	Class 2 – 19,000,000	NA

TABLE 2.6.8-1: INFORMATION ON BORROW SOURCES ALONG THE PRIMARY 2009 ROUTE									
Source Name	**Land Owner**	**Location**	**Geo-morphologic Setting**	**Landform**	**Approx. Area (km²)**	**Recoverable Volume (m³)[1]**	**Quality/ Volume[2] (Proven)**	**Quality/ Volume[2] (Probable)**	**Quality/ Volume[2] (Prospective)**
		Tuktoyaktuk	thermokarst plain	outwash					
23	Inuvialuit	42 km S of Tuktoyaktuk	Hummocky plain	Kames, outwash plain	0.115	350,000	NA	350,000[4]	350,000[4]
23A	Inuvialuit	42 km S of Tuktoyaktuk	Hummocky plain	Kame field	1.2	1,900,000	NA	1,900,000[4]	1,900,000[4]
24A	Inuvialuit	37 km S of Tuktoyaktuk	Hummocky plain	Kames, outwash plain	0.72	150,000	NA	Class 2 – 134,000	NA
27	Inuvialuit	42 km S of Tuktoyaktuk	Flat plain, polygonal	Glaciofluvial outwash	0.225	40,000	NA	Class 2 – 34,000	NA
27A	Inuvialuit	24 km S of Tuktoyaktuk	Flat plain, polygonal	Glaciofluvial outwash	0.18	190,000	NA	Class 2 – 191,000	NA
27B	Inuvialuit	24 km S of Tuktoyaktuk	Flat plain, polygonal	Glaciofluvial outwash	0.23	40,000	NA	Class 2 – 38,000	NA
304	Crown	35 km S of Tuktoyaktuk	Thermokarst plain	Esker remnants	0.018	46,000	NA	Class 3 – 45,600	Class 3 – 45,600
305	Inuvialuit	42 km S of Tuktoyaktuk	Hummocky with many ponds	Kames on outwash plain	20	230,000	NA	Class 2 – 228,000	Class 2 – 228,000
306	Inuvialuit	42 km S of Tuktoyaktuk	Thermokarst plain	Kame field	11.5	115,000	NA	NA	NA
307	Crown	55 km S of Tuktoyaktuk	Hillocks, small ponds	Kame field	5	115,000	Class 3 – 30,000	Class 3 – 300,000	Class 3 – 650,000
308	Crown	50 km S of Tuktoyaktuk	Outwash plain	Terrace remnants and kames	0.55	15,000	Class 3 – 5,000	Class 3 – 300,000	Class 3 – 1,500,000
309	Crown	56 km S of Tuktoyaktuk	Ponds, low lying	Kame field	7.5	1,500,000	Class 2 – 350,000	Class 2 – 1,000,000	Class 2 – 4,000,000
314	Inuvialuit	79 km S of Tuktoyaktuk	Terrace adjacent to stream	Post-glacial fluvial terraces	1.1	2,300,000	Class 3 – 30,000	Class 3 – 3,000,000	Class 3 – 30,000,000

TABLE 2.6.8-1: INFORMATION ON BORROW SOURCES ALONG THE PRIMARY 2009 ROUTE

Source Name	Land Owner	Location	Geo-morphologic Setting	Landform	Approx. Area (km²)	Recoverable Volume (m³)[1]	Quality/ Volume[2] (Proven)	Quality/ Volume[2] (Probable)	Quality/ Volume[2] (Prospective)
325	Inuvialuit	76 km S of Tuktoyaktuk	Lake shore deposit	Glaciofluvial terrace	7.5	750,000	Class 3 – 600,000	Class 3 – 6,000,000	Class 3 – 25,000,000
Parsons Lake 1	Inuvialuit	60 km S of Tuktoyaktuk	Riverbanks	River terrace	0.25	1,000,000	NA	NA	NA
Parsons Lake 10	Inuvialuit	60 km S of Tuktoyaktuk	Low lying plain	Kame/outwash plain	0.02	135,000	NA	NA	NA
Parsons Lake 2	Inuvialuit	60 km S of Tuktoyaktuk	Low terrace	River terrace	0.1	230,000	NA	NA	NA
Parsons Lake 3	Inuvialuit	60 km S of Tuktoyaktuk	Low lying terrace	River terrace	0.2	400,000	NA	NA	NA
Parsons Lake 4	Inuvialuit	60 km S of Tuktoyaktuk	Flat lying terrace	River terrace	0.05	150,000	NA	NA	NA
Parsons Lake 5	Inuvialuit	60 km from Tuktoyaktuk	Lake shoreline	Small kame	0.0225	30,000	NA	NA	NA
Parsons Lake 6	Inuvialuit	60 km S of Tuktoyaktuk	Lake shoreline	Small kame	0.03	7,500	NA	NA	NA
Parsons Lake 7	Inuvialuit	60 km S of Tuktoyaktuk	Flat lying terrace	River terrace	0.28	20,000	NA	NA	NA
Parsons Lake 8	Inuvialuit	60 km S of Tuktoyaktuk	Flat-lying terrace	River terrace	0.7	75,000	NA	NA	NA
Parsons Lake 9	Inuvialuit	60 km S of Tuktoyaktuk	High river terrace	River terrace	0.045	38,000	NA	NA	NA

Notes:
1 – ILA Inventory
2 – Hardy BBT Ltd. 1991; EBA 1987
3 – Not stated if proven, probable or prospective.
4 – No quality rating provided.

2.6.8.3 Borrow Material Requirements

These preliminary material volume estimates are based on preliminary horizontal and vertical geometric designs using the embankment cross section presented in Figure 2.6.5-1.

Figure 2.6.8-1 shows all known potential borrow sources in the general area between Inuvik and Tuktoyaktuk. Many sources that are not near the preferred alignment will not be considered for use in the construction as they are inefficient to haul from due to the distance that they are away from the alignment. Borrow sources proposed for construction of the Highway are highlighted in Figure 2.6.8-2 and estimated quantities from each source based on the conceptual design are presented in Table 2.6.8-2. It is important to note that all borrow source development would respect the 1 km Husky Lakes setback.

TABLE 2.6.8-2: ESTIMATED QUANTITIES FROM POTENTIAL BORROW SOURCES

Highway Segment	Potential Borrow Source	Estimated Borrow Quantity[1]	Land Owner	Quality
KM 0 - KM 5	I401A	198,000	Crown	Class 4
KM 5 - KM 10	2.46	198,000	Crown	Class 3, 4
KM 10 – KM 21	2.45	351,000	Crown	Class 2
KM 21 - KM 34	2.43	351,000	Crown	Class 3, 4
KM 34 - KM 45	325 (outside of Husky Lakes setback)	329,000	Crown	Class 3
KM 45 - KM 56	Parsons Lake – (west of alignment only)	445,000	Crown	NA
KM 56 - KM 69	309	671,000	Crown	Class 2
KM 69 - KM 83	307	516,000	Crown	Class 3
KM 83 - KM 100	173/305, 174/306	563,000	Inuvialuit	Class 1, 2
KM 100 - KM 112	172, 170	363,000	Inuvialuit	Class 3, 4
KM 112 - KM 118	27B	244,000	Inuvialuit	Class 2
KM 118 – KM 137 (Tuktoyaktuk)	177	510,000	Inuvialuit	Class 2

Note: 1 – rounded to nearest 1,000 m^3

Sources of competent borrow materials that can be used at in-situ ice contents are limited along the alignments and as a whole throughout the Project area.

The Project area has been extensively studied over the years and the likelihood of locating additional sources of quality granular material near the alignment is considered to be limited. Efforts will be undertaken in the future in a phased annual manner to collect additional information, qualitative and quantitative, from the known borrow areas to confirm material volumes, quality and ground ice conditions to confirm that the material can be used as planned.

The estimated construction costs presented earlier, in this section of the EIS, do not include royalties or administrative fees paid on materials extracted from borrow sources on Inuvialuit owned lands.

Ongoing negotiations regarding the use of borrow sources on Inuvialuit owned lands will include discussion of royalties and administrative fees.

2.6.8.4 Further Investigation of Borrow Sources

Borrow sources are required to provide materials needed to construct the proposed Highway. The sources would likely be developed during the fall and winter months when the ground is frozen. Temporary winter access roads and work pads would be used. Drill and blast methods may be used to excavate the required volumes of material for construction from frozen borrow sources.

Potential borrow sources have been identified along the Primary 2009 Route, Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) based on the granular material studies and investigations that have been undertaken over the years by industry and government agencies discussed in the previous Section.

The resources near the communities of Inuvik and Tuktoyaktuk have been ground-truthed and proven to a spatial extent. Many of the resources along the Primary 2009 Route are not proven and are described as probable or prospective (i.e., material resources whose existence and extent have been inferred or speculated). The use of these materials and access to them will need to be proved up through additional site investigation (Figure 2.6.8-2).

2.6.8.5 Site Evaluation Criteria

Criteria used to identify borrow sources included the following:

- Proximity to the proposed alignment;
- Quantity, quality and availability of borrow materials required;
- Geographic distribution of sites;
- Geographic location of sites outside the 1 km Husky Lakes setback;
- Environmental considerations;
- Supply needs along route; and
- Potential to expand and supply Project needs.

Prior to opening a borrow pit, the sites will be surveyed and investigated to ensure the expected quantity and quality of material is available. Borrow pits will be developed, operated and decommissioned in full compliance with all regulatory requirements.

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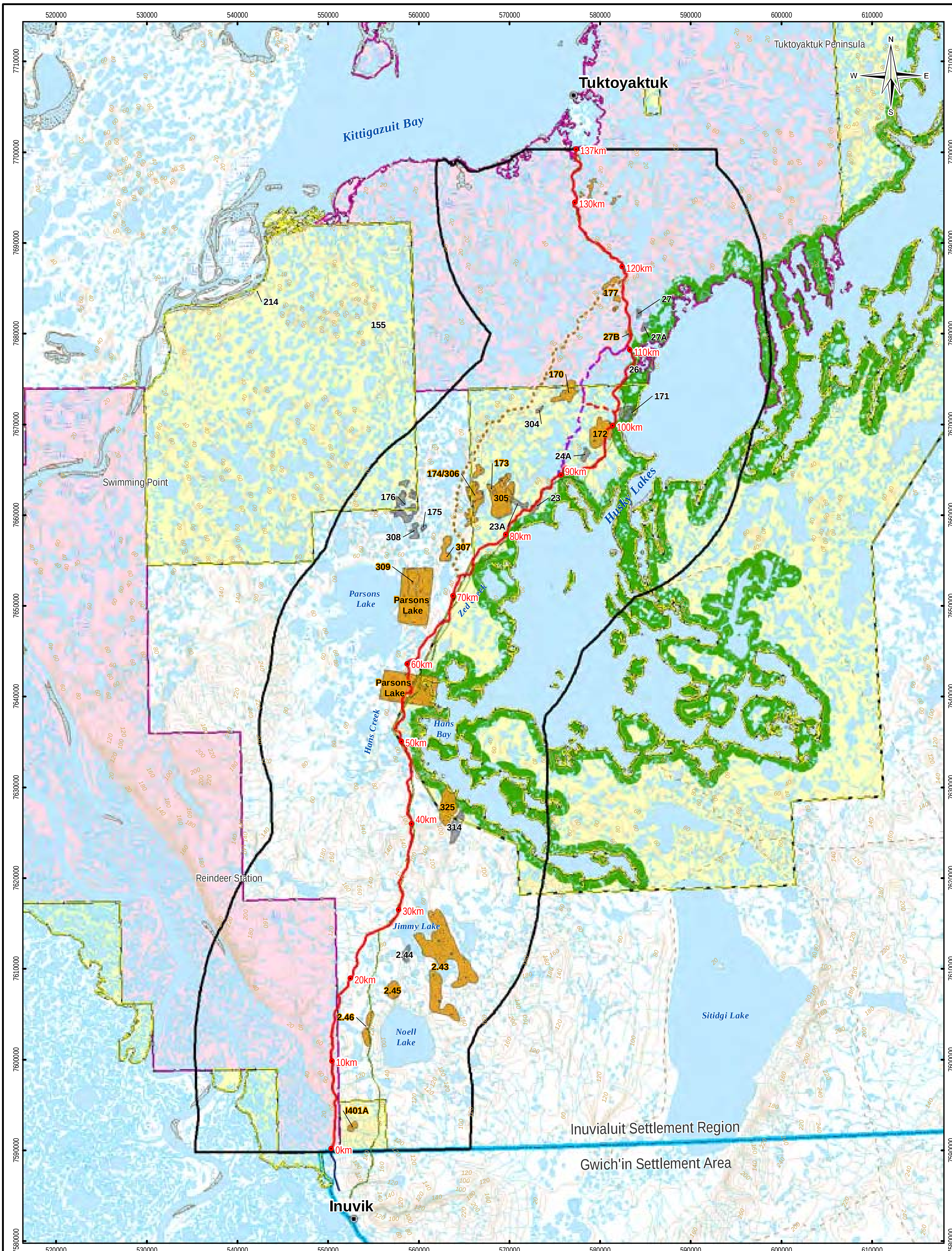

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Borrow Sources
- Potential Highway Borrow Sources - (further investigation and potential use in construction)
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Potential Borrow Sources Requiring Further Investigation For Potential Use

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
Kilometres

FILE NO.			
V23201322_EIS_Map020_Dev_GranInvest.mxd			
PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0
OFFICE	DATE		
EBA-VANC	May 19, 2011		

Figure 2.6.8-2

2.6.8.6 Pit Development Plans

Pit development plans, also known as pit management plans, will conform to the approving authority's regulations and permitting requirements. For borrow sources on Inuvialuit-owned land, the pit development plan will conform to the ILA's *Granular Management Plan* and requirements for a Quarry Permit. For borrow sources on Crown-lands, the pit development plan will conform to INAC's (2010d) *Northern Land Use Guidelines Access: Pits and Quarries,* TAC's (2010) guide for *Development and Management of Transportation Infrastructure in Permafrost Regions,* and the pit/quarry development plan requirements.

A typical pit development plan includes the following topics (INAC 2010d):

1. 1:5000 scale site map.
2. Description of proposed mitigation measures to address all identified environmental concerns.
3. Site Conditions:
    - Full delineation of granular material resource;
    - Contours, elevations and drainage features;
    - Environmentally sensitive areas (e.g. streams, wildlife habitat);
    - Extent of permafrost and ground ice;
    - Adjacent land uses.
4. Site Design and Development:
    - Adequate room for all activities;
    - Topsoil, overburden and granular pile locations;
    - Proposed site development techniques (e.g. clearing trees, windrowing brush);
    - Proposed or existing access routes;
    - Proposed or existing infrastructure (e.g. camps, refuelling areas);
    - Design for water management and erosion control; and
    - Design for progressive reclamation.
5. Operations:
    - Resource extraction and processing techniques;
    - Single-season or multi-year operation;
    - Spill contingency plan;
    - Monitoring and maintenance plans; and
    - Contingencies if changes to the original development scenario are required.

6. Reclamation:
   - Closure objectives;
   - Removal of all garbage, debris, equipment and buildings;
   - Overburden replacement for site contouring;
   - Re-establishment of natural drainage;
   - Replacement of all salvaged topsoil;
   - Revegetation activities; and
   - Reclamation of access roads.

Proposed borrow sources will typically be developed during the fall and winter months when the ground is frozen. Winter pit development will employ drilling and blasting, if required. The decision to use these methods will depend on the quality and moisture content of the granular material in the source and the quantity of material needed from the source. Drilling patterns and powder factors will be adjusted as required to optimize the size of blasted material being produced.

Borrow pits will be closed as soon as they are no longer required and reclaimed in a progressive manner by the GNWT DOT's contractors as soon as possible. Areas required for the maintenance of the Highway during operation will remain open while in use, and will be reclaimed after they are no longer required. The disturbed areas will be contoured, at closure. Borrow pits will be designed to prevent entrapment of wildlife at closure.

2.6.8.7 Winter Access Roads

Temporary winter access roads will be constructed to access borrow sources since most of the earth moving construction activities will take place during the winter months when the frozen ground is more accessible. The winter access roads will be constructed in accordance with the GNWT DOT *Field Guide to Ice Construction Safety* (2007).

Winter access roads are designed to provide an effective road access while minimizing environmental disturbance to the ground surface. First the access route is dragged with a low-ground-pressure rubber tracked machine such as a snow cat. After dragging, an initial flood of the surface with water is undertaken using a low pressure rubber tired vehicle such as a Delta 3 with a mounted water tank. After the surface is made passable, water trucks are used to flood the access. Snow is moved into depressions as required with either a loader or with small dump trucks. The snow and water is mixed together. Several layers of the snow/water mixture are applied to the surface. The surface is continually dragged with either a loader or low ground pressure tracked machine. Through the application of successive layers of snow and ice the winter road is constructed.

2.6.9 Construction Camps

This Project proposes a number of 15-20-person construction camps in the first year, although in the second year, at least one camp of greater than 50 persons may be added. Typical temporary camp facilities will include:

- Dining trailer;
- Accommodation trailers for personnel;
- Toilet and bathing facilities;
- Waste storage facility; and
- Fuel storage facility.

Construction camps will be typically located at the borrow site(s) being used in each year of construction, near the Highway construction area, to minimize the Project footprint. Once a new borrow source is approved and in use, it is anticipated that the construction camp will move to that borrow source, closer to the construction activities.

Camp facilities are trailers on sleighs, which will be towed to and from the camp location during the winter months. Temporary camps will be installed during each winter construction period and then decommissioned until the following winter construction season, for the duration of the four year construction period.

For the more limited construction activities taking place in the snow-free seasons, it is anticipated that workers will be transported to/from the work site daily, along the constructed Highway embankment.

2.6.9.1 Locations

Temporary camps and associated infrastructure will be constructed at the designated borrow site(s) to be used for each winter construction season. Construction maintenance areas, for the storage and maintenance of equipment and fuel, will be located within the camps. Detailed camp siting information will be submitted to the appropriate land management agency prior to each season of winter construction.

2.6.9.2 Domestic Water

Domestic water for the camps will be drawn from nearby lakes. The *Northwest Territories Waters Regulations* indicate that a Type B Water Licence would be required to authorize the anticipated camps. The specific locations of drinking water sources will be submitted annually prior to each season of winter construction. A minimal amount of potable water may be trucked from Inuvik and/or Tuktoyaktuk for the construction camps during the winter construction stages.

2.6.9.3 Domestic Waste

The main type of waste produced during construction of the Highway will be domestic waste from the camps. All waste products will be properly secured, stored and transported to either Inuvik or Tuktoyaktuk for disposal in approved facilities. This includes the use of bear-proof storage containers that reduce odours at all times. Waste removal crews will be sent out to areas surrounding each construction site before the arrival of breeding birds in the spring to collect and properly dispose of any waste material that have blown off site. Further information regarding waste management is located in Sections 4.2.7 and 4.4.3.

2.6.9.4 Wastewater

Standard sanitation collection and disposal methods will be employed at the construction camps. Acceptable practice for sanitary collection treatment will include the use of stationary/ portable sewage collection systems. Sewage will be hauled on a regular basis to either the Inuvik or Tuktoyaktuk sewage lagoons depending on the location of the camps (see Section 4.4.3).

2.6.9.5 Power Supply

Electricity will be generated using on-site diesel generators.

2.6.9.6 Safety

Camps and associated infrastructure will be designed to incorporate proper bear safety, including installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, and wildlife detection.

2.6.9.7 Decommissioning

The skid mounted temporary camps and associated infrastructure will be completely removed from the site during decommissioning.

2.6.9.8 Water Usage

The overall daily water usage for winter road construction is expected to range from 500 m^3/day to more than 1,000 m^3/day. Water use is anticipated to be 1,000 m^3 or more per day during peak phases of construction, particularly when establishing temporary winter access roads.

The *Northwest Territories Waters Regulations* indicate that the direct use of 300 m^3 or more per day for industrial undertakings requires a Type A Water Licence. In addition, the DFO (2005) *Protocol for Winter Water Withdrawal in the Northwest Territories* will be followed. This will include identification of suitable water withdrawal sources (lakes and streams), assessment of allowable withdrawal quantities per source, unique source identification, and water withdrawal volume tracking.

The detailed water requirement estimates and water source identification would be submitted during the detailed design phase for each of the four years of Project construction.

2.6.10 Construction Infrastructure

2.6.10.1 Construction and Equipment Staging Areas

There are likely to be four construction equipment spreads working in any given construction period, two from the north and two from the south, each with sufficient equipment and personnel to haul and place material at a rate of over 400,000 m3 per season. Equipment would initially be positioned in place at Source 177 and at the end of Navy Road once permitting is in place, and then re-positioned in advance of the next winter season construction phase. The specific locations of construction and equipment staging areas will be submitted following detailed design of this Project.

2.6.10.2 Construction Material Storage

Borrow material produced each winter will be stored at the borrow sites until used for Highway embankment construction purposes. Bridge and culvert components will be stored at contractor yards in Inuvik and Tuktoyaktuk prior to being transported to the construction sites for installation.

2.6.10.3 Excavation Equipment Storage Areas

Excavation and Highway construction equipment will generally be stored at the construction contractor's yards in Inuvik and Tuktoyaktuk during the summer period. Equipment needed to initiate early borrow development may be pre-positioned in the borrow sites to be used for the next season of construction, if necessary.

2.6.10.4 Fuel and Oil Storage

Fuel and oil needed for the aggregate borrow and Highway construction activities will be stored in double-walled storage tanks. All fuel and oil will be stored in accordance with CCME's (2003) *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities,* and to the extent applicable, and the *CEPA Storage Tank System for Petroleum Products and Allied Petroleum Products Regulations.*

2.6.10.5 Equipment Maintenance and Refueling Areas

Equipment maintenance and refuelling areas will be located a minimum of 100 m from waterbodies, following INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities*.

2.6.10.6 Resupply of Personnel, Material, Food and Equipment

Due to the end-dumping construction method and the use of a parallel winter road, access to the construction sites and temporary camps is available during the construction season.

Resupply of personnel, material, food and equipment is possible throughout the construction season by way of the parallel winter road and on completed portions of the

Highway. Effective logistics planning will be used to minimize vehicle movements, such as the use of vans or extended cab pick-up trucks to transport workers.

2.6.11 Operation and Maintenance

Once construction of the Highway is completed, it is anticipated that the Highway will continue to operate for the foreseeable future. The GNWT DOT, using local contractors to the extent possible, will be responsible for the ongoing operation, maintenance, and safety of the Highway.

The operations and maintenance phase would begin upon completion of the construction program. All maintenance activities will proceed in compliance with established road maintenance policies and programs, such as GNWT DOT's Highway Maintenance Manual (GNWT DOT 1993). The manual comprises standards for highway maintenance, and provides details regarding rationale, responsibility, scheduling, and methods for specific maintenance activities.

Maintenance activities typically involve regular inspection of the roadway and associated facilities. Particular attention will be given to maintenance of all cross drainage installations and watercourse crossings to ensure that drainage is not impeded and that the roadbed is not being eroded. In addition, the traffic surface will be inspected to ensure that it is retaining its grade and material surface and to correct any problems in a timely manner. During the winter, snow removal will be required.

Maintenance activities that are typically undertaken on gravel highways in the NWT are identified in Table 2.6.11-1. In addition, repair works, such as re-grading, re-surfacing and bridge or culvert repair or installation, is expected to be required over the life of the Project.

TABLE 2.6.11-1: TYPICAL HIGHWAY MAINTENANCE ACTIVITIES

Highway Component	Maintenance Activity
Highway Surface and Shoulders	Wet and dry blading Gravel surfacing and repairs Grade repairs Dust treatment
Drainage	Culvert cleaning and inspection Culvert repair and replacement
Bridges	Bridge inspection Bridge cleaning and maintenance
Roadside	Brush, debris and litter removal, as needed
Winter	Snow plowing Sanding
Traffic Services	Sign installation and maintenance Traffic counting
Service Functions	Highway patrols Equipment servicing and repair Material stockpiling

Operations and maintenance depots likely would be located in Tuktoyaktuk and Inuvik. These depots would serve as support centres for maintenance contractors and likely would include an office, maintenance building, and laydown area for materials.

During the operations phase of the Highway, water will be used for dust control, as needed, in accordance with the *Guideline for Dust Suppression* (GNWT 1998). The average daily water usage during the summer is anticipated to be in a similar range as during construction (500 m^3/day to 1,000 m^3/day). Procedures and mitigative measures for water usage and water extraction are described in later sections of this document.

2.7 DEVELOPMENT PHASES AND SCHEDULE

2.7.1 Production Rate, Construction Staging and Overall Schedule

The proposed construction timing and staging is based on the premise that construction will proceed from both the north (Source 177) and south (Inuvik) ends of the Highway concurrently. Embankment construction will include the installation of culverts and bridges. It is anticipated that the contractor could achieve approximately 20 km of construction per year at both the north and south ends of the Highway, for a total of 40 km per year.

Subject to completion of the EIRB review process, regulatory approvals and funding, the high level milestones by month and year are:

Spring 2012: Initiate upgrading of the Tuktoyaktuk to Source 177 Access Road to highway standards.

Summer 2012: Field studies and plans, including biophysical (e.g., rare plant, wildlife, and fish), archaeological, and engineering, will be conducted during the summer months, as needed, to prepare the permit applications for the upcoming year of construction activities.

Position equipment at Source 177 and an Inuvik source when permitting is in place and continue development of this active borrow source for initial construction requirements.

November/December 2012: Construct winter access and haul roads to borrow sources at both north and south ends of the Highway. Commence with development of borrow sources and stockpiling of material.

January to April 2013: Construct Highway, moving both northward from Inuvik area and southward from Source 177. Geotextile fabric is placed from toe to toe of the embankment and material is directly dumped and spread onto the geotextile. An initial lift of approximately 300 mm to 400 mm is placed, followed by smaller lifts, with the embankment being left some 150 to 200 mm higher than design to accommodate settlement.

Equipment at borrow sources will include drilling/sampling equipment for further geotechnical investigation, drilling/blasting/excavating equipment for working frozen material, loaders, dozers, water trucks and 15 to 24 person camps.

It is anticipated that there will be three to four borrow sources under development and being worked in any given construction period. There are likely to be four construction equipment spreads working in any given construction period, two from the north and two from the south, each with sufficient equipment and personnel to haul and place material at a rate of over 400,000 m^3 per season.

June to September 2013: Summer construction activities include grading and compaction of the embankment that was constructed during winter months, and installation of certain culverts (to protect fish habitat) or adjustments to previously installed culverts.

Field studies and plans, including biophysical (e.g., rare plant, wildlife, and fish), archaeological, and engineering, will be conducted during the summer (snow-free) months, as needed, to prepare the permit applications for the upcoming year of construction activities.

Fall 2013 to Fall 2015: Construction will continue in the same manner described above. Additional work will include placing the surfacing gravel on the embankment that was constructed, graded and compacted in the previous year.

Spring to Summer 2016: Placement of remaining surfacing gravel on embankment and upgrade of Tuktoyaktuk to Source 177 Access Road.

2.7.2 Schedule

The proposed Project review and approvals schedule and generalized construction schedule for the Highway is provided in Table 2.7.2-1. The Project schedule is cyclical, with field studies, detailed planning, and construction activities occurring on an annual basis over four years, until construction of the Highway is completed. Data required for annual permits, such as archaeology studies and pit management plans, will be conducted and/or prepared in advance of the annual permitting requirements and construction activities.

TABLE 2.7.2-1: PROPOSED SCHEDULE OF ACTIVITIES

Approximate Dates	Activities
Environmental Assessment	
May 2011	Submit Environmental Impact Statement
November 2011	EIRB Review Process
December 2011	EIRB Decision
Sept 2011 – Summer 2012	Apply for and obtain permits, licences and other approvals (i.e., scientific, archaeology, and regulatory, etc.)
Field Investigations and Highway Design	
Summer 2012 to Summer 2015	Conduct biophysical (e.g., rare plant, wildlife, and fish), archaeological, and engineering surveys and plans, as necessary, for permitting needed for the upcoming year of work
2012	Detailed Highway design

TABLE 2.7.2-1: PROPOSED SCHEDULE OF ACTIVITIES	
Approximate Dates	**Activities**
Upgrade Access Road	
Spring 2012	Initiate upgrading of Tuktoyaktuk to Source 177 Access Road to Highway Standards
Construction	
October 2012	Strip and develop initial borrow source(s) Pre-position equipment at next borrow source (e.g., pit located south of Source 177)
Nov - Dec 2012	Continue work at borrow sources, construct winter access and haul roads
Jan - April 2013	Transport, spread borrow material, construct Highway and install bridge(s) and culverts
June - Sept 2013	Complete installation of bridges and culverts. Compact and grade Year 1 embankment
Fall 2013 - Summer 2016	Repeat cycle of construction similar to Year 1

2.7.3 Anticipated Construction Equipment and Personnel

The equipment proposed for construction of the Highway will be similar to that used on the current Tuktoyaktuk to Source 177 Access Road construction, while the number of personnel required will likely double. There will likely be four (4) equipment spreads or operations. Each spread is expected to consist of the following equipment:

(2) D8T or D9N bulldozers with rippers

(2) D6R and/ or D6N bulldozers (drop D7G and D6D bulldozers)

(2) BR-180 or BR-400 snowcats

(2) EX-300 excavators

(2) 966 or 950 loaders

(8) to (12) tractor trucks with end-dump trailers

(2) 140 or 14 graders

(2) vibratory self-propelled packers

(4) water trucks with 3000 g tanks

(2) Delta 3 all-terrain vehicles with water tanks

(4) light stands

(2) to (4) 13,000 litre double walled fuel sloops

(10) to (14) dump trucks (either tandem trucks or articulated dump trucks)

(4) to (8) crew cab trucks

(1) to (2) service trucks

(1) crew bus

(2) to (4) snowmachines

As stated in the equipment estimate, the Highway will be constructed using four (4) spreads, two working at the Tuktoyaktuk end and the other working at the Inuvik end.

Table 2.7.3-1 identifies the personnel estimate per spread. A wide variety of positions will be available, including supervisors, environmental and wildlife monitors, scouts, clerks, engineers, and a variety of other positions.

TABLE 2.7.3-1: ESTIMATED PERSONNEL REQUIREMENT PER SPREAD

	Activity	Personnel
I.	Winter Road Construction	30 to 35
II.	Winter Gravel Haul	55 to 65
III.	Summer Grade and Compact	10 to 15
IV.	Fall/Early Winter Pit Development and Material Production	15 to 20

2.7.4 Labour Requirements

The number of workers required by occupation or skill will be determined during the detailed design phase of this Project. Typical types of work and skills involved in highway construction include: surveying, environmental and wildlife monitoring, environmental field studies, heavy duty equipment operators, truck drivers, heavy duty mechanics, and camp cooks. Consultants will be retained to complete the engineering design for the Project.

Depending on the occupation, work is likely to be seasonal full-time (i.e., heavy duty equipment operator) or on a per project basis (i.e., environmental field studies).

The education requirements will vary depending on the occupation. The GNWT DOT's hiring practices will meet the standards required for a safe work environment. Most of the work will be seasonal (during the winter period). Management staff will be more permanent as they will be involved in the planning and preparations associated with the anticipated four year construction process.

During the Tuktoyaktuk to Source 177 Access Road construction, approximately 70% of the workers were from local communities. It is estimated that a similar percentage may be achieved for the Inuvik to Tuktoyaktuk Highway. The Developer is committed to hiring local, regional, and NWT residents, where possible, to fill these positions.

For the construction of the Tuktoyaktuk to Source 177 Access Road, a number of training programs were implemented. For example, the contractor conducted a successful heavy equipment operator course. Likewise, the ILA sponsored an environmental monitor training program.

It is anticipated that funding for training programs will become available in association with this Project. Training local workers will be beneficial for the Project and for the region as it increases the overall skill and competence of the workforce. It is also anticipated that a number of the contractors and employees involved during the construction phase will also be involved during the operations and maintenance phase of the Highway.

2.7.5 Roles and Responsibilities

The Developers or Project Team for the proposed Inuvik to Tuktoyaktuk Highway are the Hamlet of Tuktoyaktuk, the Town of Inuvik and the GNWT Department of Transportation. The Hamlet of Tuktoyaktuk and Town of Inuvik provide political and administrative support for the Project, particularly during the permitting process. The GNWT DOT is responsible for the design and construction of the Highway, including field studies, data collection, and future funding, similar to other NWT highways. Typically, construction, operation and maintenance activities are contracted to local and regional businesses.

2.7.6 Cost

The overall capital cost for the construction of the Project, depending on the route option selected, is currently estimated to range between \$220 million (Primary 2009 Route) to \$260 million (Alternative 2 (Upland Route)).

The operations and maintenance costs will depend on the route selected. As previously discussed, Alternative 2 (Upland Route) is anticipated to have substantially higher operations and maintenance costs compared to the Primary 2009 Route.

Reclamation costs are considered to be minimal, and included in the construction costs. Reclamation will be conducted at the borrow sources, upon completion of the activities.

2.7.7 Recent Studies Completed and Additional Field Studies Required

Since the Project Description Report was completed in February 2010, additional field work was completed for fish and fish habitat. In particular, field work was completed in June 2010 and the studies were focused on the first 25 km north of Inuvik and the first 25 km south of Granular Source 177. The study resulted in a watercourse assessment with detailed analysis of fish presence, habitat features, water quality, and hydrology.

Additional field studies and detailed highway design will be conducted prior to construction of the Highway. These activities would be initiated pending the selection of a route alignment and approval of this Project.

Additional field studies, designs and plans include:

- Surveying;
- Engineering studies for the final route alignment selected;
- Pre-construction wildlife surveys;
- Complete biophysical surveys (e.g. rare plants, wildlife habitat);
- Fish and fish habitat studies for the final route alignment selected;
- Archaeology studies along the final route alignment;
- Borrow site investigation to confirm the quantity and quality of materials, and delineate the source;
- Pit development plans for borrow sources;
- Spill contingency plan;
- Erosion and sedimentation control plan;
- Waste management plan;
- Hazardous waste management plan; and
- Detailed environmental management plans.

2.8 LIFE OF THE PROJECT

The October 1999 GNWT Department of Transportation Highway Strategy described the completion of the Highway as a major policy objective of the GNWT. Building upon the Highway Strategy, the GNWT included the Inuvik to Tuktoyaktuk Highway as a prominent component of succeeding proposals to Canada for infrastructure development including "Investing in Roads For People and Economy" (2000), "Corridors For Canada" (May 2002) and "Connecting Canada – Coast to Coast to Coast" (2005). Recent interest from the federal government has reinvigorated the Project.

As well, the Beaufort-Delta region is a territorial and national asset of strategic importance. It provides the only potential NWT and Canadian deep-sea port location in the Western Arctic, and the development of oil and gas resources in Alaska may create additional and as yet unrealized opportunities, particularly if all-weather road access is available. The region is strategically located to assist shipping to/from Alaska, Asia, and the continental United States. It could receive goods from Asia for trans-shipment south to the rest of Canada (GNWT DOT 2010).

Arctic sovereignty concerns over the Northwest Passage could lead to the establishment and investment of an amplified Canadian presence. In the past few years the issue of protecting Canadian sovereignty in the Arctic has received prominent national attention. Construction of the Inuvik to Tuktoyaktuk Highway will establish a permanent transportation link to Canada's arctic coastline, which is a comparatively low-cost assertion of Canadian sovereignty in Canada's Arctic without significant on-going expenses and risks.

Furthermore, commercial and non-commercial shipping into and through the Northwest Passage is expected to increase. The Inuvik to Tuktoyaktuk Highway would allow easier and cheaper access for sovereignty and security related operations in the western Arctic Ocean, which could be based in Tuktoyaktuk and/or Inuvik. With experts predicting that Arctic channels could be open to unimpeded summer navigation by 2015, Canada's ability to exercise its sovereignty in the Western Arctic becomes more urgent (GNWT DOT 2010a).

The Highway is intended for permanent, long-term use. Highway users are anticipated to fall into one of the following categories: residents of Inuvik and Tuktoyaktuk; regional residents; tourists; and hauling companies.

The winter road currently experiences annual daily traffic of 139 vehicles (GNWT DOT 2009b). It is anticipated that with increased shipping of goods and increased tourism, that short-term use of the Highway will range between 150 to 200 vehicles per day. It is projected that without major development in the region, that this may increase slightly over time. However, if major development occurs in the region, such as the Mackenzie Gas Project, the amount of traffic may increase.

Assuming that the Mackenzie Gas Project proceeds, GNWT DOT, the Inuvialuit Regional Corporation, and other interested parties will need to work with the Mackenzie Gas proponents to ensure that increasing traffic usage of the Highway is effectively managed.

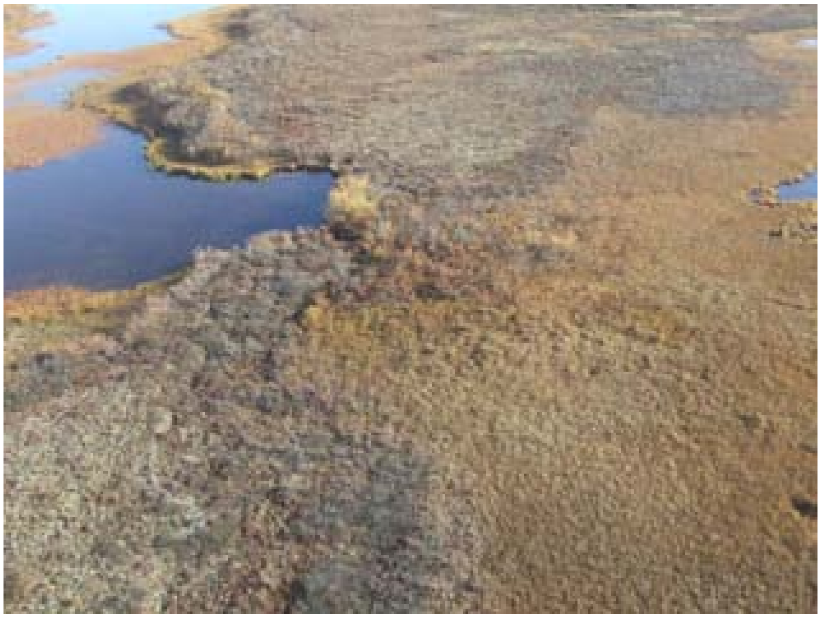

Photo 2.1.2-4
Looking south along Alternative 2 (Upland Route) at typical terrain.

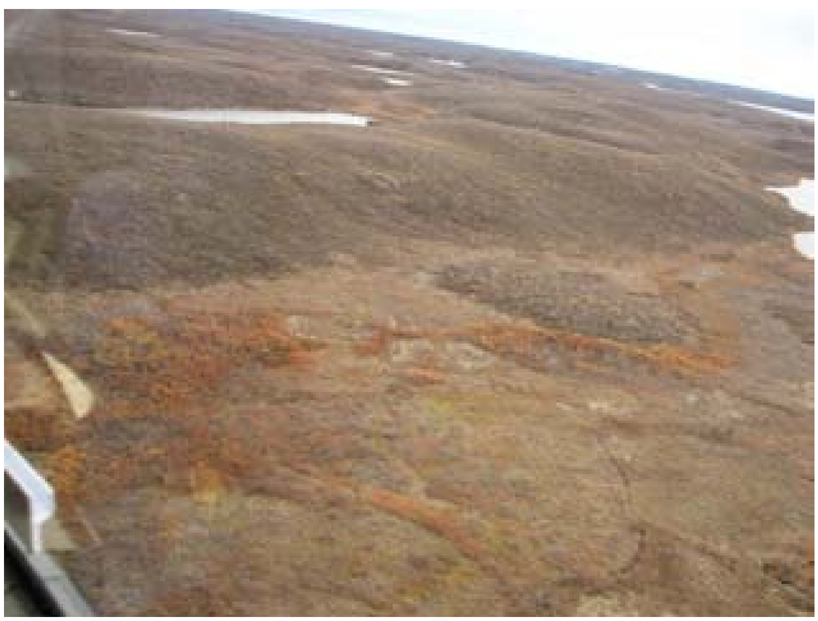

Photo 2.1.2-5
Looking south along Alternative 2 (Upland Route) at typical terrain

3.0 EXISTING ENVIRONMENT

The description of the biophysical and human environment focuses on the relevant issues identified by the EIRB, with guidance from the IFA and the Inuvik and Tuktoyaktuk CCPs. A description of the local setting is provided to allow the Review Board and others to clearly understand the rationale for assessment decisions. Baseline data represent current conditions, to the extent possible.

In general, data were gathered from publicly available sources. Efforts were made to present community level and regional data where possible. In the absence of such data, data are presented at the territorial or federal level. Both quantitative and qualitative data are presented.

3.1 BIOPHYSICAL ENVIRONMENT

The following sections provide a description of the biophysical conditions and resources existing in the Inuvik to Tuktoyaktuk Peninsula area. This background information is subsequently considered in Section 4.0 of this Environmental Impact Statement to identify potential environmental effects and proposed mitigation measures to avoid or minimize potential negative effects.

3.1.1 Terrain, Geology, Soils and Permafrost

This section provides baseline information on terrain, geology, soils, and permafrost for use in assessing potential effects to ground conditions by the Project. To describe the diversity of ground conditions, information was collected using available information and data collected during the field reconnaissance program for the Project.

The Project is located in the Taiga Plans level II Ecoregion near Inuvik and beyond the treeline, just north of Inuvik, the area transitions into the Tundra Plains Level II Ecoregion (Ecosystem Classification Group 2007, revised 2009). The proposed Highway is within the Pleistocene Coastal Plain which borders the eastern side of the Mackenzie Delta (IOL et al. 2004).

3.1.1.1 Bedrock Geology

Bedrock in the Mackenzie Delta is sedimentary, comprised of Tertiary shale and sandstone. Preglacial, glacial and post-glacial deposits overlie the bedrock. Depth to bedrock in the Delta ranges from about 50 m near Inuvik to greater than 150 m near the seaward limit of the modern delta.

In the northern and eastern parts of the Caribou Hills, north of Inuvik and adjacent to the Parsons Lake area, Tertiary shale lays beneath glacial and post-glacial deposits, and occasionally is near surface with rare exposures. The bedrock consists of weathered, poorly indurated shale, sandstone and mudstone. The bedrock in the southern part of the Caribou Hills more commonly consists of Cretaceous shale and regularly outcrops.

The proposed Highway is located within the Cenozoic Sedimentary Rock (Tertiary) (IOL et al. 2004). Quaternary glacial deposits overlie the Tertiary bedrock, which overlies Cretaceous strata.

3.1.1.2 Surficial Geology

Figure 3.1.1-1, originally generated by Rampton (1987, 1979), illustrates the surficial geology of the Tuktoyaktuk Peninsula and general Project area. The surficial geology and landforms along the proposed Highway corridor are primarily the result of glacial activity in the region. The main glacial deposits along the corridor are glacial moraine, glaciofluvial and lacustrine in origin. Fluvial, colluvial, organic and aeolian units are the result of ongoing and sometimes active processes subsequent to deposition by glaciers.

The proposed alignment crosses two distinct physiographic regions between Inuvik and Tuktoyaktuk. From Inuvik to south of Husky Lakes, the alignment crosses the eastern extension of the Caribou Hills on the edge of the Anderson Plain, which consists of mostly unconsolidated materials with varying amounts of ground ice overlying relatively shallow bedrock. Much of the topographic relief is a direct reflection of the bedrock surface, but bedrock is rarely exposed. North of this area to Tuktoyaktuk, the alignment is situated within onto the Pleistocene Coastal Plain, which is characterized by thick unconsolidated sediments, moraines, ice-contact, glaciofluvial and organic lacustrine deposits (Rampton 1987, 1979). The area also contains varying quantities of ground ice and massive ice layers. Bedrock is not near surface in the Pleistocene Coastal Plain.

Surface deposits along the more westerly Alternative 2 (Upland Route) from Parsons Lake to Source 177 are primarily hummocky glacial moraine and undulating terrain studded with numerous lakes of the Pleistocene Coastlands region. The terrain is hummocky and irregular due to ice-contact deposits, glacial depositional features, and thermokarst activity. Depressions are typically post-glacial lakes, or are infilled with organic-rich bogs and post-glacial lacustrine silt and clay sediments. Retrogressive thaw flow slides occur along the shores and banks of lakes and streams between Parsons Lake and Tuktoyaktuk. Low and high-centre ice-wedge polygons are present in moraine and lacustrine deposits.

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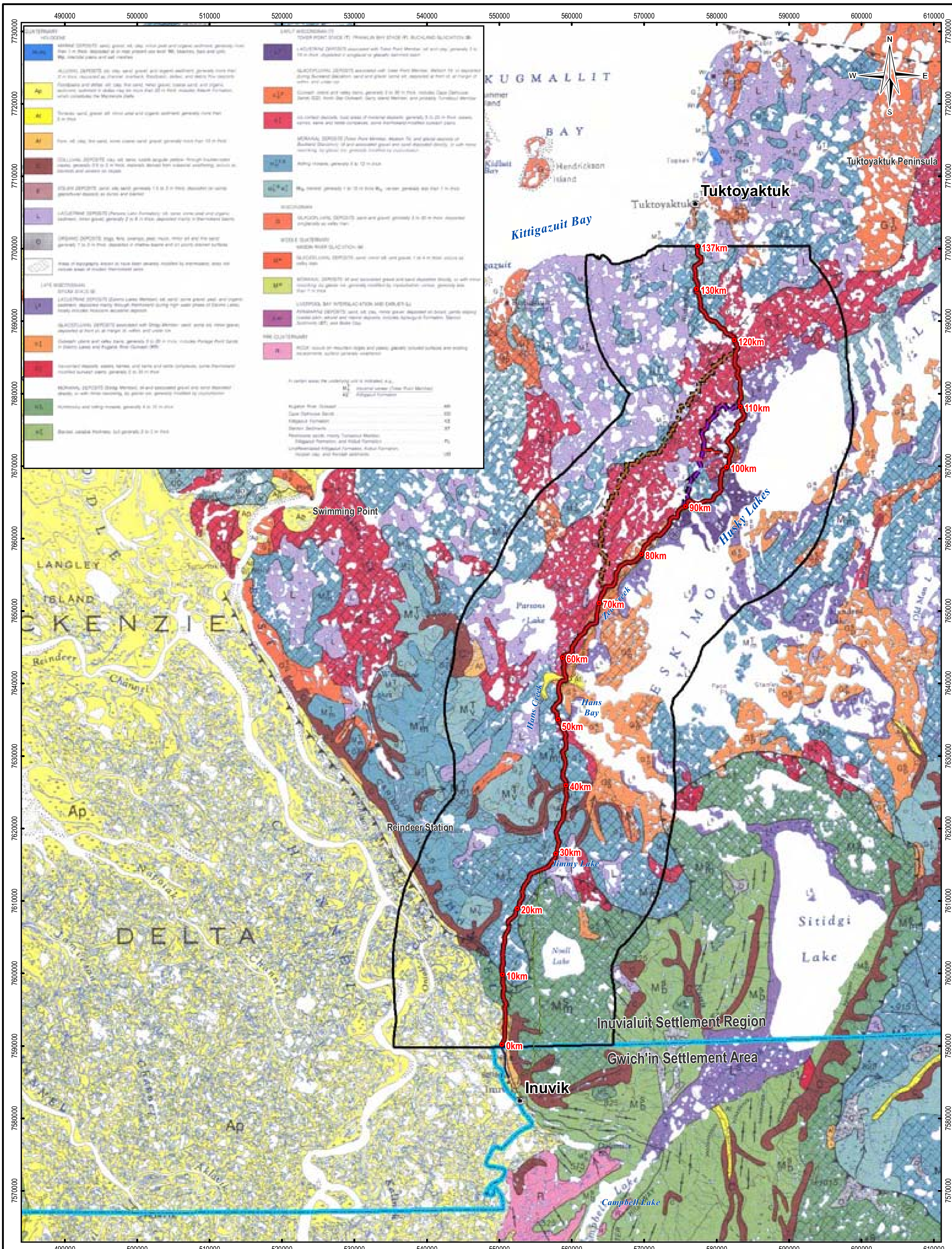


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Gwich'in / Inuvialuit Boundary

NOTES
Surfacial Geology: Natural Resources of Canada, gscmap-a_1647a_e_1987_mn01.jp2, Rampton (1974 and 1987)

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Surficial Geology

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:500,000
5 2.5 0 5 10 15
Kilometres

FILE NO.
V23201322_EIS_Map015_Ter_SurfGeology.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.1-1

Quaternary History

The Quaternary is the present geological time period, often referred to as the glacial age, and the time during which geological processes fashioned the surface of the Earth as it is known today. Quaternary events are largely responsible for the deposition of the surface materials and development of landforms present in the Inuvik to Tuktoyaktuk Highway area.

The Quaternary Period is subdivided into Pleistocene and Holocene epochs with the Holocene defined as roughly the last ten thousand years before present. The predominant characteristics of the Quaternary period are marked climatic change, glacial advances and retreats, and the activity of other processes fuelled by climatic oscillations.

Terrain Units

Terrain units common along the proposed routes vary from relatively dry upland and hummocky conditions, to wet, ice-rich lacustrine and thick organic conditions. Thick organic and ice-rich polygonal terrain was avoided where possible. Routing focused on traversing the most favorable terrain with minimal footprint size.

The surficial geology along the proposed Highway alignment has been generalized into four distinct landforms (terrain units); glacial moraine, glaciofluvial outwash, lacustrine, and alluvial/colluvial deposits. The route corridor contains many seasonal watercourses, wet lowlands, peatlands, and lakes, many of which are remnants of glacial outwash channels.

Through the remainder of the Holocene Period, periglacial processes resulted in the mechanical breakdown of materials and contributed to gravity transport of both glacial soils and products of periglacial grinding. Thin alluvial soil deposits formed along watercourses, and pond (lacustrine) deposits have accumulated in shallow depressions. Thicker organic deposits have formed on poorly drained floodplains and low, flat areas.

Table 3.1.1-1 provides a summary of the terrain units present within the Project area. Units are based on observations recorded during the field investigation, a review of orthophotographs and LIDAR topographic surveys along the Primary 2009 Route, and existing surficial geology mapping by Rampton (1987) and Aylsworth et al. (2000). The majority of the route traverses Terrain Types 1 and 2, with Terrain Types 3 and 4 comprising the remainder of the route.

TABLE 3.1.1-1: TERRAIN UNITS ALONG THE PROPOSED ALIGNMENT

Terrain Unit	Terrain Description	Approximate Percent Distribution Along Proposed Alignment
1	Glacial Moraine Deposits – deposited directly, or with minor reworking, by glacier ice; generally modified by cryoturbation. (relatively dry, stable, upland tills, overlain by a thin organic cover)	40

TABLE 3.1.1-1: TERRAIN UNITS ALONG THE PROPOSED ALIGNMENT		
Terrain Unit	**Terrain Description**	**Approximate Percent Distribution Along Proposed Alignment**
2	Glaciofluvial Outwash and Ice-Contact Deposits – deposited at front of, at margin of, within, and under glacier ice. (kame and kettle complexes and thermokarst modified plains, dry to wet, overlain by a thin to moderate organic cover)	35
3	Lacustrine Deposits – deposited in proglacial or glacially dammed basis, during high water phases of Husky Lakes, in thermokarst basins and recent lacustrine deposits. (wet, silt and clay, fine sand and organic sediments, moderate organic cover)	20
4	Alluvial/ Colluvial Deposits – deposited channel, floodplain, deltaic, and debris flow deposits, along ancient channels, present-day streams and steep slopes.	5

Soils containing fine grains in all four terrain units of the Project area are frost susceptible. A frost susceptible soil is defined in terms of its frost-heaving and thaw-weakening behaviour. The U.S. Army Corps of Engineers frost design and soil classification system bases the frost susceptibility of a soil on three factors: the percentage of particles smaller than 0.02 mm, the soil type (based on the Unified Soil Classification System), and a field laboratory test (Andersland and Ladanyi 2004).

Terrain Unit 1

Morainal deposits, also known as "till", consist of well-compacted to non-compacted material that is non-stratified and contains a heterogeneous, variable mixture of particle sizes, often in a matrix of sand, silt, and clay that is deposited by direct glacial action. Morainal deposits are generally moderately-well-drained, relatively ice-poor within the active layer, and smooth to rolling topography, with little surface expression of ice-rich permafrost conditions. Morainal deposits can also include wet till and till with ice-rich permafrost features indicative of more thermally sensitive terrain; these less favorable conditions were avoided where possible.

Morainal deposits can be subdivided into moraine veneer and hummocky and rolling moraine. Moraine veneer is generally less than 2 m in thickness while the hummocky and rolling moraine is generally between 4 and 10 m thick. Permafrost within the moraine veneer takes the form of 10-25% segregated ice in thin, irregular, discontinuous seams. Ice content within hummocky moraine is likely low. In rolling moraine, permafrost takes the form of 10-25% segregated ice as thin, irregular, discontinuous seams in the upper 2-3 m. As well, irregularly distributed large masses of segregated ice are common at greater depths in rolling moraine (Aylsworth 2000).

Terrain Unit 2

Glacial outwash and ice-contact deposits dominate the middle section of the route. Materials in these depositional environments are usually interbedded mixes of sand and gravel with some silt and typically range between 3 and 30 m in thickness. Materials have generally been transported away from a glacier by a stream of meltwater. Deposition patterns can vary; however, with materials deposited as a floodplain along a preexisting valley bottom, broadcast over a preexisting plain, or deposited in ridges, terraces, and hummocky terrain along glacial ice contacts.

The ground ice contents of these deposits vary greatly and are usually dependent on topographic location. Crests of prominent ridges and hummocks are typically well-drained and ice free to depths of 2-5 m. Below this depth the till is generally icy with ice lenses, and massive ice is common at depth. The deposits are moderately susceptible to thermokarst activity with signs of subsidence and ground ice slumping and gullying. Local drainage patterns tend to be deranged or contorted, draining to local ponds. The potential of these deposits to serve as borrow material is limited by ice content. Typically high crests and hummocks yield useful material.

Ice-contact deposits are often hummocky and irregular, characteristic of the kettle lake and thermokarst terrain. Drainage in most instances is good over the irregular terrain, however imperfect to poorly drained outwash materials are found where groundwater seepage is pronounced. Textures are quite variable and range from silt to subrounded gravels. There is generally a low ice content in the near surface (active layer), but ice content increases with depth and massive ice can be encountered. These deposits represent essentially the only source of useful borrow material on the Pleistocene Plain.

Terrain Unit 3

Lacustrine deposits include wet silt, clay, and fine sand, pond/lake bottom sediment deposits that occur in low-lying wet lowland terrain and old lakebeds. They are defined as sediments that have settled from suspension, and occasionally by underwater gravity flows in bodies of standing fresh water. In general, this terrain type is poorly drained with standing water, overlain by a moderate to thick organic cover. Permafrost is usually present under this terrain unit, except adjacent to large waterbodies.

Permafrost, when present, is generally composed of 10-25% segregated ice by volume and occurs as thin, irregular, discontinuous seams in the upper 1-3 m. Segregated ice or thick tabular bodies of nearly pure ice is common at greater depth. Growth of massive ice can result in the formation of pingos in drained thermokarst lake basins in the far north. Lacustrine deposits are subject to thermokarst processes and active layer detachment slides. Retrogressive thaw-flow slides are common on slopes in the area.

Lacustrine deposits are generally found in low-lying areas and depressed topography where slopes are nearly flat. Such deposits are present along the entire shoreline of Husky Lakes and in the coastal lowlands of the Pleistocene Plain. Because of the fine textured nature of these sediments, combined with imperfectly to poorly drained conditions, these sediments are usually ice-rich and highly susceptible to compaction and rutting.

Terrain Unit 4

Post-glacial alluvial and colluvial deposits are materials transported and deposited by streams and gravity, respectively. Alluvial deposits are found along many of the watercourses in the area, while colluvial materials are indicative of instability on steeper slopes, as noted along the Hans River valley where thick sediments have slumped into the valley. Alluvial sediments are commonly moderately-to-well sorted and display stratification. Colluvial materials are unsorted surficial deposits that have moved downslope because of gravity-induced movement. Colluvial deposits are typically less than 5 m in thickness, whereas alluvial deposits can vary in thickness between 2 and 5 m.

Ice content within this unit varies greatly and depends on the texture of the material and the depth to bedrock. For example, deposits that directly overlay impervious bedrock are more likely to have high ice content.

From an engineering perspective, many of the alluvial deposits, such as those identified along the north terrace of Hans Creek, represent potential aggregate sources. These sediments are generally well drained, however, areas with poor drainage or groundwater springs are more vulnerable to disturbance.

3.1.1.3 Borrow Materials

Potential borrow sources have been identified along the Primary 2009 Route based on the granular material studies and investigations that have been undertaken over the years by ILA, INAC, Geological Survey of Canada, and Public Works Canada.

The resources near the communities of Inuvik and Tuktoyaktuk have been ground-truthed and proven to a spatial extent. However, many of the resources along the Primary 2009 Route are not proven and are described as probable or prospective material resources whose existence and extent have been inferred or speculated. Additional site investigation is necessary prior to using these materials.

The following information regarding borrow sources is described in Section 2.6.8:

- Location;
- Type of material;
- Size of deposit;
- Quantity and quality of deposit; and
- Ownership and availability.

Further information regarding the depth of deposit, permafrost conditions and ice content within deposits will be identified during future site investigations.

3.1.1.4 Permafrost Conditions

The Inuvik to Tuktoyaktuk Highway corridor is located entirely within the zone of continuous permafrost (NRC 2007a; Heginbottom 2000). Ground temperatures are within the range of -3˚C to -7˚C (Burn and Kokelj 2009).

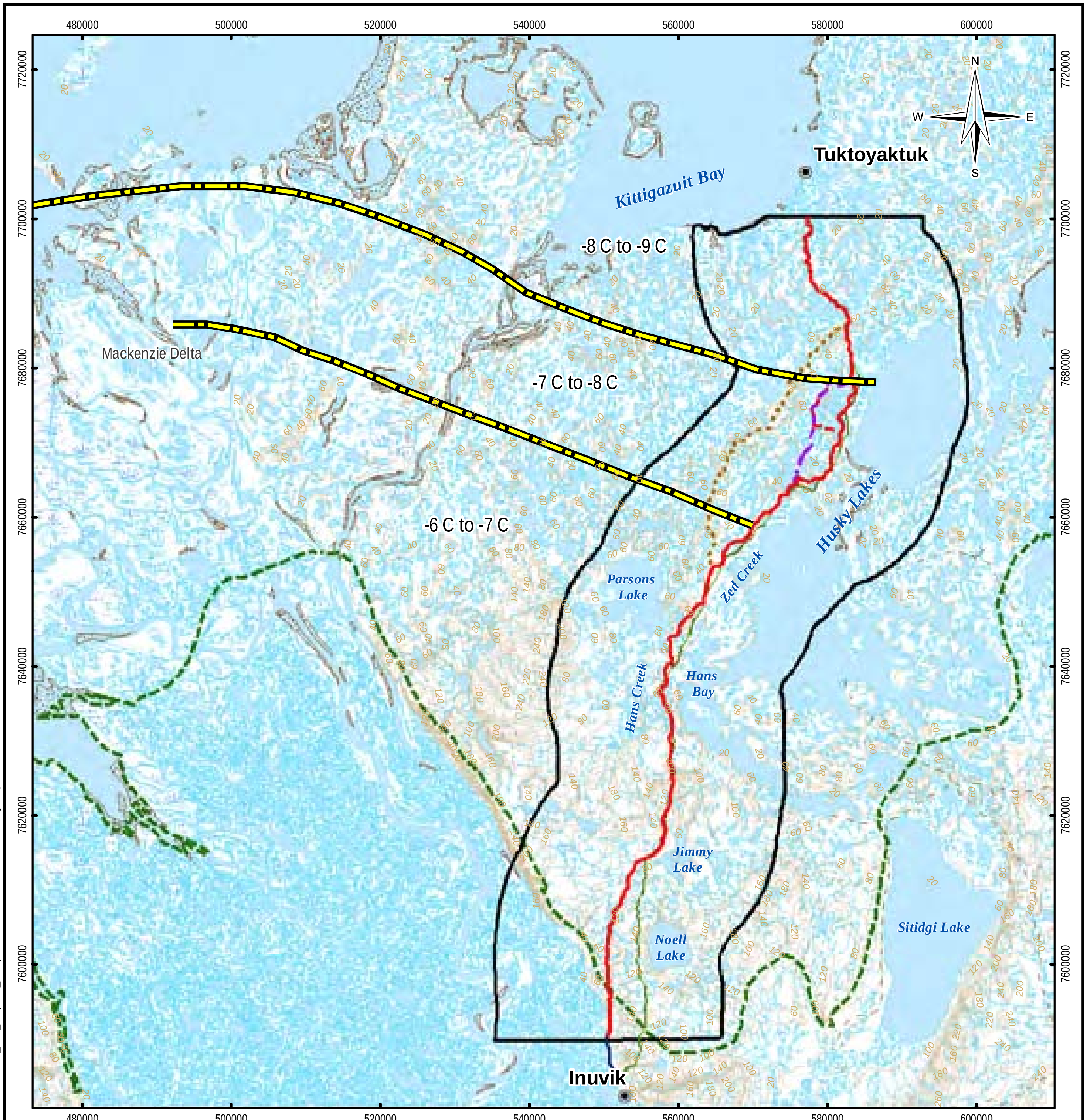
Spatial Variation in Ground Temperatures

The mean annual ground temperatures in the region vary due to climatic and ecological factors. Near-surface ground temperatures are similar in the uplands north and south of the treeline in summer, but diverge in winter due to varying snow depths south of the treeline.

Figure 3.1.1-2 summarizes ground temperature data from the 1960s and 1970s compiled from borehole temperature measurements at about the depth of zero annual amplitude. These data show a clear difference in mean annual ground temperatures between the uplands and the delta. In the uplands, the ground tends to cool with proximity to the coast. The warmer ground in the delta is due to the extent of waterbodies. In the delta, the lower temperatures measured south of the treeline can be attributed to the interception of snow by the forest canopy, which reduces snow depth in comparison to accumulations in the tall willows north of the treeline. The temperatures also decline in the sedge wetlands near the north coast of the delta. These data serve as a benchmark against which the effects of climate change on ground temperatures in the region can be measured (Burn and Kokelj 2009).

Figure 3.1.1-3 presents a composite map of mean annual ground temperatures in the area with data compiled by INAC during 2003 to 2007. These data are from a more extensive distribution of ground temperature records from the central and southern delta and near Inuvik than the data used to create Figure 3.1.1-2. The data presented in Figure 3.1.1-3 include borehole temperature measurements taken at the top of permafrost throughout the year.

A comparison of Figures 3.1.1-2 and 3.1.1-3 shows that the increase in near surface ground temperatures due to climate warming has been 1˚C to 2˚C in the uplands.



LEGEND

- Temparature Boundaries (approximate)
- Treeline
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Temperature boundaries: Burn and Kokelj (2009).

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Near-surface Ground Temperatures, late 1960s to early 1970s

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map049_Temp1970.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.1.1-2

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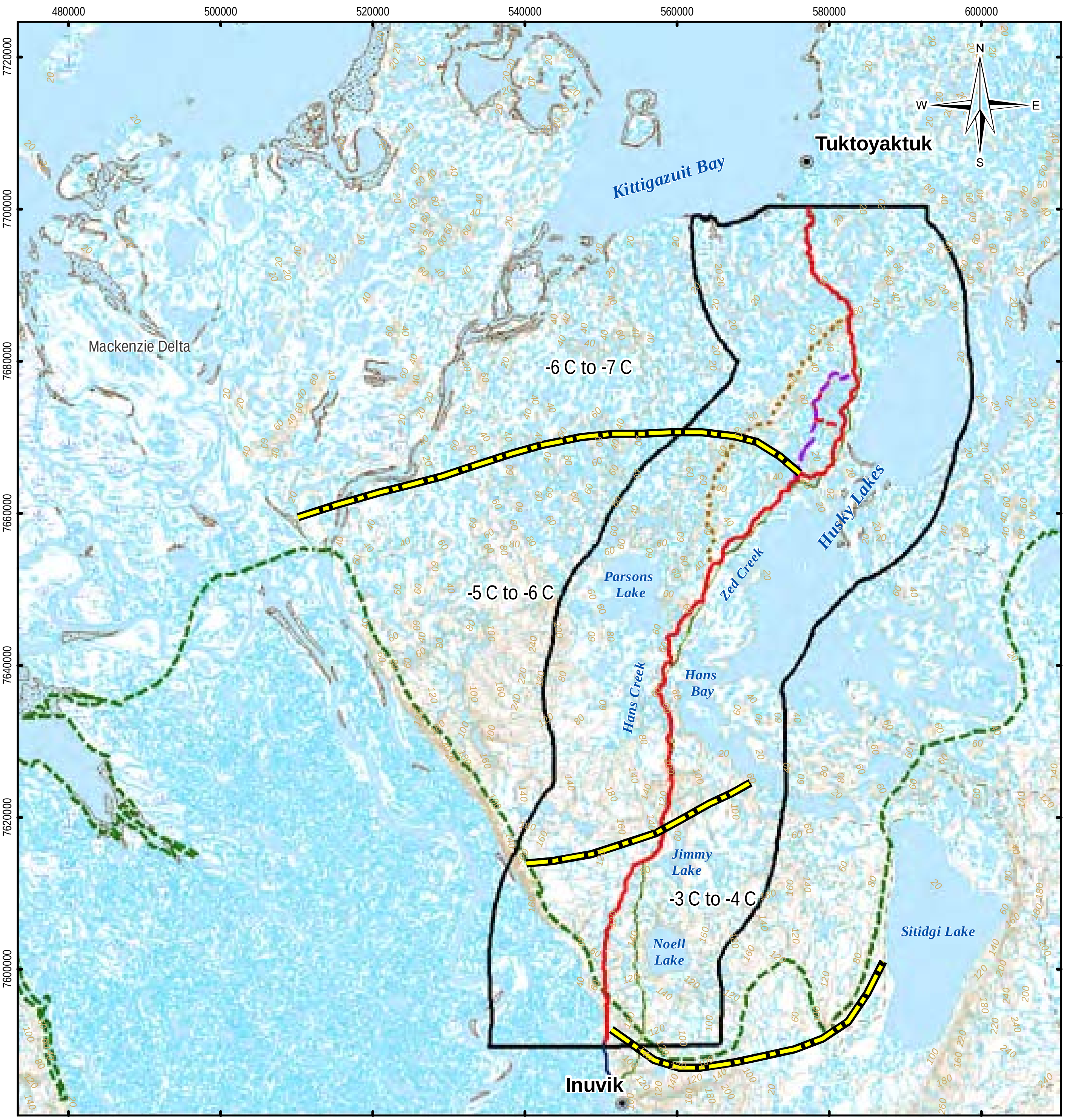

LEGEND

- Temparature Boundaries (approximate)
- Treeline
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Temperature boundaries: Burn and Kokelj (2009).

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Near-surface Ground Temperatures, 2003 to 2007

PROJECTION: UTM Zone 8	DATUM: NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.: V23201322_EIS_Map050_Temp2007.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.1-3

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Permafrost

Permafrost is defined as any rock or soil material that has remained below 0˚C continuously for two or more years, without consideration of material type, ground ice distribution, or thermal stability. The two-year minimum stipulation is meant to exclude from the definition the overlying ground surface layer which freezes every winter and thaws every summer (called the “active layer” or “seasonal frost”).

The upper portion of the permafrost layer experiences an annual range in ground temperature which fluctuates with the seasons. With increasing depth, the seasonal difference in temperature decreases. The point at which there is no discernable change in temperature is termed the “depth of zero annual amplitude” (NRC 2007b). Within the Project area, the depth of zero annual amplitude ranges from 10-20 m; below this depth, temperatures change very little during the year (Burgess et al. 2000).

Despite the proposed Highway being located in the continuous permafrost zone, talik zones of unfrozen ground are expected to exist under deeper lakes in the area such as Parsons Lake and Husky Lakes. Since the Highway will be set back from such large waterbodies, potential talik zones will be effectively avoided.

The underlying permafrost is typically a few hundred metres thick, but depends on various factors including proximity to lakes, slope, aspect, and other site-specific conditions. To the north and east of Parsons Lake, the permafrost thickness has been shown to range from 354 m to 378 m (IOL et al. 2004).

The extent of permafrost is a result of past and present climates, hydrological characteristics in the ground, mineralogy, surface organic cover, and annual snow cover (Nixon 2000). The proposed Highway alignment is within an area of continuous permafrost (Heginbottom 2000). The thickness of the active layer in the Project area is typically between 0.6 m and 0.8 m, but varies from less than 0.5 m to greater than 2.0 m on elevated, slopes with little to no organic cover.

Soil type and ground cover are key elements that help determine the depth of the active layer. In thick organic peats and silts, the active layer can be more than 30 cm thick and greater than 1 m in sparsely vegetated glaciofluvial gravels and sands.

Wildfire can greatly affect the permafrost layer by removing the insulating properties provided by the organic layer, without which the rate of permafrost melting increases. Melting of permafrost can result in substantial thaw settlement, loss of soil structural integrity, and can potentially affect the Highway foundation. Minimizing disturbance to permafrost is integral in maintaining Highway stability.

Common permafrost-related features in the Project area include ice-rich polygonal ground, retrogressive thaw-flow slides, thermokarsts, and peatlands.

Permafrost is reflected in well-developed patterned ground and periglacial processes. Mineral soils in the region, that promote capillary flow, generally have high ice content and are sensitive to disturbance. In this periglacial condition there are several forms of frozen ground that can occur. Frozen ground can contain excess ice, where the amount of water contained in the soil matrix in a frozen state is higher than would be retained in the soil in an unfrozen state. The excess ice can be found mixed (disseminated, non-visible) within the soil matrix, or can be in the form of pure ice, ice lenses, or ice wedges. Soil ice content by volume within the RSA ranges between 0-5% near the Husky Lakes and 5-15% south of the Husky Lakes, and in some areas near Tuktoyaktuk (Heginbottom 2000). The presence of perennially frozen ground limits the percolation of water and promotes the accumulation of organic material. The importance of these ice inclusions is the susceptibility of these materials to melt, the resultant ground disturbance, and the suitability for use as construction material (NRC 2007b).

Fluvial Geomorphology

Ice decay in lakes begins once snow is melted from the ground surface. The increase in lake water storage lags behind snowmelt due to meltwater retention within the snow cover and in small depressions on the land surface (Kiggiak-EBA 2010a). During the melt, snow dams generally cause water levels in lakes to rise above outlet elevations. Breaching of these dams causes rapid increases in downstream discharge. The freshet recharges tundra ponds, creating surface flow connections typically for a period of two weeks (Kiggiak-EBA 2010a).

The spring freshet is the peak period of fluvial geomorphological events. The spring freshet results in a sudden peak in the hydrograph as meltwater fills the many depressions on the land surface and flows over-land in sheets or rills (Kiggiak-EBA 2010a). The shallow active layer is not able to retain much water, causing the water table to rise rapidly, delivering runoff to the lower slopes and stream channels. Over the spring and summer, the active layer increases in depth due to heating from the surface, causing the water table to drop and resulting in a decline in surface flows. Summer rainfall causes short-period rises in water levels above base flows, the magnitude of which is a function of the ability of the ground to receive and attenuate flow.

Sensitive Terrain

The majority of the proposed alignment is located in the Mackenzie Delta of the Pleistocene Plain, a region of limited topographic relief. The southern portion of the route is located on the Caribou Hills, with rolling terrain and steeper slopes. There are various landforms and specific areas along the alignment that would be considered as being sensitive to construction activities.

A major routing design consideration was to avoid problematic or sensitive areas and to design accordingly to mitigate potential issues. Also, construction over ice rich permafrost terrain requires substantial quantities of materials to maintain a grade with continuous thick fill over thaw-sensitive terrain.

This has been confirmed by the recent construction of the Tuktoyaktuk to Source 177 Access Road. Mr. R. Newmark (CEO, E. Gruben's Transport Ltd., pers. comm., May 8, 2011) indicated that the construction of the Tuktoyaktuk to Source 177 Access Road traversed similar terrain and that the construction techniques employed (e.g., thicker road embankments and use of geotextile fabric) were sufficient to address these challenges.

The following subsections describe the relevant landforms identified as being sensitive to construction activities and disturbance.

Polygons

Polygons are a type of patterned ground found primarily in low-lying, poorly drained areas (i.e., drained lakebeds). These features are commonly classified as high- or low-centered. Low-centered polygons consist of flat terrain enclosed by relatively dry ridges.

Frost cracking begins when thermally derived stresses generated upon cooling, typically when temperatures reach their annual minimum, exceed the strength of the surface materials (Mackay 1986; Trenhaile 2007). During spring and early summer, water (from thawed snow, surface water, or water released by active layer thawing) may fill the crack and eventually freeze and subsequently crack during the fall and winter (Mackay 1986; Trenhaile 2007). In this manner ice wedges grow progressively.

Ice wedge growth pushes up the surface soil to form linear ridges. Intersecting ridges give the surface of the ground a polygonal appearance. Over time low-centered polygons can become high-centered polygons. Ice-rich patterned ground was avoided, where possible, along the Highway alignment.

Thick Organics (Peatland)

Generally these deposits occur as peat deposits or fens on flat terrain and usually cover underlying mineral soil. Peatlands are wetlands with massive deposits of peat that are typically greater than 0.5 m thick and may be several metres thick. There are many classes of peatland, but most in the Mackenzie Valley are bogs and fens. Bogs are a form of peatland, having a water table at or near the surface, where the waters are virtually isolated from nutrient rich groundwater from the surrounding terrain. Most bogs contain permafrost and take the form of peat plateaus, polygonal peat plateaus, and plazas (Tarnocai et al. 2003). Fens support nutrient rich waters that originate from mineral soil. Peatlands identified during the field reconnaissance and from orthophotos have been avoided.

Thermokarst

Thermokarst refers to surface subsidence and expression resulting from the melting of ice rich permafrost, particularly massive ice lenses. Thermokarst is a slow natural process that can be aggravated and accelerated if not cautious. As ground ice thaws and the resulting water cannot drain away and contributes to further degradation of the permafrost, the result is the creation of small ponds and lakes, expressing in the numerous kettle lake topography seen along the route. Old thermokarst lake beds occur where fine-grained clay, silt, peat, and local sand deposited in low, flat areas previously occupied by lakes/ponds become exposed. These lake beds often support an organic cover and the areas tend to be very wet. Ice content is generally high is these fine-grained, organic materials. These areas often exhibit thermokarst subsidence with erosion along ice wedge cracks and pingos are commonly associated with this environment. These areas have been avoided when possible.

Retrogressive Thaw Flow Slides

These are characterized by landslides that occur only in ice-rich soils in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and hundreds of these features line the river banks and tundra lakes in the Project area. These landslides are typically relatively small, but over time can continue retreating back from the rim and from the escarpment. Such landslides would be of significant consequence to a road if they were to occur. The likelihood of a retrogressive thaw slide occurring along the Highway is reduced by purposely routing away from existing slides and steeper slopes that would be susceptible to failure.

Figure 3.1.1-4 identifies the distribution of recorded landslides on the Tuktoyaktuk Peninsula and the proposed Highway alignments (Aylsworth et al. 2001).

Pingos

Pingos are ice-cored hills that are forced up by the hydrostatic pressure in a wet area underlain by permafrost. Pingos may be up to 50 m high and have a base of up to 600 m in diameter. Mackay (1963) reported the existence of some 1,400 pingos in the Delta Area. Several particularly large pingos are located near Tuktoyaktuk and to the west of the proposed Highway alignment near the Beaufort coastline. Pingos are cultural and heritage resources that have been avoided entirely.

The drainages of Hans Creek and Zed Creek, and the wetland north of Zed Lake have been identified as being particularly sensitive to disturbance and construction activities given their environmental settings. Particularly careful design and construction will be undertaken in these areas.

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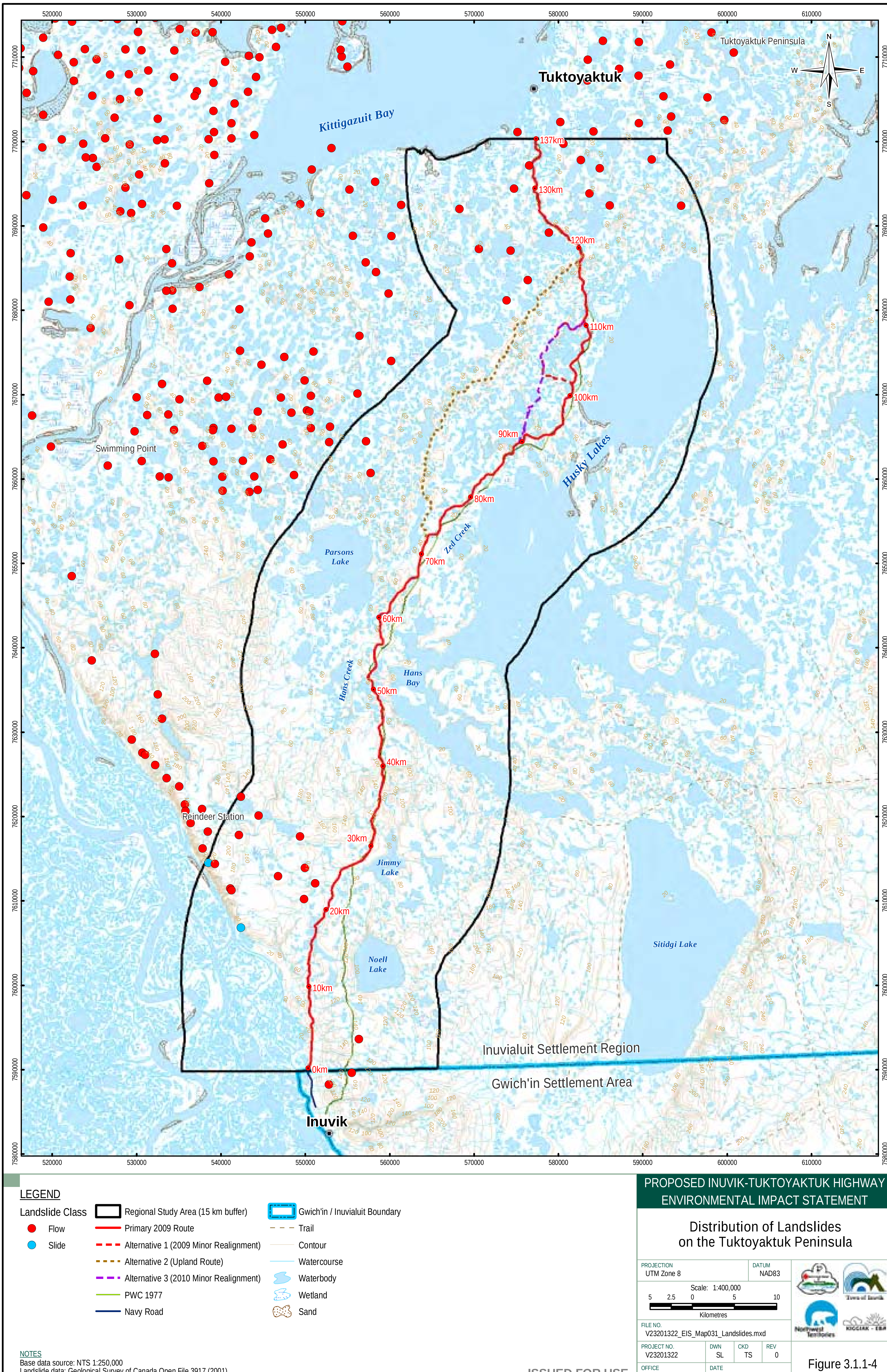

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Distribution of Landslides
on the Tuktoyaktuk Peninsula

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
Kilometres

FILE NO.
V23201322_EIS_Map031_Landslides.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.1-4

Other Geotechnical Hazards

Other geotechnical hazards that were reviewed during the planning stage of the Project include karst structures, fault zones and active seismic areas. The seismic hazard within the Project area is considered low based on the 2005 Seismic Hazard Map produced by the Geological Survey of Canada (NRC 2010b). While thermokarsts are expected in the Project area, karst structures are not expected as they form in carbonate rocks, which are not present in the Project area.

3.1.2 Climate

3.1.2.1 Location of Recording Stations and Length of Record

Climate data from two meteorological stations operated by Environment Canada, Tuktoyaktuk-A and Inuvik-A are used for the discussion of climate for the Inuvik and Tuktoyaktuk areas. Inuvik climate normals between 1971-2000 and 1976-2005 are summarized in Tables 3.1.2-1 and 3.1.2-2, respectively. Tuktoyaktuk climate normals between 1971-2000 and 1978-2007 are summarized in Tables 3.1.2-3 and 3.1.2-4, respectively.

3.1.2.2 Spatial and Temporal Boundaries

The spatial boundaries of the Project are defined by the climatic area that can be reasonably represented by each weather station, while considering the influence of geography. Each station can be assumed to generally represent a radius of 10 km, although the actual area of representation is dependent on local geography (L. Coldwells, Environment Canada Meteorologist – Arctic Region, personal communication February 1, 2011). Features such as mountain ranges, large lakes, etc. will have an influence on climate and climate data. The terrain located within a 10 km radius of the Tuktoyaktuk-A and Inuvik-A weather stations is representative of what is present along the entire route and therefore this climatic data is generally representative of the entire route.

The temporal boundaries for the description of climate conditions are based on climate normals from 1971-2005 for Inuvik and climate normals from 1971-2007 for Tuktoyaktuk.

The spatial boundary between the Tuktoyaktuk and Inuvik data sets is the treeline (Figure 3.1.2-1), located just north of Inuvik. The area beyond the treeline more closely represents that of Tuktoyaktuk.

TABLE 3.1.2-1: CLIMATE DATA, INUVIK-A STATION*, NWT (1971-2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-27.6	-26.9	-23.2	-12.8	0.2	11.3	14.2	11.0	3.7	-8.2	-21.0	-25.7	-8.8
Standard Deviation	4.8	4.7	3.7	4.0	3.0	1.6	1.8	2.0	2.2	2.7	4.8	3.4	1.9
Daily Maximum (˚C)	-23.2	-22.0	-17.5	-7.1	5.0	17.3	19.8	16.1	7.8	-4.8	-16.8	-21.3	-3.9
Daily Minimum (˚C)	-31.9	-31.7	-28.8	-18.4	-4.7	5.3	8.5	5.9	-0.4	-11.6	-25.1	-30.1	-13.6
Extreme Maximum (˚C)	5.4	5.2	6.1	13.8	25.0	32.8	32.8	32.5	26.2	15.0	10.6	5.0	
Extreme Minimum (˚C)	-54.4	-49.4	-47.6	-46.1	-26.6	-5.1	-2.2	-5.9	-20.1	-32.9	-42.8	-47.2	
Precipitation:													
Rainfall (mm)	0.1	0.0	0.0	0.0	6.1	20.2	32.9	37.5	18.7	1.3	0.0	0.0	117.0
Snowfall (cm)	17.4	15.0	14.6	13.5	13.1	1.9	0.3	2.4	10.7	34.9	23.7	20.4	167.9
Precipitation (mm)	13.8	11.6	11.0	10.5	17.0	22.1	33.2	39.9	28.0	28.0	17.8	15.7	248.4
Average Snow Depth (cm)	46	54	57	54	20	0	0	0	0	11	29	39	
Median Snow Depth (cm)	47	54	57	55	19	0	0	0	0	10	29	39	
Snow Depth at Month-end (cm)	51	56	59	41	1	0	0	0	2	23	34	42	51
Extreme Daily Rainfall (mm)	1.8	0.2	0.8	.04	19.3	19.1	41.0	33.0	22.9	13.2	0.8	0.4	
Extreme Daily Snowfall (cm)	11.4	13.7	13.0	17.8	24.9	10.2	4.8	22.6	12.2	44.2	22.0	18.6	
Extreme Daily Precipitation (mm)	10.4	13.7	10.8	17.8	24.2	19.3	41.0	42.9	30.7	29.2	16.9	15.8	
Extreme Snow Depth (cm)	89	97	96	99	**87**	8	3	5	16	81	79	81	
Wind:													
Maximum Hourly Speed (km/hr)	65	56	61	46	47	46	46	56	50	56	56	64	54
Direction of Maximum Hourly Speed	E	E	E	E	NE	NE	NE	E	E	E	E	E	E

Source: Environment Canada (2010a)

Note *: Location: 68°18' N, 133°28.8' W; Elevation: 68.3 m. Climate Station ID: 2202570

TABLE 3.1.2-2: CLIMATE DATA, INUVIK-A STATION*, NWT (1976-2005)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-26.7	-26.0	-22.8	-12.0	0.2	11.4	14.0	11.0	3.9	-7.6	-20.4	-24.9	-8.3
Standard Deviation													
Daily Maximum (˚C)	-22.5	-21.3	-17.2	-6.5	5.0	17.5	19.5	16.1	7.9	-4.3	-16.4	-20.7	-3.6
Daily Minimum (˚C)	-30.8	-30.6	-28.3	-17.6	-4.6	5.3	8.5	5.9	-0.1	-10.9	-24.4	-29.1	-13.1
Extreme Maximum (˚C)	5.4	5.2	4.7	13.8	25.0	32.8	32.8	32.5	26.2	20.9	6.9	4.3	
Extreme Minimum (˚C)	-50.0	-49.1	-47.6	-40.0	-26.6	-5.1	-1.0	-5.9	-20.1	-32.9	-42.6	-47.2	
Precipitation:													
Rainfall (mm)	0.1	0.0	0.0	0.5	6.6	19.0	31.5	35.9	19.7	0.8	0.0	0.0	114.2
Snowfall (cm)	15.4	15.1	14.4	12.2	14.1	1.9	0.2	2.5	11.5	30.2	21.9	18.9	158.2
Precipitation (mm)	13.6	12.1	11.5	9.9	17.0	20.6	32.0	38.5	28.5	23.8	16.5	14.1	237.9
Average Snow Depth (cm)													
Median Snow Depth (cm)													
Snow Depth at Month-end (cm)	50	55	58	37	0	0	0	0	2	20	32	40	
Extreme Daily Rainfall (mm)													
Extreme Daily Snowfall (cm)													
Extreme Daily Precipitation (mm)													
Extreme Snow Depth (cm)													

Source: Environment Canada (2010b)
Note *: Location: 68°18' N, 133°28.8' W; Elevation: 68.3 m. Climate Station ID: 2202570

TABLE 3.1.2-3: CLIMATE DATA, TUKTOYAKTUK-A STATION*, NWT (1971-2000)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-27.0	-26.6	-25.7	-16.8	-4.8	6.0	11.0	8.9	2.8	-8.1	-21.0	-25.4	-10.6
Standard Deviation	4.5	4.6	3.5	3.0	2.6	1.6	2	1.9	1.9	2.9	4.0	3.1	
Daily Maximum (˚C)	-23.4	-22.6	-21.8	-12.2	-1.1	10.5	15.2	12.3	5.3	-5.6	-17.5	-21.8	-6.9
Daily Minimum (˚C)	-30.8	-30.8	-29.7	-21.2	-8.4	1.5	6.8	5.5	0.3	-10.9	-24.5	-29.1	-14.3
Extreme Maximum (˚C)	0.6	0.7	-0.5	4.8	20.9	28.2	29.4	27.6	20.4	11.7	2.2	0.8	
Extreme Minimum (˚C)	-48.9	-46.6	-45.5	-42.8	-28.9	-8.9	-1.7	-2.5	-12.8	-28.5	-40.1	-46.7	
Precipitation:													
Rainfall (mm)	0.2	0.0	0.0	0.0	1.3	8.1	21.4	27.2	15.6	1.2	0.1	0.3	75.2
Snowfall (cm)	10.1	10.6	6.3	8.9	5.6	1.6	0.1	1.9	8.9	19.2	12.3	9.8	95.2
Precipitation (mm)	9.8	10.2	6.2	8.6	6.8	9.7	21.5	29.1	24.2	19.9	12.2	9.6	167.8
Average Snow Depth (cm)			35	35	21	1	0	0	1	7		18	
Median Snow Depth (cm)			35	35	23	0	0	0	0	6		19	
Snow Depth at Month-end (cm)	30	35	37	32	9	0	0	0	2	11	21	21	
Extreme Daily Rainfall (mm)	2.5	0.4	0.0	0.4	4.0	11.5	19.6	14.7	24.2	8	1	4.8	
Extreme Daily Snowfall (cm)	8.8	9.8	6.5	7.1	9.6	7.6	1	7.4	12.8	9.1	15	9.4	
Extreme Daily Precipitation (mm)	7.1	9.8	6.5	7.1	10.8	11.5	19.6	14.7	24.2	9.1	15	9.4	
Extreme Snow Depth (cm)	61	62	72	72	**61**	45	0	0	21	26	34	49	
Wind:													
Maximum Hourly Speed (km/hr)	78	89	63	60	67	56	74	74	77	69	74	87	72
Direction of Maximum Hourly Speed	W	W	W	NE	NE	NE	W	SW	NW	W	NW	NW	W

Source: Environment Canada (2010c)
Note *: Location: 69°25.8' N, 133°1.8' W; Elevation: 4.6 m. Climate Station ID: 2203912

TABLE 3.1.2-4: CLIMATE DATA, TUKTOYAKTUK -A STATION*, NWT (1978-2007)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-26.4	-26.8	-25.4	-16.0	-4.7	6.2	11.0	8.9	3.2	-7.3	-20.0	-24.1	-10.1
Standard Deviation													
Daily Maximum (˚C)	-22.8	-22.7	-21.3	-11.8	-1.2	10.8	15.0	12.3	5.7	-4.7	-16.5	-20.3	-6.5
Daily Minimum (˚C)	-30.1	-30.9	-29.3	-20.4	-8.2	1.6	6.9	5.5	0.7	-9.8	-23.3	-27.8	-13.8
Extreme Maximum (˚C)	0.0	0.7	-0.5	4.8	20.9	28.2	29.3	27.6	20.9	17.4	0.5	0.8	
Extreme Minimum (˚C)	-46.0	-46.6	-45.5	-39.0	-28.9	-8.9	-1.5	-2.5	-11.2	-28.5	-40.1	-42.9	
Precipitation:													
Rainfall (mm)	0.0	0.0	0.0	0.0	1.6	9.6	22.8	25.8	15.2	1.5	0.0	0.2	76.8
Snowfall (cm)	12.6	9.7	9.3	9.8	6.3	1.3	0.1	1.4	8.9	20.2	13.0	11.6	104.1
Precipitation (mm)	10.0	8.6	7.7	8.8	7.1	10.9	22.8	27.2	23.1	19.1	10.9	9.4	165.6
Average Snow Depth (cm)													
Median Snow Depth (cm)													
Snow Depth at Month-end (cm)	29	32	36	31	6	0	0	0	2	11	18	23	29
Extreme Daily Rainfall (mm)													
Extreme Daily Snowfall (cm)													
Extreme Daily Precipitation (mm)													
Extreme Snow Depth (cm)													

Source: Environment Canada (2010d)
Note *: Location: 69°25.8' N, 133°1.8' W; Elevation: 4.6 m. Climate Station ID: 2203912

3.1.2.3 Climate Related Extreme Events

Climate related extreme events are included in Table 3.1.2-1 and 3.1.2-2 for Inuvik and in Table 3.1.2-3 and 3.1.2-4 for Tuktoyaktuk. Data are recorded for the following types of extreme events: low or high temperatures, daily rainfall, daily snowfall, daily precipitation and snow depth. Data are reported as climate normals for the period 1971-2000 and 1976-2005 for Inuvik, and 1971-2000 and 1978-2007 for Tuktoyaktuk. Therefore, the frequency of occurrence of extreme events is not available.

3.1.2.4 Current Climatic Conditions for Baseline

The current baseline period was based on climate data obtained from two meteorological stations located near the Project site at Tuktoyaktuk-A and Inuvik-A (Figure 3.1.2-1). Climate normals (or averages) are used to summarize or describe the average climatic conditions of a particular location. At the end of each decade, Environment Canada updates its climate normals for as many locations and as many climatic characteristics as possible (Environment Canada 2010e).

For both locations the climate is characterized by long, cold winters followed by short summers.

Air Temperature

The Inuvik climate normals for the periods of 1971-2000 and 1976-2005 are summarized in Tables 3.1.2-1 and 3.1.2-2, respectively. July is the warmest month with a daily average of 14.1˚C. The lowest average daily winter temperatures occur in February and the two sets of climate normals indicate that these temperatures have increased over time from -26.9˚C (1971-2000) to -26.0˚C (1976-2005). The average annual temperature has also increased from -8.8˚C (1971-2000) to -8.3˚C (1976-2005).

The Tuktoyaktuk climate normals for the periods of 1971-2000 and 1978-2007 are summarized in Tables 3.1.2-3 and 3.1.2-4, respectively. July is the warmest month with a daily average of 11.0˚C. This is 3.1˚C cooler than equivalent Inuvik temperatures. The lowest average daily winter temperatures based on the 1971-2000 climate normals occur in January. These temperatures have increased over time from -27.0˚C (1971-2000) to -26.4˚C (1978-2007). The average annual temperature has also increased from -10.6˚C (1971-2000) to -10.1˚C (1978-2007).

In general the temperature data indicate that the Tuktoyaktuk climate is 2-3˚C cooler than Inuvik.

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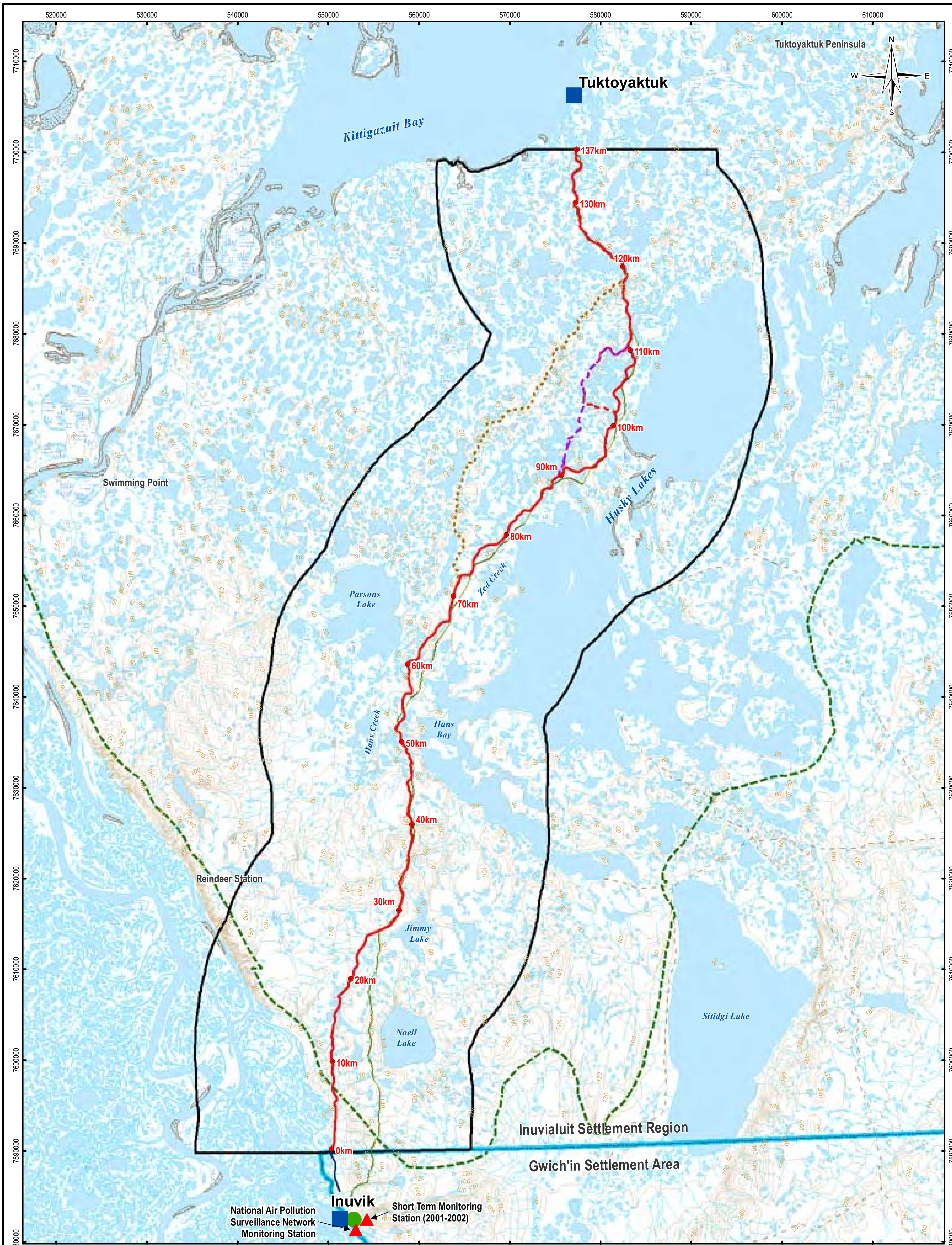


LEGEND

- Air Quality Monitoring Site
- Climate Station
- Meteorological Station
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Gwich'in / Inuvialuit Boundary
- Treeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Air Quality, Climate, and Meterological Stations: Mackenzie Gas Project EIS (Vol 3 Figure 2-5); locations are approximate.

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Climate and Air Quality Monitoring Stations

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map029_AirQuality.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.2-1

Precipitation

Rainfall generally occurs throughout June through September; while snowfall generally occurs from September through May (Tables 3.1.2-1 through 3.1.2-4).

The mean annual total precipitation measured at Inuvik has decreased from 248.4 mm (1971-2000) to 237.9 mm (1976-2005). The proportion of rainfall to precipitation has increased from 47.0% (1971-2000) to 48.0% (1976-2005). There has been a decrease in the mean annual total snowfall recorded from 169.9 cm (1971-2000) to 158.2 cm (1976-2005). This indicates that slightly less winter precipitation (snowfall) is occurring over time.

The mean annual total precipitation measured at Tuktoyaktuk has decreased from 167.9 mm (1971-2000) to 165.6 mm (1978-2007). The proportion of rainfall to precipitation has increased from 44.8% (1971-2000) to 46.4% (1978-2007). There has been an increase in the mean annual total snowfall recorded from 95.2 cm (1971-2000) to 104.1 cm (1978-2007). This indicates that slightly greater winter precipitation (snowfall) is occurring over time.

On an average annual basis, Inuvik receives 67% more precipitation that Tuktoyaktuk.

Wind Speed and Direction

The mean annual maximum hourly wind speed at Inuvik between 1971 and 2000 was 54 km/hr, with winds generally from the east. The period with the lowest maximum hourly wind speeds (46 km/hr) occur during April through July. During this period the winds shift direction from east to northeast. The period with the highest maximum hourly wind speed occurs from December to March, (>60 km/hr) typically blowing from the east.

The mean annual maximum hourly wind speed at Tuktoyaktuk between 1971 and 2000 was 72 km/hr, with winds generally from the west. The period with the lowest maximum hourly wind speeds (61 km/hr) occur during March through June where the winds shift direction from west to northeast. The period with the highest maximum hourly wind speeds (85 km/hr) occurs from December to February, typically from the west.

Tuktoyaktuk is located close to the Beaufort Sea and its topography and vegetation leave it less sheltered and more susceptible to greater wind speeds than other communities further inland, such as Inuvik. This is reflected in the average annual winds of 72 km/hr for Tuktoyaktuk compared to Inuvik where the average is 54 km/hr.

Visibility

Visibility in the region is primarily affected by atmospheric humidity. Typically, the greater the humidity, the lower the visibility. Two humidity conditions that can affect visibility in the region are fog and ice fog. Fog is formed when moisture in the air condenses and can restrict aircraft and other transportation. Ice fog is a uniquely northern situation that occurs below -30'C. Ice fog events are typically associated with local temperature inversions. Table 3.1.2-5 summarizes the fog and ice fog events that have been observed (IOL et al. 2004).

TABLE 3.1.2-5: SUMMARY OF AVAILABLE FOG AND ICE FOG DATA (INUVIK)					
Parameter	**Average**				
	Dec -Feb	**March - May**	**June - August**	**Sept - Nov**	**Annual**
Normal number of days with fog[1]	3	5[3]	6[3]	8	24
Number of days with fog[2]	5	13	22	22	60
Fog frequency (number of hours)	19	67	106	111	303
Number of days with ice fog[2]	23	7	0	6	35
Ice fog frequency (number of hours)	156	28	0	20	203

Notes:
The days with fog in the climate normals include only days where the visibility is reduced to less than 1 km.
The number of days with fog and ice fog include all days when fog is recorded for at least 1 hour.
March through July data missing.
Source: IOL et al. (2004)

3.1.2.5 Variability/Trends within the Current Climate Normal Period

Several studies have documented a slight warming of air temperatures in the Mackenzie River Delta. It is anticipated that the Canadian Arctic will continue to experience greater warming and generally higher precipitation, according to the General Circulation Model. The General Circulation Model is one of Environment Canada's Global Climate Models that "Provide quantitative estimates of potential climate change by "modeling" the physical climate system". Any changes in mean annual temperature would most certainly affect the distribution of permafrost and thermokarst processes (Lawford and Cohen 1989). Environment Canada (1997a, 1997b) agrees with these observations.

In northern regions, warming is expected to be greatest on land, during winter. Winter precipitation and soil moisture are expected to increase over much of the North. Over the past 100 years, the average temperature of the Mackenzie Basin has risen by approximately 2.5˚C, with the greatest warming occurring in winter and spring (Environment Canada 1997a, 1997b; IOL et al. 2004).

3.1.2.6 Climate and Meteorological Conditions Relating to Air Quality

Data specific to air quality are discussed in the following paragraphs.

The meteorological conditions near the Project areas will determine how Project emissions are transported in the atmosphere and, as a result, how these emissions might change the air quality. These meteorological conditions describe the assimilative capacity of the environment with respect to air emissions. Data from Inuvik are used to describe the meteorological conditions in the airshed, as described in Sections 3.1.2.2 and 3.1.3.1).

Dispersion models are based on five full years of hourly meteorological input data to simulate the dispersion and transport of Project emissions. The specific parameters are wind speed and direction, temperature, precipitation, atmospheric stability and turbulence and mixing height.

Atmospheric stability can be viewed as a measure of the atmosphere's ability to disperse emissions. The amount of turbulence is important in determining how a plume is dispersed as it is transported by the wind. Turbulence can be generated either thermally or mechanically. Surface heating or cooling by radiation contributes to generating or suppressing thermal turbulence, and high wind speeds contribute to generating mechanical turbulence.

The Pasquill-Gifford (PG) stability classification is one method for classifying atmospheric stability. The classification ranges as follows: unstable (Stability classes A, B and C); neutral (Stability class D); and stable (Stability classes E and F).

Unstable conditions are primarily associated with daytime heating that results in enhanced turbulence, i.e., enhanced dispersion. Stable conditions are associated primarily with night-time cooling that result in suppressed turbulence, i.e., poorer dispersion. Neutral conditions are primarily associated with higher wind speeds or overcast conditions.

The mixing height is a measure of the depth of the atmosphere through which mixing of emissions can occur. The mixing height often exhibits a strong diurnal and seasonal variation. During the night, heights are lower, whereas during the day they are higher. Heights are typically lower in the winter and higher in the late spring and early summer.

To describe the meteorological conditions and dispersion in the airshed, data are summarized from IOL et al. (2004) using Inuvik data from 1994 to 1998.

Winds

The hourly winds at Inuvik were predominantly from the east, and most of the strong winds were from the northwest. The average speed of winds from the east is 10 km/h. The strong winds from the northwest can reach up to 109 km/h (IOL et al. 2005). Prevailing winds were easterly during the fall, winter and spring seasons. During summer, wind directions were more variable (IOL et al. 2004).

Temperature

The average temperature between 1994 and 1998 was -7.0°C (from 1994 to 1998), slightly higher than the long-term climate normal of -9.5°C. Hourly temperature data were used for the dispersion modelling.

Precipitation

There is a high annual and monthly variability in precipitation in Inuvik. Most of the precipitation occurred as rain in the summer, July and August.

Atmospheric Stability

Unstable conditions (Stability classes A, B and C) of the Pasquill-Gifford scheme occur in Inuvik about 20% of the time. Neutral conditions (Stability class D) occur about 46% of the time. Stable conditions (Stability classes E and F) occur about 34% of the time.

Mixing Height

Average mixing heights in Inuvik are typically higher during summer, at about 1,500 m. The most frequent mixing heights are in the 300 to 900 m range. These occur about 40% of the time. Mixing heights less than 300 m occurred only 4% of the time. Mixing heights greater than 3,000 m occur about 1% of the time.

3.1.2.7 Contribution of Traditional Knowledge

Research conducted by the Arctic Borderlands Ecological Knowledge Coop amongst northern communities in Alaska, the Yukon and the Northwest Territories over the last 10 years details many of the changes that northerners are witnessing in their environment. The findings of these studies are reflected in the comments of Traditional Knowledge interview participants, as summarized in the document entitled *Inuvialuit Settlement Region Traditional Knowledge Report* (ICC et al. 2006). The Traditional Knowledge, which is described in brief, in the following paragraphs, was used by the Developer to further understand climate conditions and variability from the local perspective, and to learn about potential conditions or issues that relate to Project design and implementation.

There were consistent observations of weather change and its effects from all three ISR communities (Inuvik, Tuktoyaktuk, and Aklavik); these include warmer and shorter winters, hotter summers, earlier breakup of river ice, later freeze-up, more wind, particularly west wind, and increased erosion due mostly to melting permafrost.

In addition, some Elders have noted more dampness in the air. Elders have become prone to pneumonia. Some participants report an unusual degree of variability in recent weather:

Some winters are mild, some winters are cold, some springs are short, some are long. Now you notice summer is really hot, next summer is really cold and last fall was mild fall - we were driving boat in November 2003, this year (2004) come around almost 40 below November 1st. When I was growing up July 1st there used to still be ice.

However, the last couple of winters suggest to some that intense winters are possibly returning to the area. Elders stated that long ago there would be storms that lasted three or four days, and that this trend appears to be coming back.

The fall months can bring rain and mud. Later in the fall, overflow can make travel on frozen water extremely dangerous. Fall-weather conditions impact fishing and therefore the ease of using the resources in the study area.

3.1.2.8 Synthetic Climate Data

No synthetic climate data has been generated for establishing the baseline climate conditions as the historical climate data was considered sufficient for determining the baseline condition.

3.1.2.9 Climate Change

Information collected over many years at northern climate stations, indicates that the climate in the Mackenzie Delta and the Mackenzie Valley region has been changing. Communities and other stakeholders are concerned about the potential effects of climate change on the northern environment and the economy.

Natural variability, expressed as averages over the last 30 years, shows variations in average annual temperatures of 3˚C to 6˚C in the Mackenzie Delta. Depending on the climate model scenario used, these exceed (by two to three times) the average annual temperature increases obtained from the model. Nonetheless, based on observed trends and future modeled predictions, there is a consistent and gradual warming trend. Generally, modeling results indicate a warming trend in air temperature of up to 2.5˚C and an increase in precipitation of up to 11.8% in the 30 years between 2010 and 2039 (IOL et al. 2004).

Inuvialuit Settlement Region

Table 3.1.2-6 summarizes the current climatic conditions as well as past and future climate trends in the Inuvialuit Settlement Region. Expected future temperature changes will be comparable to the changes that have occurred over the last 30 years. For example, the future predicted change in average temperature is between +1.3˚C and +2.5˚C. These values are similar to the +1.5˚C increase observed between 1971 and 2000. The current average annual temperature is -10.3˚C and the annual average winter temperature is -26.5˚C (IOL et al. 2004).

TABLE 3.1.2-6: CLIMATE CONDITIONS AND CHANGE IN THE INUVIALUIT SETTLEMENT REGION

Parameter	Current[1] Conditions	Trend (1971-2000)	Forecasted Trend[2] (2010- 2039)		
			Low	Medium	High
Average annual temperature (˚C)	-10.3	+1.5	+1.3	+1.6	+2.5
Average winter temperature[3] (˚C)	-26.5	+2.1	+1.3	+2.1	+2.2
Total precipitation[4,5] (mm)	191.0	+5.2	+2.1%	+7.4%	+11.8%

Notes:
1. Current conditions are based on observations from 1996-2000.
2. Trend estimate ranges (Burn 2003).
3. Winter temperatures include the months of December, January and February.
4. Total precipitation is presented as millimetres of equivalent rainfall.
5. Future trends are presented as percentage change from the 1961 to 1990 climate normals.
Source: IOL et al. (2004)

The future trend in total precipitation in this region ranges from 2.1 to 11.8% above the 1961-1990 climate normals. Total precipitation in the Inuvialuit Settlement Region has increased by 5.2 mm during the past 30 years. Current annual total precipitation is 191 mm (IOL et al. 2004). Section 4.5.1 of this Environmental Impact Statement discusses the possible effects of climate change on the future integrity of the Highway and current approaches to the mitigation of this concern.

Potential Climate Change and the Project

A risk-based approach for incorporating climate change into design of highway infrastructure on permafrost is now recommended practice. The challenge for design and construction over thaw sensitive permafrost terrain is to balance the capital cost of constructing the Highway, against long-term maintenance implications. The design parameters and construction techniques consider these risks and provide mitigative approaches in the Highway design and are discussed in Sections 3.1.1 and 4.2.1 of the document.

3.1.3 Air Quality

Air quality is determined by the concentrations of pollutants in the atmosphere, which are, in turn, affected by the dispersion of pollutants from emission sources.

The air quality baseline section addresses the interrelated subjects of ambient air quality, air emissions, and climate and meteorology. Ambient air quality is measured according to the concentration of airborne constituents in the environment or the rate at which these constituents are deposited. Air emissions are releases of gases or particles in the atmosphere that can contribute to changes in air quality that can result from anthropogenic (human) activities or natural sources. Climate is a measure of key atmospheric variables including temperature, precipitation and wind, while meteorology refers to the variability of these atmospheric variables, which determines how emissions might affect air quality (IOL et al. 2004).

Regulatory agencies have established standards and objectives to which ambient measurements are compared to determine the air quality (IOL et al. 2004).

3.1.3.1 Airshed Spatial boundaries

An airshed represents the space in which air emissions interact and defines the limits over which air quality models might meaningfully predict potential changes in air quality. There are no formal airshed designations or management areas used for government monitoring purposes. However, the proposed Highway falls within an area designated as the "northern airshed" by Imperial Oil and its partners for the environmental assessment of the Mackenzie Gas Project. This assessment included detailed model predictions for various pipeline facilities and the area encompasses the proposed Inuvik to Tuktoyaktuk Highway; therefore, the model predictions were deemed relevant for this Project (see Figure 3.1.2-1).

The northern airshed is a 150 km by 200 km area. The area extends from west of the Mackenzie River delta, north of Tuktoyaktuk, east of the Husky Lakes, and south of Inuvik. The northern airshed encompasses the Project's Regional Study Area (RSA) (defined as the area within 15 km of the Highway (30 km total width)) and Local Study Area (LSA) (defined as the area within 0.5 km of the Highway (1 km total width)). Most Project emission effects are expected to occur in this LSA.

3.1.3.2 Emission Sources and Factors Affecting Air Quality

Emission sources can have three different configurations, which have significantly different atmospheric dispersion characteristics. Point sources are emissions from well-defined stacks/exhausts or vents within industrial plants and electric utilities. Area or volume sources are emissions that come from a relatively large area such as windblown dust, emissions from furnaces in a residential area. Line sources are emissions from vehicles along a highway, which are the anticipated emission configuration for this proposed Project during the Operations Phase.

Due to the relatively remote location of the proposed Highway, there are very limited sources of emissions currently. Existing emission sources in the RSA include:

- Aviation, including all air traffic, i.e., fixed wing and rotary-wing aircraft;
- Marine sources, including seasonal boat traffic on the Mackenzie River or Husky Lakes;
- Community sources, including local and winter road traffic, off-road (i.e., snowmachines) traffic, vehicle refuelling and residential heating (e.g., fuel oil, natural gas, wood combustion);
- Other industrial sources, including existing oil and gas operations in the region (IOL et al. 2004); and
- Natural sources, including forest fires (GNWT ENR 2009e).

Air emissions undergo one or more of the following processes: atmospheric dispersion, atmospheric chemistry, and/or atmospheric deposition. Atmospheric dispersion is the physical process that transports and disperses air emissions, resulting in increased ground-level concentrations and direct effects on air quality. Atmospheric chemistry involves the processes that transform emissions as they are dispersed in the atmosphere, resulting in increased acid deposition. Atmospheric deposition is the process associated with removal of emissions dispersed in the atmosphere and their deposition onto the ground, e.g., dust deposition and acid deposition. The result of these processes can cause three possible changes in air quality: increased ambient concentrations, acid deposition, and/or dust deposition (IOL et al. 2004).

Factors that affect the concentration of air pollutants in the atmosphere include:

- The geometric configuration (e.g., point/line/area source), and geography in the vicinity of the emission site (e.g., lakes, valleys);
- The total amount of pollutant emitted;
- The meteorological conditions; and
- The amount of pollutant emitted (SENES 2005).

Weather plays an important role in the dispersion of air pollutants. Meteorology is a vital part of predicting both the current air quality as well as developing any strategies to improve the future situation. The parameters of particular importance are wind speed and direction, and atmospheric stability. The amount of sunshine also directly influences photochemical production of secondary pollutants (SENES 2005).

Air quality issues such as regional scale smog, acid deposition, and the concentration of hazardous air pollutants in the lower levels of the atmosphere are linked to climate through temperature, precipitation, humidity, solar radiation, cloudiness and the large scale circulation of the atmosphere which acts to re-distribute air pollutants through long range transport (SENES 2005).

3.1.3.3 Ambient Air Quality Standards

The *Canadian Environmental Protection Act* (CEPA) is the principal Act for the regulation of environmental contaminants. The CEPA allows the federal government to regulate and control substances through national quality objectives, guidelines and/or standards (Health Canada 2006). Under CEPA, the federal government can assess air pollutants and control their impact through the setting of National Ambient Air Quality Objectives (NAAQOs) and Canada-wide Standards (CWSs).

National Ambient Air Quality Objectives (NAAQOs) identify benchmark levels of protection for people and the environment. NAAQOs guide federal, territorial and regional governments in making risk-management decisions, such as local source permitting and air quality index, and are viewed as effects-based long-term air quality goals. The current framework establishes a national goal for outdoor air quality that protects health, the environment, or aesthetic properties of the environment. NAAQOs are established under CEPA but may be used differently in each province or territory (Health Canada 2006).

In June 2000, the Canadian Council of Ministers of the Environment[1] (CCME) endorsed a Canada-wide Standards (CWS) Agreement for Particulate Matter (PM) and Ozone in air, in accordance with the 1990 *Canada-wide Accord on Environmental Harmonization* and its *Canada-wide Environmental Standards Sub-Agreement*. The CWSs are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe (Health Canada 2006).

Airborne particulates (or particulate matter) and ground-level ozone have been identified as priority substances for the development of CWS. In particular, the Agreement established numerical ambient concentration targets for $PM_{2.5}$ (fine particulate matter) and ozone that are to be met by 2010 (CCME 2007).

The CWS Agreement commits jurisdictions to implementation of programs under CCME's Guidance Document on Continuous Improvement and Keeping-Clean-Areas-Clean (CCME 2007). The programs must address the following pollutants:

- In the ambient environment:
  - ozone and $PM_{2.5}$
- In emissions:
  - direct $PM_{2.5}$ emissions
  - the $PM_{2.5}$ and ozone precursor pollutants NOx and VOCs
  - the $PM_{2.5}$ precursor pollutants SO_2 and NH_3

[1] With the exception of Quebec.

Although there is evidence of health effects due to the coarse fraction, the current Canada-wide Standards do not include a target for particulates larger than $PM_{2.5}$ (i.e., $PM_{2.5\text{-}10}$) as available information is not sufficient to suggest a standard at this time (CCME 2007). However, it is recommended by CCME (2007) that where monitoring facilities are in place, ambient $PM_{2.5\text{-}10}$ data be reported in at least one of the statistical forms similar to that specified for $PM_{2.5}$.

CCME (2007) acknowledges that despite the absence of local significant anthropogenic sources, such as a large city, the ambient levels of $PM_{2.5}$ and ozone in a given area may be close to or may exceed the levels of the Canada-wide Standard.

The GNWT, under the NWT *Environmental Protection Act*, developed the *Guideline for Ambient Air Quality Standards in the Northwest Territories: Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) Ground Level Ozone (O_3), Total Suspended Particulate (TSP), Fine Particulate Matter ($PM_{2.5}$)* (GNWT ENR 2011). The guideline sets standards for the maximum concentrations of CO, SO_2, NO_2, O_3, TSP and $PM_{2.5}$ acceptable in ambient air throughout the Northwest Territories. These standards are applied as a long term management goal for air quality (GNWT ENR 2011).

Table 3.1.3-1 identifies the territorial and federal ambient air quality standards.

TABLE 3.1.3-1: TERRITORIAL AND FEDERAL AMBIENT AIR QUALITY STANDARDS

Parameter and Averaging Time	NWT Ambient Air Quality Standards	National Ambient Air Quality Objectives (NAAQO)			Canada-wide Standards
		Max. Desirable Level	Max. Acceptable Level	Max. Tolerable Level	
Fine Particulate Matter ($PM_{2.5}$)					
24-hours	30 µg/m³	--	--	--	30 µg/m³
Total Suspended Particulate (TSP)					
24-hours	120 µg/m³	--	120 µg/m³	400 µg/m³	--
Annual	60 µg/m³	60 µg/m³	70 µg/m³	--	--
Carbon Monoxide (CO)					
1-hour	13,000 ppb 15,000 µg/m³	13 ppm	31 ppm	--	--
8-hours	5,000 ppb 6,000 µg/m³	5 ppm	13 ppm	--	--
Ground Level Ozone (O_3)					
1-hour	--	51 ppb	82 ppb	153 ppb	--
8-hours	65 ppb 130 µg/m³	--	--	--	65 ppb
24-hours	--	15 ppb	25 ppb	--	--
Annual	--	--	15 ppb	--	--

TABLE 3.1.3-1: TERRITORIAL AND FEDERAL AMBIENT AIR QUALITY STANDARDS					
Parameter and Averaging Time	NWT Ambient Air Quality Standards	National Ambient Air Quality Objectives (NAAQO)			Canada-wide Standards
		Max. Desirable Level	Max. Acceptable Level	Max. Tolerable Level	
Sulphur Dioxide (SO_2)					
1-hour	172 ppb 450 μg/m³	172 ppb	334 ppb	--	--
24-hours	57 ppb 150 μg/m³	57 ppb	115 ppb	306 ppb	--
Annual	11 ppb 30 μg/m³	11 ppb	23 ppb	--	--
Nitrogen Dioxide (NO_2)					
1-hour	213 ppb 400 μg/m³	--	213 ppb	532 ppb	--
24-hours	106 ppb 200 μg/m³	--	106 ppb	160 ppb	--
Annual	53 ppb 60 μg/m³	32 ppb	53 ppb	--	--

Units: μg/m³ = Micrograms per cubic metre
ppb = parts per billion by volume
ppm = parts per million by volume
Sources: GNWT ENR (2011); Health Canada (2006); CCME (2007)

3.1.3.4 Air Quality Monitoring Stations

The GNWT ENR monitors air quality in the Northwest Territories (NWT). ENR maintains and operates the NWT Ambient Air Quality Monitoring Network, consisting of four monitoring stations located in Yellowknife, Inuvik, Fort Liard and Norman Wells. Each station is capable of continuously sampling and analyzing a variety of air pollutants and meteorological conditions. The Yellowknife and Inuvik stations are operated in partnership with the National Air Pollution Surveillance (NAPS) program, a joint federal/provincial/territorial monitoring network, with the objective of tracking urban air quality trends throughout Canada. A secondary overall objective of the stations is to establish baseline levels of SO_2, H_2S, NOx, O_3 and PM ahead of development as well as track the trends and cumulative impacts from source emissions should they occur (GNWT ENR 2009e).

No long-term historic air quality measurements have been made near the Project. Limited, historic, short-term air quality measurements for SO_2, NO_2, and O_3 were conducted in 1972 and 1973 near Inuvik and Richards Island (F.F. Slaney and Co. Ltd. 1973b, 1973c). Continuous air quality monitoring has been in place in Inuvik since October 1, 2004.

The Inuvik monitoring station collects continuous data using a 60 minute timebase. Information for this indicator is obtained from the NWT Air Quality Monitoring Network, which is operated by GNWT ENR in collaboration with Environment Canada.

The National Pollutant Release Inventory (NPRI) is Canada's legislated, publicly-accessible inventory of pollutant releases (to air, water and land), disposals and transfers for recycling. Over 8,600 facilities across Canada reported to the NPRI on more than 300 listed substances, including facilities in Inuvik and Tuktoyaktuk. Monitoring data are reported for Inuvik (from the NWT Air Quality Monitoring Network) and release data are reported for the NWT (NPRI) (Environment Canada 2010f). Air quality data will be reported for the northern airshed and not divided into RSA and LSA for this proposed Project.

Parameters Monitored

Parameters monitored at the Inuvik Air Quality Monitoring Station include: fine and coarse particulate matter ($PM_{2.5}$ and PM_{10}); sulphur dioxide (SO_2), hydrogen sulphide (H2S), nitrogen oxides (NOx), and ground level ozone (O_3). Wind speed and direction and precipitation are also monitored (GNWT ENR 2009e). Data have been recorded at this station continuously since October 1, 2004.

Table 3.1.3-2 compares the parameters monitored at Inuvik compared to substances listed in NWT Ambient Air Quality Objectives, National Ambient Air Quality Objectives and Canada-wide Standards.

TABLE 3.1.3-2: COMPARISON OF PARAMETERS MONITORED AT INUVIK TO FEDERAL AND TERRITORIAL STANDARDS AND OBJECTIVES

	Parameters Monitored at Inuvik	Parameters Listed Under:		
		NWT Ambient Air Quality Objectives	National Ambient Air Quality Objectives	Canada-wide Standards
Fine Particulate Matter ($PM_{2.5}$)	✓	✓		✓
Coarse Particulate Matter (PM_{10})	✓			
Total Suspended Particulate (TSP)		✓	✓	
Hydrogen Sulphide (H_2S)	✓			
Carbon Monoxide (CO)		✓	✓	
Ground Level Ozone (O_3)	✓	✓	✓	✓
Sulphur Dioxide (SO_2)	✓	✓	✓	
Nitrogen Dioxide (NO_2)	✓	✓	✓	

Sources: GNWT ENR (2011); Health Canada (2006); CCME (2007)

Total suspended particulate (TSP) is a general term for dust. TSP includes a wide variety of solid and liquid particles found floating in the air, with a size range of approximately 50 micrometres (µm) in diameter and smaller (a human hair is approximately 100 µm in diameter). While TSP can have environmental and aesthetic impacts, it is the smaller particles contained within TSP that are of concern from a human health. Road dust, forest fires, mining activities and combustion products from vehicles, heating and electricity generation contribute to TSP levels.

Total suspended particulates are not monitored at the Inuvik station.

Fine Particulate Matter ($PM_{2.5}$) is the fraction of particulate matter with a diameter of 2.5 microns or less. It can be directly emitted, usually from combustion sources, or formed in the atmosphere due to reaction of precursor pollutants such as NOx, SO_2 and ammonia (NH3). Smoke from forest fires can result in widespread high concentrations of $PM_{2.5}$ at great distances from the fire source. Due to its microscopic size, $PM_{2.5}$ can be inhaled deep into the lungs and is associated with a range of human health concerns, especially heart and respiratory effects. It also causes visibility degradation (GNWT ENR 2009e).

Coarse Particulate Matter (PM_{10}) is the fraction of particulate matter with a diameter of 10 microns or less (i.e., the sum of the coarse and fine fractions). It is comprised of coarser material than $PM_{2.5}$ but is still inhalable. It is therefore associated with the same health concerns as $PM_{2.5}$. Some of the sources of PM_{10} include dirt and dust from roads and industrial activities, natural deposition of sand and soil, and pollen (GNWT ENR 2009e).

Carbon monoxide (CO) is a colourless, odourless gas emitted from numerous sources associated with burning of fuel (i.e., industrial activities, commercial and home heating, vehicle use). Natural sources such as forest fires also contribute to ambient carbon monoxide concentrations. Carbon monoxide affects humans and animals by interfering with the ability of the blood to carry oxygen around the body (GNWT ENR 2009e). Carbon monoxide is not monitored at the Inuvik station.

Ground level ozone (O_3) should not be confused with stratospheric O_3, which occurs at much higher elevations and forms a shield that protects life on the planet from the sun's harmful ultraviolet radiation. The gas is the same, but at ground level O_3 is regarded as undesirable due to its association with a variety of human health concerns, environmental impacts and property damage. O_3 is a highly reactive gas and is defined as a secondary pollutant. It is not emitted in large quantities from any source, but is formed through a series of complex chemical reactions involving other pollutants called precursors (e.g. NOx and volatile organic compounds or VOCs) in the presence of sunlight.

Sulphur dioxide (SO_2) is a colourless gas, with a pungent odour at elevated concentrations, which can have negative effects on human and environmental health. Certain types of vegetation (especially lichens) are very sensitive to SO_2 impacts. SO_2 also plays a role in acid deposition and formation of secondary fine particulate through chemical reactions with other pollutants in the air.

There are some natural sources of SO_2 in ambient air (forest fires, volcanoes), but human activity is the major source. Emissions of SO_2 primarily result from the burning of fossil fuels containing sulphur. Sources include natural gas processing plants, gas plant flares and oil refineries, metal ore smelting, power generating plants and commercial or residential heating.

Nitrogen oxides (NOx) consist of a mixture of nitrogen-based gases, primarily nitric oxide (NO) and nitrogen dioxide (NO_2). Emissions of both NO and NO_2 results from the high temperature combustion of fossil fuels. The predominant emission is NO, which then rapidly converts to NO_2 through chemical reaction in the atmosphere. NO is a colourless and odourless gas, whereas NO_2 is a reddish-brown colour with a pungent, irritating odour.

Greenhouse Gas (GHG) is a group of gases collectively referred to as greenhouse gases (GHGs), which primarily include carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O). GHG in the atmosphere absorbs and emits radiation within the thermal infrared range. Burning fossil fuels has increased the levels of carbon dioxide in the atmosphere. Increasing concentrations of greenhouse gases in the atmosphere are likely contributing to a rise in global temperatures, with potentially adverse effects to human and environment health.

For the purpose of this assessment, the rationale used to select key indicators includes:

- Substance emissions are monitored at the regional level, in Inuvik;
- Substance emissions have territorial and/or federal standards and objectives; and/or
- Substance emissions are directly related to this Project, such as coarse particulate matter and greenhouse gas (as it relates to vehicle emissions).

The key indicators selected for this Project include:

- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx);
- Ground level ozone (O_3);
- Greenhouse gas; and
- Visibility.

3.1.3.5 Air Quality Baseline Data

To establish a basis for consideration of ambient air quality conditions expected to occur in the Project area, a review of ambient air quality monitoring data for the Inuvik area was conducted. The following subsections summarize data from the 2009 NWT Air Quality Report (GNWT ENR 2009e). Due to mechanical failure of nitrogen oxide monitoring equipment at Inuvik in 2009, additional data from the 2008 NWT Air Quality Report are also reported (GNWT ENR 2008a). Territorial level greenhouse gas emissions are also summarized from the 2009 NWT State of the Environment Report (GNWT ENR 2009a). Where possible, historic or comparative data for the region or the territory are provided.

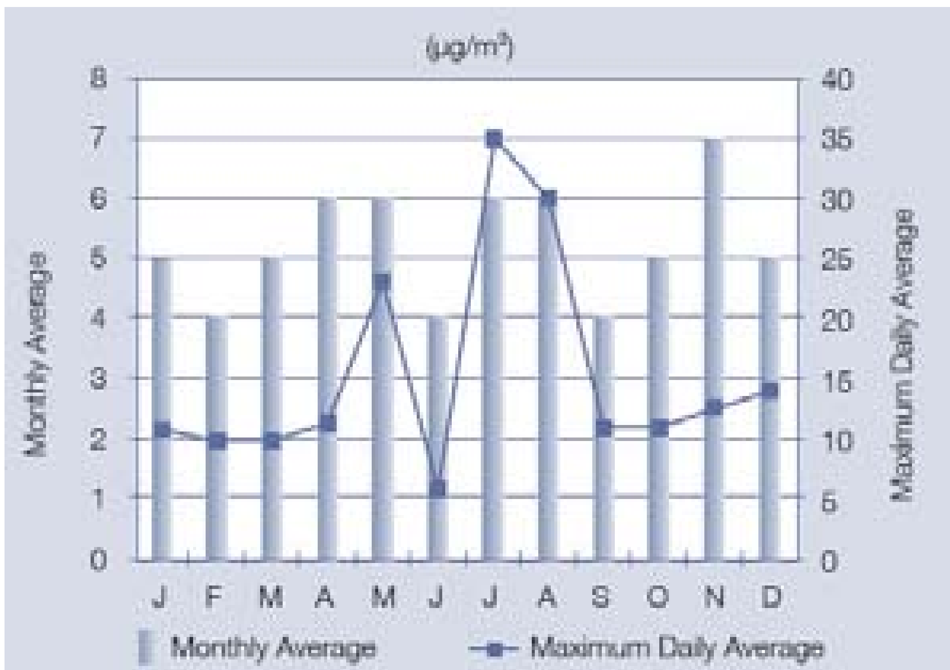
The overall air pollutant emissions for Northwest Territories, per sector and source are identified in Table 3.1.3-3 (Environment Canada 2010f). Data specific to Inuvik are discussed in the following subsections.

Overall, air quality in Inuvik in 2009 remained excellent for the most part, although the effects of dust were noticeable throughout the summer. Forest fire smoke, measured as fine 'dust' ($PM_{2.5}$), was elevated in the air in Inuvik on occasion in July and August. The coarse particle 'dust' (PM_{10}) monitor showed some high readings in the spring months related to the residual gravel on the roads following the snow melt (GNWT ENR 2009f).

Fine Particulate Matter ($PM_{2.5}$)

The 2009 Beta Attenuation Monitor (BAM) readings produced an annual $PM_{2.5}$ average of 5 $\mu g/m^3$. There were only two exceedances of the NWT 24-hour standard (30 $\mu g/m^3$) for $PM_{2.5}$, which occurred in July. These exceedances are attributed to long distant transport of smoke from forest fires burning in Alaska and the Yukon at that time. Relative to previous years, impacts from forest fires were negligible in 2009.

Figure 3.1.3-1 shows the monthly averages and maximum daily averages of $PM_{2.5}$ measured at the Inuvik station in 2009. The maximum 24-hour $PM_{2.5}$ value of 35 $\mu g/m^3$ occurred during the month of July and was attributed to forest fire smoke.



Source: Figure 11, 2009 NWT Air Quality Report (GNWT ENR 2009e)

Figure 3.1.3-1: Fine Particulate Matter ($PM_{2.5}$) at Inuvik, 2009

This substance was not monitored in the region prior to October 2004. However, historic data from Yellowknife, monitored from 2000 to 2002, indicates that the average $PM_{2.5}$ levels ranged from 3 to 5 $\mu g/m^3$ (IOL et al. 2004).

TABLE 3.1.3-3: AIR POLLUTANT EMISSIONS FOR NORTHWEST TERRITORIES, 2008							
SECTORS	TPM (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	SOx (tonnes)	NOx (tonnes)	VOC (tonnes)	CO (tonnes)
Industrial Sources							
Cement and Concrete Industry	71	22	10				
Mining and Rock Quarrying	564	239	91	9	4275	300	1469
Upstream Petroleum Industry	14	13	13	61	271	262	93
Downstream Petroleum Industry						35	
Petroleum Product Transportation and Distribution	2	2	2				
TOTAL INDUSTRIAL SOURCES	**651**	**276**	**116**	**70**	**4546**	**597**	**1562**
Non-Industrial Sources							
Commercial Fuel Combustion	10	8	7	4	110	4	56
Electric Power Generation (Utilities)	126	99	99	320	2,663	39	176
Residential Fuel Combustion	7	4	3	6	76	2	19
Residential Fuel Wood Combustion	266	251	251	3	24	387	1,576
TOTAL NON-INDUSTRIAL SOURCES	**407**	**361**	**360**	**334**	**2,873**	**432**	**1,827**
Mobile Sources (v6.7)							
Air Transportation	19	19	19	35	389	123	1,561
Heavy-duty diesel vehicles	11	11	11	1	345	13	83
Heavy-duty gasoline trucks	0	0	0	0	21	9	173
Light-duty diesel trucks	1	1	0	0	6	3	4
Light-duty diesel vehicles	0	0	0	0	1	0	1
Light-duty gasoline trucks	1	1	1	1	122	170	2,964
Light-duty gasoline vehicles	0	0	0	1	139	194	3,108
Marine Transportation	0	0	0	1	6	1	1
Motorcycles	0	0	0		2	3	24
Off-road use of diesel	69	69	67	9	990	84	447
Off-road use of gasoline/LPG/CNG	41	41	38	0	236	1,140	7,039
Rail Transportation	2	2	2	1	63	2	10
Tire wear & Brake Lining	4	4	1				
TOTAL MOBILE SOURCES	**150**	**150**	**140**	**49**	**2,319**	**1,742**	**15,414**
Incineration Sources							
Industrial & Commercial Incineration	0	0	0	0	0	0	1
TOTAL INCINERATION	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Miscellaneous Sources							
Cigarette Smoking	1	1	1			0	4
General Solvent Use						187	
Meat Cooking	11	11	11				
Refined Petroleum Products Retail						24	
Printing						2	
Structural Fires	1	1	1			1	5
Surface Coatings						52	
TOTAL MISCELLANEOUS	**13**	**13**	**13**			**265**	**8**
Open Sources							
Agriculture	2	0	0				
Construction Operations	190,276	56,382	10,996	0	1	0	0
Dust from Paved Roads	2,749	527	126				
Dust from Unpaved Roads	7,866	2,358	312				
Waste	11	6	6	0	2	28	31
Mine Tailings	898	72	18				
TOTAL OPEN SOURCES	**201,801**	**59,345**	**11,459**	**1**	**3**	**28**	**31**
Natural Sources							
Biogenics (vegetation, soils) and Forest Fires	52,034	44,229	36,424	31	20,816	2,282,518	428,515
TOTAL NATURAL SOURCES	**52,034**	**44,229**	**36,424**	**31**	**20,816**	**2,282,518**	**428,515**
GRAND TOTAL	**255,057**	**104,375**	**48,511**	**485**	**30,557**	**2,285,583**	**447,359**
WITHOUT OPEN AND NATURAL SOURCES	**1,222**	**801**	**629**	**454**	**9,738**	**3,037**	**18,813**

Notes:
1. A blank space indicates that no emissions data is available or applicable.
2. "0" indicates that the value was approximated to zero, as the value was very small in the context of the sector and pollutant.
3. The emission totals and sub-totals may not add up exactly, due to rounding.
4. The air pollutant emissions data was compiled in collaboration with provincial, territorial and regional environmental agencies using the latest emission estimation methodologies. It represents the most comprehensive information on emissions of key air pollutants available in Canada.
5. Emission summaries and trends for a given year may be different from those previously published by Environment Canada, other governmental agencies and international organizations.
6. A portion of emissions from the Marine Transportation sector is attributed to movement ("innocent passage") of domestic and international commercial vehicles through provincial waters. These emissions have been proportionally allocated to the provinces nearest to the release of the emissions in the different waterways.

Source: Environment Canada (2010f)

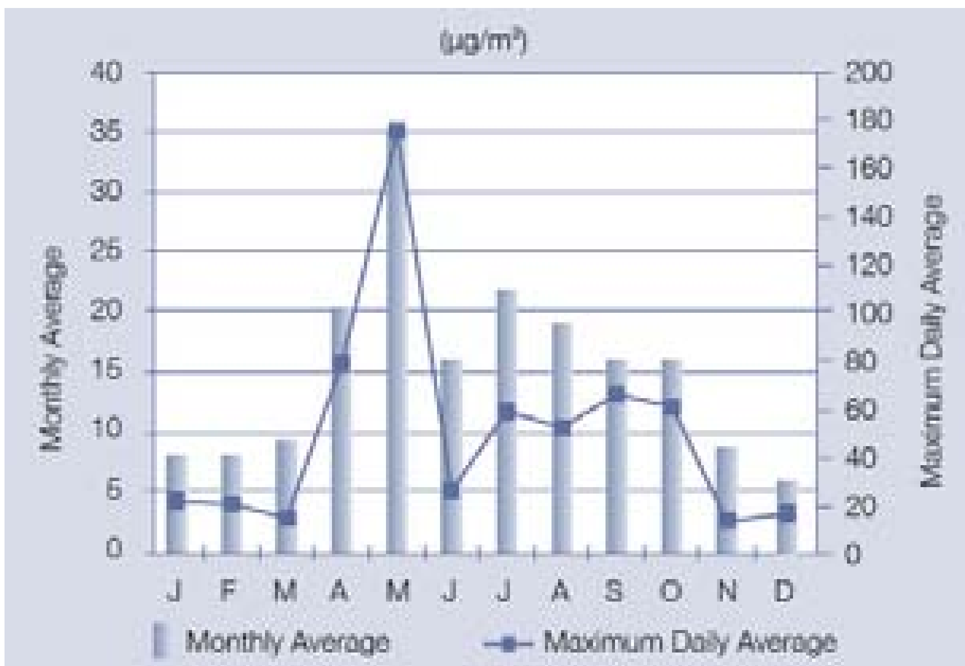
Coarse Particulate Matter (PM_{10})

The maximum daily average measured from the PM_{10} BAM in Inuvik in 2009 was 175µg/m^3, recorded in May, which coincided with the highest hourly maximum (415µg/m^3). There were 10 exceedances of the adopted 24-hour standard (50µg/m^3), which generally occurred in the snow-free months. Similar to previous years, the spring-time levels were elevated and were representative of the typical 'spring-time dust event' associated with residual winter gravel.

The PM_{10} exceedances were more numerous than previous years, which may be attributed to influences from local construction activities.

Figure 3.1.3-2 shows the monthly averages and the maximum daily average concentrations of PM_{10} from the BAM in Inuvik. The spring spike is attributed to the residual winter gravel following the thaw.

Historic or comparative data is not available for the region or territory.



Source: Figure 12, 2009 NWT Air Quality Report (GNWT ENR 2009e)

Figure 3.1.3-2: Coarse Particulate Matter (PM10) at Inuvik, 2009

Sulphur Dioxide (SO_2)

The 2009 annual average was less than 1 µg/m^3, the maximum 1-hour average was 8 µg/m^3. The SO_2 concentrations measured in 2009 were very low and similar to previous year's results, with no exceedances of the NWT hourly (450 μg/m³), 24-hour (150 μg/m³) and annual average (30 μg/m³) standards.

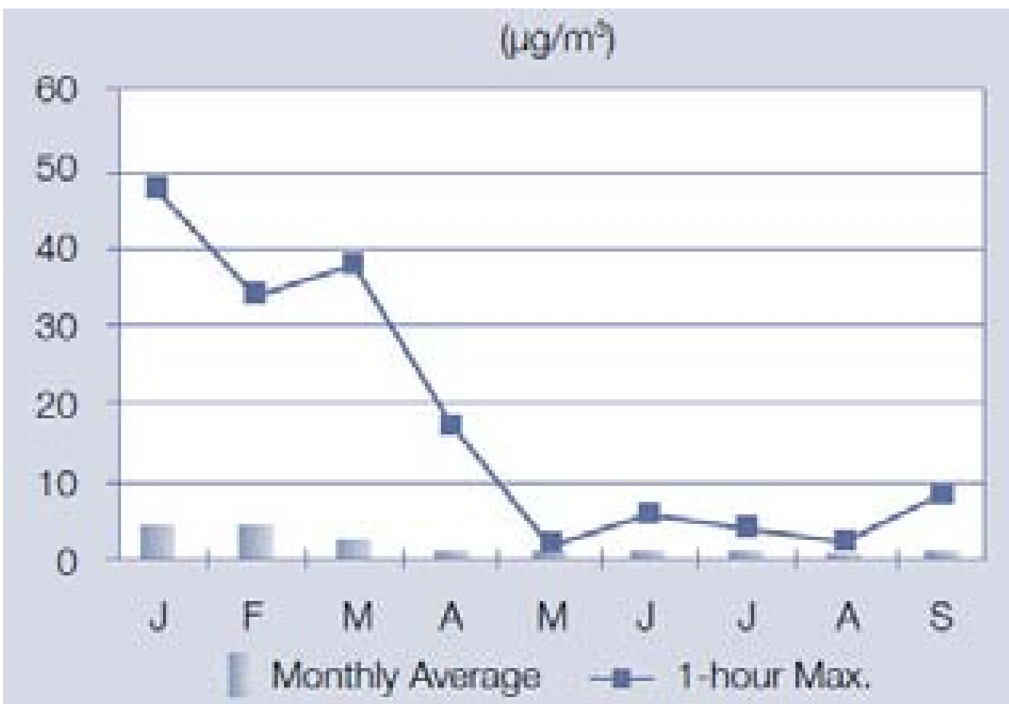
In comparison, IOL et al. (2004) passively monitored SO_2 levels in Inuvik from August 2001 to September 2002. During that time, the annual average of SO_2 was 0.1 ppb or 0.41 μg/m³.

Nitrogen Oxides (NOx)

The focus of NOx monitoring is on the NO_2 portion in determining air quality, although NO is of interest for other reasons (e.g. assessment of secondary pollutant formation).

The Inuvik NOx analyzer suffered a serious breakdown in October of 2008 and was not fully operational again until November of 2009. This resulted in the inability to record NO_2 data for 2009. The following information is based on data recorded during the nine months when the analyzer was operational in 2008.

The 2008 Inuvik data show that there were no exceedances of the 1-hour and 24-hour national and territorial standards for NO_2 (GNWT ENR 2008a). The maximum 1-hour average was 48 μg/m³ and the annual average was 2 μg/m³. Figure 3.1.3-3 shows the 2008 monthly averages and highest hourly concentrations.



Source: Figure 13, 2008 NWT Air Quality Report (GNWT ENR 2008a)

Figure 3.1.3-3: Nitrogen Dioxide (NO_2)at Inuvik, 2008

Figure 3.1.3-3 shows both the highest monthly averages and the highest hourly concentrations of NO_2 occurred during the winter months. Meteorological data collected over the last four winters has shown that Inuvik is prone to winter inversions and experiences more inversion days than the other three regions. It is not uncommon in the middle of winter to see consecutive days of extremely cold temperatures accompanied with very low wind speeds (calms), reducing dispersal of pollutants.

In comparison, nitrogen dioxide was passively monitored from August 2001 to September 2002 in the Inuvik region. The annual average concentration was 0.4 ppb or 0.8 μg/m³ (IOL et al. 2004).

Ground Level Ozone (O_3)

The maximum 1-hour average was 112 μg/m³, while the maximum 8-hour average was 106 μg/m³. Neither the 1-hour national standard (160 μg/m³) nor the 8-hour NWT standard (130 μg/m³) for ground level ozone was exceeded in 2009. The annual average was 40 μg/m³, which is typical of background levels.

The typical elevated readings in the spring-time were observed, which is consistent with historical data.

Figure 3.1.3-4 shows the maximum hourly and maximum 8-hour average per month as well as the monthly averages for ground level ozone recorded in 2009.

Source: Figure 13, 2009 NWT Air Quality Report (GNWT ENR 2009e)

Figure 3.1.3-4: Ground Level Ozone (O_3) at Inuvik, 2009

Historic, short-term monitoring in the region conducted in 1972 and 1973 indicated that ozone levels were low, i.e., below the method detection limits (F.F. Slaney and Co. Ltd. 1973b, 1973c). Additional passive field monitoring was completed near Inuvik from August 2001 to September 2002 to determine background ozone levels. Consistently elevated ground level ozone concentrations were identified (i.e., annual average concentration of 23.7 ppb or 46.5 μg/m³), that likely result from the intrusion of stratospheric ozone from

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weather systems passing through the region (IOL et al. 2004). The stratosphere (i.e., the region of the atmosphere containing the ozone layer) is closer to the ground at high latitudes than farther south (IOL et al. 2004).

Carbon Monoxide (CO)

Carbon monoxide is not actively monitored at the Inuvik station. Carbon monoxide in the environment typically results from partial or incomplete combustion, usually from vehicle exhaust. Given the absence of anthropogenic sources, such as vehicles, near the proposed route (other than intermittent snowmachines and aircraft), background CO levels were assumed to be zero for the air quality assessment.

However, the Northwest Territories Power Plant for Inuvik reports 70 tonnes of carbon monoxide emitted in 2009 (Environment Canada 2008).

Greenhouse Gas Emissions

Greenhouse gas emission data are collected at the territorial level. Currently the NWT is producing around 2300 Kt of CO2e /year. GHG emissions in the NWT are increasing steadily. The increase is being caused primarily by resource development activities. The mining sector currently dominates as the major GHG emitter but the Mackenzie Gas Project, if developed, would place the oil and gas sector on top as the major GHG producer (GNWT ENR 2009a). By 2020 it is projected that the NWT will be emitting around 3800 Kt of CO2e/year, a 65% increase in emissions from current levels (GNWT ENR 2009a).

3.1.3.6 Climate and Meteorological Conditions Relating to Air Quality

Climate and meteorology conditions relating to air quality are described in Section 3.1.2.

3.1.4 Noise

Although noise is sometimes considered to be any sound it is more correctly defined as loud, unwanted, unpleasant or unexpected sound. Noise is considered during an EIS because it has the potential to affect both humans and wildlife. Typically, noise considerations relate to occupational noise impacts. However, environmental noise effects are also important.

Noise effects assessments compare expected future noise levels to existing noise levels. This baseline section characterizes the current sound environment (i.e., noise level) in the vicinity of the proposed Highway. Baseline conditions are based primarily on work conducted during the Mackenzie Gas Project (IOL et al. 2004) and on broad guidelines established by various agencies.

The descriptor used to measure environmental sound is the energy equivalent sound level (L_{eq}). The L_{eq} value, expressed in decibels (dBA), is the energy-averaged, A-weighted sound level for the complete measurement interval. It is the steady, continuous sound level over a given period that has the same acoustic energy as the actual varying sound levels occurring over the same period in the measured environment.

3.1.4.1 Noise Spatial Boundaries

The spatial boundary for noise is represented by the area in which effects are likely to occur. The local study area is considered to be within 0.5 km of the Highway center-line while the regional study area is defined the area within 15 km of the Highway center-line.

3.1.4.2 Relevant Standards and Guidelines

Federal, provincial and municipal levels of government have different roles and responsibilities with respect to noise-related issues. Standards related to noise levels are primarily directed at occupational exposure limits. Guidelines for environmental noise levels are less developed and have been produced primarily in the United States.

Construction noise has traditionally been excluded from impact assessments because, although it can have great magnitude, it is usually temporary in nature.

Occupational

Federal

The federal government is responsible for establishing and ensuring compliance with standards for noise emission labelling and maximum noise emission for consumer products, equipment, and vehicles. As well, the federal government also establishes guidelines for noise control over interprovincial transportation systems including aircraft, trains and navigable waterways. Health Canada is legally required to provide expert advice on the health effects of environmental noise to environmental assessments involving other federal departments.

Federal noise exposure regulations are found in the *Canada Labour Code* (Part II) and the *Canada Occupational Health and Safety Regulations* (Section 7). Section 7.4 states that "no employee shall, in any 24 hour period, be exposed to a noise exposure level (L_{ex} 8) that exceeds 87 dBA."

Provincial/Territorial

Provincial and territorial governments establish guidelines for noise control in land use planning. They authorize and assist municipalities in creating and implementing municipal plans and noise control by-laws to abate individual sources of noise. Provincial and territorial governments are also responsible for controlling the operational noise levels of many consumer products, equipment and vehicles.

Noise exposure limits in Northwest Territories workplaces are found in the *General Safety Regulations* under the territorial *Safety Act* (Section 30 and 31, Schedule A, Table 1). Table 3.1.4-1 summarizes these limits:

TABLE 3.1.4-1: NWT *SAFETY ACT* – OCCUPATIONAL NOISE EXPOSURE LIMITS	
Continuous Noise	
Sound Level (dBA)	**Maximum Exposure (hours per day)**
80	16
85	8
90	4
95	2
100	1
105	0.5
110	0.25
115	0.125
>115	0
Impulse Noise	
Peak Sound Pressure Level (dBA)	**Maximum Permitted (impulses per 8 hours)**
120	10,000
130	1,000
140	100
>140	0

An employer must ensure that an employee is not working with noise levels above the limits set in the regulation. The limit is 85 decibels for 8 hours within a 24 hour period. If the employee works with noise levels higher than 85 decibels for 8 hours, then the employer must decrease the number of hours the employee works at that noise level, according to precise noise levels and work hours set in the regulation. If the noise level is higher than the legal limit, the employer must provide the employee special hearing protection equipment. Prior to providing the hearing protection equipment, the employer is legally obliged to try to decrease the noise level and separate the employee from the source of the noise.

Municipal

Most noise control legislation has been enacted at the municipal level. Municipalities exercise environmental noise control through municipal noise control by-laws, municipal land use plans and zoning, traffic management and road noise barrier retrofit programs.

The Highway is located outside of municipal boundaries; therefore, municipal noise by-laws are not applicable. However, typical municipal regulations limit construction activities to “normal working hours” to minimize disturbance. Normal working hours are often defined as 07:00 to 19:00, Monday to Friday, with work outside these times requiring a municipal variance.

3.1.4.3 Environmental

The NWT has no acceptability criteria for noise levels associated with construction activities or road activities. Little information is available for acceptable limits of environmental noise.

3.1.4.4 Existing Noise Conditions

The proposed Highway is located in a remote, generally uninhabited area of NWT. Existing noise conditions are dominated by natural environment contributions such as wind and rain (IOL et al. 2004). Anthropogenic contributions are associated with annual winter traffic on the existing winter road, local off-road ATV and snowmachine traffic, helicopter and aircraft overflights, and associated hunting that occur seasonally in the area.

Typical noise level of quiet outdoors is 35 dBA; intermittent sources, such as winter traffic, measure in the 75 to 85 dBA range (Alberta EUB 2007). Elevated noise levels, from traffic, aircraft, all-terrain vehicles, and snowmachines are infrequent, of short duration, and transient in nature. Therefore, current noise conditions along the proposed route are expected to mostly be at 35 dBA with occasional peaks of 75 to 85 dBA when off-road vehicles or aircraft pass through the area.

3.1.4.5 Previous Noise Monitoring

Baseline sound levels have been recorded at the proposed Mackenzie Gas Project's Inuvik Area Facility which was considered representative of ambient sound levels along most of the pipeline corridor. Measurements were recorded in December 2002 (winter) and July 2003 (summer) to account for seasonal variations that may affect sound levels. Table 3.1.4-2 summarizes the measurement results.

TABLE 3.1.4-2: BASELINE SOUND LEVELS AT INUVIK AREA FACILITY

Survey Period	Sound Level				
	Daytime L_{eq} Day (dBA)	Night-time L_{eq} Night (dBA)	Daily L_{eq} (dBA)	Minimum Hourly L_{eq} (dBA)	Maximum Hourly L_{eq} (dBA)
Dec. 3-4, 2002	21	19	20	17	24
July 5-6, 2003	33	25	31	21	39

Source: IOL et al. (2004)

Sound levels at the survey sites were low and were consistent with remote environments. During periods when the winds were light, the sound of the wind dominated and raised sound levels to between 20 and 30 dBA; short periods of wind and rain caused the sound level to rise to between 30 and 40 dBA. There is currently no industrial presence within audible distance of the monitoring site. The only audible sounds were from wind and occasional air traffic at the Inuvik Airport.

The daily sound level after validation for the Inuvik Area Facility were between 20 dBA (winter) and 31 dBA L_{eq} (summer).

The Inuvik Area Facility is approximately 20 km east of Inuvik and the proposed Highway alignment. These data are considered representative of noise conditions in the study area. It is reasonable to assume that background noise levels along the proposed Highway corridor will have a similar range to those found during the Mackenzie Gas Project and be approximately 35 dBA.

3.1.5 Water Quality

Water quality is an important consideration for protection of the aquatic environment within the development area as the lake and stream waters of the watersheds crossed by the proposed Highway provide fish habitat and are sources of freshwater (Rescan 1999a). Previous water quality studies have been conducted by Percy and Hoban (1975), Anema et al. (1990a, 1990b), Pienitz et al. (1997) and INAC (2010b) at stream crossings and lakes in the area. This information has been used collectively to establish a baseline for predicting future potential impacts of the proposed Inuvik – Tuktoyaktuk Highway on water quality in the area. Currently there are no developments along the proposed corridor.

As indicated in Rescan (1999a), watersheds that will potentially be affected include the Mackenzie River Delta, Husky Lakes and Kugmallit Bay drainage basins. The previous studies noted above address water quality conditions and potential impacts specifically within these watersheds.

Remote northern lakes and rivers that have not been affected by human activities, such as these, commonly report water quality parameters with concentrations that exceed guideline values due to natural influences such as surficial and bedrock geology, interactions between lake water and groundwater, physical features of lakes and associated drainage basins, local weather and seasonal hydrological changes (IOL et al. 2004). For example, sampling during spring runoff typically results in elevated concentrations of some metals (e.g. aluminum, iron and manganese) and nutrients (e.g. total phosphorus) because of their association with suspended solids, which commonly increase during freshet.

However, since much of the particulate-bound contaminants in natural waters are not readily bioavailable and hence not harmful, apparent exceedances of guidelines for the protection of aquatic life may be misleading (IOL et al. 2004). These observations of seasonally high background levels of some metals and nutrients were repeated within each of the ten sub-basins of the Mackenzie River basin, and particularly in the Lower Mackenzie sub-basin within which the Inuvik to Tuktoyaktuk Highway is proposed. Although historical data for waters of the Lower Mackenzie indicate total metal concentrations were mostly below aquatic life and drinking water guideline levels, aluminum, iron, cadmium (and others) occasionally exceeded guidelines in response to discharge and suspended sediment regimes (IOL et al. 2004).

With respect to the Husky Lakes system, Perrin (2007) found that mean copper, lead, and zinc concentrations were substantially less than CCME guideline values, implying little risk of toxicity from those metals. However, mean cadmium concentrations within basins 1-5 of Husky Lakes were an order of magnitude above CCME guidelines.

Additional background research also determined that chemical parameters in the surface waters between Inuvik and Tuktoyaktuk mostly reflect climatic and vegetation conditions, but also the geology of the study area (Rescan 1999a). The nutrient regime or trophic status of a waterbody is also influenced by these factors. Results of previous studies have shown that on average most lakes in the area are alkaline (pH above 7.0). Lakes investigated by Pienitz et al. (1997) in boreal forest and forest-tundra areas of the Tuktoyaktuk Peninsula region, had total nitrogen and phosphorus concentrations at levels which indicate trophic states ranging from oligotrophic to mesotrophic.

Stream water quality has also been determined to closely reflect that of lake water (Rescan 1999a). In addition, background studies show that lakes tend to be slightly acidic to alkaline, with lowest pH values reported from forest-tundra lakes near Inuvik due to the widespread occurrence of muskeg, which decreases from south to north (Rescan 1999a) and that concentrations of inorganic nitrogen (nitrite, nitrate, and ammonia) are very low or below the detection limit (Pienitz et al. 1997). Additionally, iron is usually high when bogs and peatlands occur in the catchments of lakes, as is the case for this study area (Rescan 1999a).

To build on the available water quality data which exists for the area, Kiggiak-EBA and INAC conducted field based water quality testing at select watercourse crossings along the proposed route in early June and late September 2010, respectively. In addition, INAC collected water quality samples and had them analyzed at Taiga Environmental Laboratory.

Field sampling by INAC was carried out using a portable Oakton pH/Conductivity meter. The results of the INAC sample analyses are shown in Table 3.1.5-1. Water quality parameters tested were compared against the Canadian Council of Ministers of Environment (CCME) *Water Quality Guidelines for the Protection of Freshwater Aquatic Life* (CCME 2002, 2007) in order to determine potential background level exceedances. Although pH results at stream crossings 23A and 29A in Table 3.1.5-1 appear to be erroneous, the field sampling equipment was calibrated according to manufacturers' instructions and are considered to be more accurate than lab results, which were based on analyses of samples that exceeded recommended hold times.

While Kiggiak-EBA's field work was timed to coincide with spring freshet, high water levels actually occurred prior to the spring 2010 field program. Field water quality testing was carried out using a YSI 550A Temperature Conductivity meter and a WTW 340i pH Conductivity meter. The results of the Kiggiak-EBA field sampling measurements are provided in Table 3.1.5-2. Values for pH were within CCME water quality guidelines for all stream crossings sampled, while dissolved oxygen levels were lower than the cold water guideline of 6.5 mg/L for all watercourses except 5, 10, 13A, 17 and 18.

Values for all parameters represent natural background within these watercourses in spring and fall since sampling was carried out in the absence of any development within Project area watersheds.

TABLE 3.1.5-1: RESULTS OF INAC WATER QUALITY ASSESSMENT OF SELECTED WATERCOURSE CROSSING LOCATIONS

	Inorganics – Physical[1]					Trace Metals, Total						
Crossing (km)	Total Alkalinity (mg/L)	Specific Conductivity (µS/cm)	pH	Temperature (°C)	Salinity (units)	Aluminum (mg/L)	Cadmium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Mercury (mg/L)	Zinc (mg/L)
13A (17.0)	36.6	142.6	8.30	2.7	59.4	0.021	<.0001	0.0009	0.252	<0.0001	<0.00001	<0.005
18 (26.1)	61.7	-	-	-	-	0.0097	**.00026**	.0006	0.180	<.0001	<0.00001	0.0012
23A (40)	52.4	12.9	**4.16**	4.2	-	**0.0103**	<.00005	<0.0002	0.090	<0.0001	<0.00001	<0.0004
29A (55)	25.8	78.1	9.89	0.6	29.2	0.014	<.0001	0.0006	0.228	0.0003	<0.00001	<0.005
30A (56)	27.9	94.1	8.12	0.5	36.1	0.049	<.0001	0.0015	**0.908**	0.0002	<0.00001	<0.005
35A (90)	11.3	103.4	7.25	0.0	51.5	**0.291**	<.0001	0.0015	**2.2**	0.0001	<0.00001	0.022
39 (108.7)	20.5	84.6	7.65	1.5	33.4	0.066	<.0001	0.0017	**1.420**	0.0001	<0.00001	<0.005

1. Physical parameters reported from INAC field sampling. Inorganic physicals and inorganic nutrient parameter results from lab analyses exceeded permitted holding times and are not valid.

* Bold type indicates an exceedance of parameter when compared to CCME guidelines

Source: INAC (2010b)

TABLE 3.1.5-2: FIELD WATER QUALITY ANALYSES, JUNE 2010

Crossing	Km Marker[1]	Temp (°C)[2]	pH[3]	Dissolved Oxygen (mg/L)[4]	Conductivity (μS/cm)[5]	Turbidity[6]
1	1.3	-	-	-	-	-
2	1.7	10	7.9	3.4	160	Clear
3	2.3	10.5	8.4	5.3	134	Clear
4	3.2	7.0	8.2	3.6	148	Clear
5	3.9	7.0	7.6	**15.6**	152	Clear
6	4.1	-	6.5	2.9	280	-
7	7.0	8.6	6.6	4.1	160	Clear
8	7.8	9.0	8.2	6.4	150	Clear
9	8.4	-	-	-	-	-
10	9.1	4.1	8.3	**6.9**	160	Clear
11	9.4	6.3	7.6	5.5	187	Clear
12	11.1	11	8.0	<1.5	120	-
13	13.3	-	-	-	-	-
13a	17.0	13	8.0	**8.9**	118	Clear
14	19.1	10.3	6.5	5.8	86	Clear
15	22.0	12	8.2	2.2	49	Clear
16	23.0	7.9	7.5	4.1	270	Clear
17	23.4	7.0	8.1	**7.2**	43	-
18	26.1	9.0	8.9	86.2%	44	Clear
36a	94.1	-	-	-	-	-
37	95.0	8.0	8.4	1.9	120	Clear
37a	96.3	12.8	7.2	2.0	121	-
38a	102.8	8.0	7.6	2.6	122	Clear
39	108.7	6.1	7.9	5.7	93	Clear
39a	109.8	7.8	7.9	5.3	90	Clear
39b	115.1	5.6	8.2	4.3	48	Clear
39c	115.8	-	-	-	-	-

1. Kilometre marker is measured from the northern end of the Navy Road (see Figure 3.1.7-2).
2. Recorded from YSI 550A Temperature/Conductivity field probe.
3. Recorded from WTW pH/Cond 340i field probe.
4. Recorded from YSI 550A Temperature/Conductivity field probe.
5. Recorded from WTW pH/Cond 340i field probe.
6. Turbidity based on observer visual estimate ranging from (C)lear – (L)ightly turbid – (M)oderately turbid – (T)urbid

Based on the INAC field and laboratory results (Table 3.1.5-1) two watercourses exhibited water chemistry results that were within applicable CCME guidelines (crossings 13A and 29A) for all tested parameters; however, exceedances were reported for other sites, as follows:

- Crossing 18 – Cadmium (Cd) concentration of 0.00026 mg/L exceeded allowable limit of 0.00017 mg/L.
- Crossing 23A – pH of 4.16 was below the allowable range of 6.5 to 9.0 and aluminum (Al) concentration of 0.0103 mg/L exceeded allowable limit of 0.005 mg/L at a pH of less than 6.5.
- Crossing 30A – Iron (Fe) concentration of 0.908 mg/L exceeded allowable limit of 0.300 mg/L.
- Crossing 35A – Aluminum (Al) concentration of 0.291 mg/L exceeded allowable limit of 0.1 mg/L at a pH of greater than 6.5 and iron (Fe) concentration of 2.2 mg/L exceeded allowable limit of 0.3 mg/L.
- Crossing 39 – Iron (Fe) concentration of 1.420 mg/L exceeded allowable limit of 0.3 mg/L.

3.1.6 Hydrology

The proposed Highway will cross numerous ephemeral and permanent stream channels and wetland areas, and as such, will be affected by hydrological characteristics of the region. The alignment crosses through the Delta Hydrologic Region (IOL et al. 2004), which is characterized by very large numbers of shallow lakes and ponds that generally drain through small streams into either the Mackenzie River or the Husky Lakes. The hydrology of the northern portion of the route, as described in Rescan (1999a) and EBA (2008), is summarized here.

Due to the low relief of the Tuktoyaktuk Peninsula, Rescan (1999a) suggested that the proposed route will probably cause some unavoidable disruption of drainage patterns. According to Percy and Hoban (1975), minimal terrain disturbance could potentially result in a number of smaller lakes completely drying up and alternatively, a road could block natural flow paths and thus cause ponding. Issues such as these are discussed more thoroughly in Section 4.2.5, Fish and Fish Habitat Impact Assessment, along with mitigative measures to reduce or eliminate potential impacts.

The hydrological regimes of the Arctic lakes near Inuvik and on the Tuktoyaktuk Peninsula are largely a factor of low precipitation and existence of permafrost, with snowmelt runoff in the spring being the dominant hydrological event (Rescan 1999a). The principal hydrologic processes therefore include snowmelt, surface runoff and stream flow.

Hydrological characteristics of the area result primarily from climatic factors including long, cold winters, short cool summers, and relatively low precipitation, of which 45-70% falls as snow (IOL et al. 2004). In this area, not more than four months of the year have a mean temperature above 10 °C. Based on Environment Canada meteorological data, the mean annual temperatures and precipitation values for Tuktoyaktuk and Inuvik are -10.5° C/ 142 mm and -9.5° C/257 mm, respectively. Snowmelt occurs in May to July, followed by the wettest months which normally occur in July and August, while the driest months are typically March and April. Permafrost underlies the entire area, above which an active layer varies in depth.

These climatic factors result in surface runoff patterns that are based on the annual freeze-thaw cycle, although summer rainstorms can cause rapid rises in water levels. The volume of snow accumulation governs the magnitude of spring flows. Ice formation and deterioration follows an annual pattern, which is identified in Table 3.1.6-1 for the Inuvik and Tuktoyaktuk areas.

TABLE 3.1.6-1: APPROXIMATE FREEZE THAW DATES IN SUBARCTIC REGIONS

	Tuktoyaktuk[1]	Inuvik[2]
First ice	Sep 27	Oct 1
Freeze over	Oct 1	Oct 19
First ice deterioration	May 28	May 13
Clearing of rivers	June 19	June 5
River ice thickness	1.55 m	1.32 m
Lake ice thickness	1.75 m	1.73 m

Source: Allen (1977)

1. Unnamed small lake near Tuktoyaktuk
2. East Channel Mackenzie River

The time of ice melt in May and June results in sudden peaks in the hydrograph that follow a typical pattern, as described in Woo (1993). Meltwater fills the many depressions on the land surface and then flows over frozen ground in sheets or rills. Because the shallow, seasonally thawed suprapermafrost layer cannot retain much meltwater or rainwater, the water table rises rapidly so that water is delivered quickly to lower slopes and stream channels. Fairly rapidly, the active layer increases in depth due to increased solar radiation, causing the water table to drop below the surface and a corresponding decline in surface flows. The hydrograph for Trail Valley Creek near Inuvik (Figure 3.1.6-1; stream location shown at stream crossing 23, KM 40) exemplifies this seasonal runoff pattern.

Ice decay in lakes begins once snow melts from their surfaces. Increases in lake storage lag behind snowmelt due to melt-water retention within the snow cover and in small depressions which dot the land surface (Woo 1993). Generally, water levels in lakes during spring runoff initially rise beyond their outlet elevations due to snow dams. The breaching of these dams results in rapid increases in downstream discharges. Peak annual outflows occur at this time.

Source: Environment Canada (2006)

Figure 3.1.6-1 Hydrograph for Trail Valley Creek

The numerous tundra ponds in the Arctic are recharged during spring freshet, which results from snowmelt. These freshets create surface flow connections between ponds, but such flow connectivity usually only lasts about two weeks. After that, the ponds become separated from lateral drainage (Woo and Guan 2006). The nival regime in the Arctic shows one major flood period in spring followed by a rapid recession to base flow, interrupted by rainstorm generated peaks. As shown in the Trail Valley Creek hydrograph (Figure 3.1.6-1), minimum flows are usually from August to September before autumn rainfall produces a notably increased flow. Streams usually start freezing in mid-September and are completely frozen by November.

During the September, 2009 preliminary reconnaissance field survey, significant water flow was observed in relatively few stream channels, in particular Zed Creek, Hans Creek, and Trail Valley Creek. These streams have relatively large catchments[2], which result in active flows throughout the ice-free season. Most other streams within the proposed alignment footprint that were viewed during the preliminary reconnaissance survey appeared to be either ephemeral or contained slowly flowing or standing water in discrete pockets. It was further observed that the landform was etched with rills, signifying the myriad of runoff channels that carry meltwater in spring. Observations of flow characteristics at each stream crossing are provided in Table 3.1.7-3. These observations were made during aerial reconnaissance, with flow and channel characteristics confirmed for select watercourses during the spring 2010 field program (Kiggiak-EBA 2010b).

[2] Hans Creek watershed: 329 km^2, mean annual flow 1.09 m^3/s; Trail Valley Creek watershed: 68.3 km^2, mean annual flow 0.2 m^3/s

The Highway design will be influenced by the hydrologic patterns and characteristics of the Project area. Stream crossing structures and cross drainage culverts will need to be appropriately sized to accommodate flash freshet flows, which can be sudden and intense, as shown in the Trail Valley Creek hydrograph (Figure 3.1.6-1). Hydrological conditions also govern fish presence, abundance, and behaviour in streams. The flow extremes that are characteristic of the Project area diminish the availability and quality of stream habitats in most channels, since these generally carry significant volumes of water for only short periods of time.

Such conditions also denote small drainage systems with shallow headwater lakes that generally do not provide suitable spawning, rearing, or overwintering habitat due to a variety of reasons, including extreme flow fluctuations, vegetation encroachment in streams, lack of winter flow, and oxygen deprivation during winter. In contrast, channels draining medium to large catchments, such as Zed Creek, Hans Creek, and Trail Valley Creek, retain flow throughout the ice-free months, and provide suitable habitat conditions to support spawning and rearing during late spring and summer.

3.1.7 Fish and Fish Habitat

The proposed Inuvik to Tuktoyaktuk Highway will cross approximately 46 ephemeral and/or permanent streams, and be located near many lakes along its route. The Husky Lakes provide important fish habitat, and are historic and current subsistence harvest areas for the people of Inuvik and Tuktoyaktuk. As such, a one kilometre development setback has been prescribed by the ILA to protect the important resources of this area.

This section of the report identifies the species that may be encountered or affected by the Highway construction and operation, based on previous studies and observations of existing habitat characteristics made during Kiggiak-EBA's preliminary fish and fish habitat reconnaissance in the fall of 2009, and a spring aquatics field program in 2010. The fish and fish habitat effects section (Section 4.2.5) provides discussion on the potential effects of the Highway development and a commitment to protection measures with respect to fish and fish habitat.

The proposed Highway occurs slightly within and adjacent to the spring, summer, fall, and winter fish harvesting areas near Husky Lakes, sites 305C, 307C, 310C, and 316C (see Harvesting Section 3.2.8, Figure 3.2.8-17; Community of Tuktoyaktuk et al. 2008). As well, the Highway crosses a portion of the Fish Lakes and Rivers management area, site 704C (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). These areas provide important fish habitat as well as an important historic and current subsistence harvest area for people of Inuvik and Tuktoyaktuk (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008; Roux et al. 2010; J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

A number of fish species exist within the freshwater and marine environments of the mainland Arctic. Table 3.1.7-1 provides a partial list of species with potential to exist in the area of the Highway (Community of Inuvik et al. 2008; Community of Tuktoyaktuk et al. 2008).

TABLE 3.1.7-1: FISH SPECIES WITH POTENTIAL TO EXIST ALONG THE INUVIK TO TUKTOYAKTUK HIGHWAY
Arctic cod (*Borerogadus saida*)
Blue herring (*Clupea pallasi*)
Capelin (*Mallotu villosus*)
Chum salmon (*Oncorhynchus keta*)
Fourhorn sculpin (*Myoxocephalus quadricorris*)
Greenland cod (*Gadus ogac*)
Pink salmon (*O. gorbuscha*)
Saffron cod (*Eleginus gracilis*)
Sand lance (*Ammodytes* sp.)
Starry flounder (*Platichthys stellatus*)
Lake chub (*Cousesius plumbeus*)
Arctic char (*Salvelinus alpinus*)
Arctic cisco (*Coregonus autumnalis*)
Arctic grayling (*Thymallus arcticus*)
Broad whitefish (*Coregonus nasus*)
Burbot or loche (*Lota lota*)
Dolly Varden (*S. malma*)
Finescale dace (*Phoxinus neogaeus*)
Flathead chub (*Platygobio gracilis*)
Inconnu (*Stenodus leucichthys*)
Lake trout (*S. namaycush*)
Lake whitefish (*C. clupeaformis*)
Least cisco (*C. sardinella*)
Longnose dace (*Rhinichthys cataractae*)
Longnose sucker (*Catastomus catastomus*)
Nine-spine stickleback (*Pungitius pungitius*)
Northern pike (*Esox lucius*)
Pond smelt (*Hypomesus olidus*)
Rainbow smelt (*Osmerus mordax*)
Round whitefish (*Prosopium cylindraceum*)
Slimy sculpin (*Cottus cognatus*)
Spoonhead sculpin (*C. ricei*)
Trout perch (*Perscopsis omiscomaycus*)
Walleye (*Stizostedion vitreum*)
White sucker (*C. commersoni*)

Note: fish identified in **bold** were the focus of the 2009 and 2010 fish surveys, as the most likely to be encountered.

Fish surveys have been conducted previously in streams and within the Husky Lakes system along the proposed Highway. Results of these surveys were summarized in Rescan (1999a), Roux et al. (2010), Perrin (2007) and the Environmental Impact Statement (EIS) for the Mackenzie Gas Project (IOL et al. 2004).

Ten fish species were identified by these studies as having potential to utilize habitats in streams along the proposed route and are highlighted in bold type in Table 3.1.7-1. The Husky Lakes also represent an important spawning ground for Pacific herring and lake trout (Community of Tuktoyaktuk et al. 2008). Actual species presence is, however, dependent on several habitat and watershed characteristics, often including the availability and accessibility of upstream lakes that provide feeding, rearing, and/or overwintering habitats. It is unlikely that any of the streams along the Highway route provide overwintering habitat. Similarly, many of the small, shallow headwater lakes within the watersheds crossed by the proposed route would freeze either to the bottom or to a sufficient depth to preclude the possibility of overwintering, partly due to a diminishment of oxygen to lethal levels (Cott et al. 2008a).

Table 3.1.7-2 provides a generalized summary of habitat preferences and life cycle information for each of the major fish species likely utilizing stream habitats in the vicinity of the proposed Highway. Arctic grayling is the valued species most likely to be affected by Highway construction activities and stream crossing structures. This is because grayling utilize and are dependent upon stream habitats for spawning, juvenile rearing, and adult life stages, and require clean, well oxygenated gravel-cobble substrates to complete their life cycle (Table 3.1.7-2). As such, their productivity within a system is highly sensitive to perturbations that degrade or alter migration access or habitat quality.

The following sections provide brief life history and habitat preference information for each of the valued fish species with potential to be encountered along the proposed Highway alignment, or that may be found in larger lakes downstream of the alignment.

3.1.7.1 Burbot

Burbot (*Lota lota*; "Tittaaliq") are unique in that they spawn in rivers and lakes during the winter under ice. Spawners tend to select shallow waters over gravel substrates. Eggs filter down into interstitial spaces where they develop for the next 4-5 weeks. The newly hatched larvae are only about 3-3.5 mm and are transported downstream into quiet waters where they feed. In streams, young burbot seek out shallow waters that have vegetation and debris. As they grow they move to rocky riffles and then on to pools or beneath undercut banks. Adult burbot prey on smaller fish. The selection of stream habitats by some burbot for both spawning and rearing suggests that they may be encountered in streams crossed by the proposed Highway.

Burbot comprise part of the subsistence fishery of the Husky Lakes (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

3.1.7.2 Lake Whitefish

Lake whitefish (*Coregonus clupeaformis*; "Humpback"; "Crooked Backs"; "Pikuktuq") are primarily a freshwater fish, inhabiting lakes and larger rivers. However, they will enter brackish water (Scott and Crossman 1973). Lake whitefish feed on aquatic insects, molluscs, amphipods and a variety of small fish and fish eggs. They are an important commercial and domestic fish in the north. Lake whitefish are an important component of the subsistence fishery of the Husky Lakes (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

Lake whitefish are primarily a lake dwelling fish that prefer cool water. They generally move from shallow to deep water during the summer months, and then back into shallow water as the temperature cools. Spawning occurs in early fall, normally in shallow areas of lakes where the substrate is composed of cobble and gravel, and less frequently, sand. Whitefish may on occasion move into tributary streams to spawn. Eggs are broadcast over the substrate and hatch during the following spring. Larval fish tend to stay near steep shorelines, but as juveniles, move into deeper waters during summer. Given their habitat preferences, it is unlikely that these fish will be encountered in the small, shallow streams that make up most of the watercourses crossed by the proposed Highway.

3.1.7.3 Round Whitefish

Round whitefish (*Prosopium cylindraceum*) are primarily a freshwater species, although it is known to inhabit brackish estuarial waters, such as in the mouth of the Mackenzie River (Scott and Crossman 1973). Spawning normally occurs during October in northern latitudes, over the gravelly shallows of lakes or river mouths. Eggs hatch in spring. Round whitefish are predominantly found in moderate to deep lakes where they feed on benthic invertebrates. Given their habitat preferences, it is unlikely that these fish will be encountered in the small, shallow streams that make up most of the watercourses crossed by the proposed Highway.

3.1.7.4 Least Cisco

Least cisco (*Coregonus sardinella;* "Big-Eye Herring") inhabit the fresh and brackish waters of the Mackenzie Delta and also occur as inland, landlocked populations (Rescan 1999a). They are less migratory than the Arctic cisco and tend to be associated with the plume of their home river. In freshwater, spawning migrations take place in the fall (late September-early October). Clear streams or lake shores with sand or gravel bottoms are their preferred spawning habitats. They are eaten by predacious coney, pike, and burbot, as well as other mammals and birds (Community of Tuktoyaktuk et al. 2008). The Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008) identifies the inland lakes of the Mackenzie Delta-Tuktoyaktuk region as important least cisco habitat. However, since this species predominantly prefers lake habitats, it would be uncommon in the small streams that comprise most of the watercourses along the proposed Highway.

3.1.7.5 Inconnu

Inconnu (*Stenodus leucichthys;* "Coney"; "Higaq") is the largest and fastest growing member of the whitefish family. They are primarily anadromous (fish are that migrate from the sea to spawn in fresh water), migrating long distances up the Mackenzie River and its major tributaries to spawn just prior to freeze up in October. After spawning, inconnu move back downstream to the lower reaches of the Mackenzie River, Tuktoyaktuk Harbour and west along the Beaufort Sea coast to feed and overwinter (DFO 1998). At maturity, these fish are greater than a half-metre in length (Scott and Crossman 1973). Their size and preference for large tributaries for spawning suggests that they are unlikely to spawn in the small streams that predominate along the proposed Highway corridor.

An Integrated Fisheries Management Plan for inconnu was signed by the FJMC and the communities of Tuktoyaktuk, Inuvik and Aklavik (Community of Inuvik et al. 2008). Inconnu are an important component of the subsistence fishery of the Husky Lakes (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

In addition, inconnu has a NWT general status rank of Sensitive, indicating that it may require special attention or protection to prevent it from becoming at risk and has a medium priority for detailed assessment, but is not currently at risk of extinction or extirpation (Working Group on General Status of NWT Species 2011).

3.1.7.6 Northern Pike

Northern pike (*Esox lucius*; "Siulik") are highly carnivorous fish that prefer slow, meandering vegetated rivers or lakes. Spawning takes place in shallow, heavily vegetated areas (Scott and Crossman 1973) soon after ice-out. The eggs adhere to grass, rocks, or other debris. Incubation generally takes about 30 days in the north. Pike fry start life feeding on small crustaceans and insects, but begin eating smaller fish by the time they are only about 5 cm in length. As adults, these voracious feeders principally feed on fish but will also take shore birds, small ducks, muskrats, mice, shrews, and insects. In winter, pike will migrate to large rivers or lakes; smaller lakes are avoided due to the potential for oxygen depletion. Generally, pike migrations between summer and winter habitats are short. In summer, their movements from feeding habitat areas are minimal. Due to the habitats selected by pike, it is expected that the proposed Highway alignment will cross some streams used by pike for spawning, rearing, and feeding.

TABLE 3.1.7-2: LIFE HISTORY INFORMATION FOR COMMON FISH SPECIES IN STREAMS ALONG THE PROPOSED HIGHWAY

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Highway Construction
Burbot *Lota lota* *"Tittaaliq"*	▪ Migrate to lake spawning areas in winter ▪ Migrate to tributaries in late winter/early spring ▪ Migrate to deep water in summer	▪January-March ▪Water temp. 0-4°C	▪Under ice in Lakes or river ▪Sand/gravel substrate ▪shallow (<3 m bays or on gravel shoals	At ice-out	▪Shallow waters ▪Debris cover ▪Rocky riffles ▪Pools or deeper water in lakes	▪Mouths of creeks in fall ▪May be found during winter/spring in coastal embayments (brackish or freshwater ▪Deep water in summer	Moderate
Lake whitefish *Coregonus clupeaformis*	Resident or anadromous	Late September-early October	▪Lakes and large rivers ▪Hard or stony substrate ▪Water <7.5m	Late spring	▪Larvae along steep shorelines ▪Juveniles move to deep water in summer	Deep water in lakes and large rivers.	Low
Round whitefish *Prosopium cylindraceum*	Limited migrations to lake shallows or upstream to rivers	Late September-October	Gravelly shallows of lakes or river mouths	Spring	Near or beneath rocks	Moderate to deep lakes	Low
Least cisco *Coregonus sardinella*	Migrate upstream to spawning grounds in fall	Early October	▪Clear streams ▪Gravel substrates	Spring	Lakes, rivers, lowest reaches of tributary streams	▪Lakes and streams ▪estuaries, plume of home river	Moderate
Inconnu (Coney) *Stenodus leucichthys* "Higaq"	▪Anadromous or lake dwelling. ▪Begin upstream migrations at spring break-up. ▪Return to coastal areas or lakes after spawning.	Late September to early October	▪1-3 m depth ▪Fast current ▪Gravel substrate	6 mos. after spawning	Fry washed downstream to coastal areas or lakes	Coastal areas or lakes	Low
Northern pike *Esox lucius* *"Siulik"*	▪Limited range ▪Move from deep water winter habitat to spawning habitat in spring	Early spring, occasionally before ice melt	▪Grassy margins of lake shores ▪slow moving streams or sloughs	Spring, ~30 days after spawning	▪Stream or lake margins ▪Slow flowing waters	▪Lakes ▪Main river channels ▪Slack water areas in rivers	Moderate
Lake trout *Salvelinus namaycush* *"Iqaluakpak"*	▪Limited migrations, usually within resident lake or large, deep river ▪Migrate to nearshore areas for spawning ▪Move into surface waters in winter ▪Move into deeper waters in summer	Early September	▪Littoral areas of lakes ▪Cobble boulder substrates ▪5-40 m water depth	May-June, depending on water temperature	Shallow, inshore waters	▪Large deep lakes (common) ▪Large rivers (less common) ▪Little movement in summer	Low
Arctic grayling *Thymallus arcticus* "Hulukpaugaq"	▪Can be highly migratory at all life stages or non-migratory ▪Usually migrate to winter habitat in early fall	Spring, just as ice breaks up	▪Gravel substrate ▪<20-30% fines ▪Good flow (25-60 cm/s)	Spring (hatch 3 weeks after spawning)	Fry: quiet waters near site of hatching	▪Clear small, shallow streams or medium rivers ▪groundwater fed springs ▪overwinter in lakes or lower reaches of rivers ▪segregate in streams by age	High
Slimy sculpin *Cottus cognatus*	Very limited movements	Spring, after breakup	Cobble in shallow water	Hatch 30 days after spawning	Gravel/cobble substrates in streams	Rocky or gravel substrates	Low
Ninespine stickleback *Pungitius pungitius*	Very limited movements	Summer	Male builds nests of vegetation and debris		Quiet, shallow waters in vegetated areas of streams or brackish waters	▪Brackish or freshwater lakes and streams ▪Streams: vegetated areas in quiet waters	Low

3.1.7.7 Lake Trout

Lake trout (*Salvelinus namaycush*; "Iqaluakpak") are representatives of the char family that live exclusively in deep, cold lakes throughout their life cycle. They spawn during early fall over clean cobble substrates in water that is generally less than 16 m deep (Marsden and Chotkowski 2001). Lake trout occur in several large, deep lakes on the Tuktoyaktuk Peninsula and on the Mackenzie Delta (Rescan 1999a), as well as in large rivers and brackish waters (Community of Tuktoyaktuk et al. 2008). The Husky Lakes are important habitat areas for this species. Due to the preference of this species for lake habitats during all life stages, it is unlikely that spawning or rearing would take place in the relatively shallow streams that would be crossed by the proposed Highway.

Lake trout are an important component of the subsistence fishery of the Husky Lakes (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). For this reason, research about the biology and movement of lake trout and in monitoring water quality where lake trout are harvested is a high priority to the communities of the area (Community of Inuvik et al. 2008).

3.1.7.8 Arctic Grayling

Arctic grayling (*Thymallus arcticus*; "Hulukpaugaq"), a cousin of the trout, are game fish of clear, cold streams known for their beautiful colours and flowing, sail-like dorsal fins. They can be highly migratory, or spend much of their lives within a fairly short distance of their preferred section of stream or lake. Generally, grayling spawn in clean, cool streams in spring at about the time of ice break-up, over silt free gravel substrates. They do not create nests (redds), which leaves the eggs vulnerable to high water velocities and stream bed disturbances (Beauchamp 1990). During the fall, grayling will migrate to overwintering habitats in lakes or deep sections of slow flowing rivers. Due to their choice of stream habitats for spawning and rearing in summer, the proposed Highway route will cross streams that support these fish. Observations of grayling occurred during the spring 2010 field program.

In addition, Arctic grayling has a NWT general status rank of Sensitive, indicating that it may require special attention or protection to prevent it from becoming at risk and has a medium priority for detailed assessment, but is not currently at risk if extinction or extirpation (Working Group on General Status of NWT Species 2011).

3.1.7.9 Fish and Fish Habitat Information Review

Species at Risk

A review of the *Species at Risk Act* (SARA) Species Registry indicates that none of the fish species detailed above, or those listed in Table 3.1.7-1 are species of special management concern or have been listed by SARA. However, as indicated above, the Government of NWT has ranked both inconnu and Arctic grayling as Sensitive (Working Group on General Status of NWT Species 2011). No other fish species at risk have potential to exist within waterbodies that may be affected by Highway construction.

Fish Health and Condition

The EIRB has requested information on the health and condition of fish species which may be encountered along the Highway corridor. Following extensive literature review it was determined that there is no information available to suggest that potential fish species present with lakes and rivers along the Highway corridor have shown signs of health issues or degraded condition. During an investigation to determine the economic viability of a commercial fishery in the Mackenzie Delta it was noted that broad whitefish are highly sought after because it is cyst free, while lake whitefish had high cyst (*Triaenophorus crassus*) counts (Anderson 1995).

Furthermore, as discussed in the Water Quality Section (Section 3.1.5) some water quality parameters have historically exceeded guidelines for aquatic life, an observation that was confirmed during recent sampling by Kiggiak-EBA and INAC. Variations in total metal concentration, as well as other water quality parameters such as pH and nutrients (nitrogen and phosphorus), can be attributed to the seasonal response to discharge and suspended sediment regimes (IOL et al. 2004). These results suggest that there is no negative affect to the health and condition of local fish populations.

Furthermore, because remote northern lakes and rivers have not been affected by human activities and yet commonly report water quality parameters with concentrations that exceed guideline values due to natural influences, it is not anticipated that harvested fish species in these waterbodies have been subjected to adverse contaminant concentrations.

Non-native Fish Species

The EIRB has requested information on the potential presence of non-native fish species which may be encountered along the Highway corridor. Following extensive literature review it was determined that there is no evidence of known non-native fish species that present a potential risk to local native fish populations.

Harvest Areas and Rights

The EIRB has requested information on areas subject to exclusive harvesting rights granted to land claim beneficiaries along the Highway corridor. While exclusive harvesting rights have been granted for game species, fish are not included. The *Inuvialuit Final Agreement* states in paragraphs 14(31) and 14(32) that the Inuvialuit are granted preferential right within the Inuvialuit Settlement Region (per paragraphs 7(1)(a) and 7(1)(b) to harvest fish for subsistence usage according to non-transferable licences.

Within the Mackenzie Delta, Anderson reported that broad whitefish is the most sought after species of the subsistence and commercial fisheries. Other species commonly harvested include lake whitefish, inconnu, and northern pike (Anderson 1995).

Subsistence fish harvest data between 1988 and 1997 are presented in Figures 3.2.8-18 to 3.2.8-21 (Section 3.2.8). Spring, summer, fall and winter fish harvest areas and fish lakes and rivers have previously been reported on maps 3, 5, 6, 9, and 13 respectively of the Tuktoyaktuk Community Conservation Plan (Tuktoyaktuk et al. 2008).

While there have been numerous attempts to develop large scale commercial fisheries in the region, too many constraints existed in order to create a feasible commercial fishery. At this time, no commercial fishery exists in the region (Anderson 1995).

3.1.7.10 Stream Crossing Site Investigations (2009 and 2010)

The results of stream crossing field studies conducted in 2009 and 2010 are summarized in this section; a copy of the Spring 2010 Aquatic Field Program Results is included in Appendix C.

A preliminary fish habitat reconnaissance field study was carried out in 2009 over a three day period, from September 15-17. The survey involved low level helicopter flights over the proposed and alternate routes to permit visual inspection of streams at possible stream crossing locations. The overview flights afforded an opportunity to observe watershed conditions upstream and downstream of the crossing sites as an indication of the potential of these systems to support valued fisheries resources. While the scope of the preliminary reconnaissance field survey was limited to an overview of channel characteristics along the proposed Highway, stream channels potentially possessing suitable fish habitat were further evaluated on the ground. Time (and weather) constraints limited ground investigations to the specific stream crossing sites within these selected locations. At these sites, the following basic parameters were identified:

- Wetted width;
- Total channel width, determined from abrupt changes in elevation and from vegetation changes;
- Water depth;
- Substrate;
- Cover (type and percent);
- Flow/habitat characteristic (e.g. riffle, run, pool);
- Water temperature; and,
- Water velocity (using the timed float method, where there was a sufficient length of unobstructed channel).

The number of sites surveyed on the ground during the fall 2009 reconnaissance did not necessarily indicate that these were the only locations potentially supporting fish populations. Some sites (e.g. stream crossings 3 and 21) appeared from the air to have only limited habitat potential, although on closer inspection displayed stream characteristics suitable for fish passage, spawning, or rearing, which were obscured by heavy riparian overgrowths of willow (Photos 3.1.7-1 to 3.1.7-2). Further site investigations took place in the spring of 2010 to provide a more complete inventory of habitat conditions, as well as fish presence and relative abundance in streams that will be crossed during the proposed first year of construction (i.e., approximately KM 0 to 25 north of Inuvik and KM 112 to 137 south of Source 177).

Table 3.1.7-3 summarizes the information collected at ten stream crossing locations assessed on the ground during the preliminary reconnaissance in 2009. Sampling locations were selected as close as possible to the originally identified proposed stream crossing locations. Stream crossing numbers conformed to those identified in the Kiggiak-EBA Inuvik to Tuktoyaktuk 1:25,000 Map Book (Appendix D).

Photo 3.1.7-1
Stream Crossing 03 aerial view, September 2009

Photo 3.1.7-2
Stream Crossing 03 ground view, looking upstream, September 2009

Photo 3.1.7-3
Stream Crossing 21 aerial view, September 2009

Photo 3.1.7-4
Stream Crossing 21 ground view, looking upstream, September 2009

TABLE 3.1.7-3: STREAM CHANNEL AND HABITAT CHARACTERISTICS AT SELECTED STREAM CROSSINGS ALONG THE PROPOSED HIGHWAY, SEPTEMBER 2009													
Location	Stream Crossing No.	Water Temp. (°C)	Wetted Width (m)[1]	Total Width (m)[2]	Water Depth (cm)	Substrate	Overhead Cover		Instream Cover[3]		Habitat Type	Water Velocity (m/s)	Comments
							Type	%	Type	%			
KM 2.5	03	5	2.6	10.5	0.61	silt	willow grass Birch	10 30 30	LWD SWD	20 10	riffle-pool	N/A	Crossing location at pool. Channel narrows and becomes shallower and faster flowing with a more complete canopy cover upstream. Velocity measurement not taken due to insufficient length of unobstructed stream. Substrate upstream appears to consist of gravel/cobble. Large upstream watershed. Good potential for spawning/rearing fish.
KM 26	18	8	3	15.5	0.43	gravel/ cobble/ silt	willow	100	LWD SWD	30 40	riffle	N/A	Major tributary to Jimmy Lake. Potential habitat productive capacity may be reduced due to heavy willow cover reducing light penetration, and because there are no major lakes upstream of the crossing. Fish from Jimmy Lake may migrate for spawning (grayling). Velocity estimated at 1 m/s. Could not be measured due to insufficient length of unobstructed stream for float.
KM 28	21	8	1.3	6	0.33	gravel/ cobble/ silt	willow/ grass	80	LWD SWD	30 40	riffle	N/A	Well defined tributary to Jimmy Lake. Heavy canopy cover may restrict productivity. Medium sized lakes upstream. Fish from Jimmy Lake may migrate for spawning (grayling). Velocity approximated at 1 m/s. Could not be measured due to insufficient length of unobstructed stream for float.
KM 40	23a Trail Valley Creek	5	1.5	17	0.43	cobble	willow/ grass	60	SWD	20	riffle	1	Well defined tributary to Husky Lakes. Very good habitat potential due to partial canopy, good flow, and cobble substrate. Habitat likely restricted to spawning and rearing for Husky Lakes' fish as there are no significant lakes upstream.
On PWC Route, ~KM 54.5	30 Hans Creek												No measurements made due to high water/velocity that prevented wading. Similar in width and depth to Zed Creek. Appears to have gravel/cobble substrate. Known from previous reports to support Arctic grayling and sculpin.
KM 67.5	31 Zed Creek (a.k.a. Parsons Creek)	8	9	29	0.43	gravel 75% cobble 25%	willow	5	N/A		riffle-run	1	Excellent migratory, spawning, and rearing habitat. May have the potential for very high flows during freshet. Known (from previous reports) to support lake whitefish, round whitefish, lake trout, Arctic grayling, stickleback, and sculpin.
On PWC Route, KM 75	33	5	2.8	30	0.17	silt	willow	90	SWD	20	pool	N/A	Habitat is limited due to sluggish flow, silt substrate, and almost complete willow canopy cover. However, a juvenile Arctic grayling (tentative identification) was observed (~9cm) during the ground survey. This stream flows into Zed Lake, located a short distance downstream of the proposed crossing. The upstream watershed contains several small lakes. Stream has low-moderate fisheries potential.
On PWC Route, no km marking	35	6	2.75	39	0.28	gravel/ cobble	willow	65	SWD	10	riffle	N/A	Velocity was high; measurement not taken due to insufficient length of unobstructed stream. Downstream pool weedy and silted. From the air, several weedy, slow flowing areas identified as having good potential for northern pike spawning, rearing, and feeding habitat. Faster flowing area has good potential for grayling spawning, and grayling/whitefish rearing. Total length of channel is less than 2 km. It drains a series of mid-size lakes and flows into an arm of Husky Lakes. Subsequent to the field investigation, the crossing location was moved further upstream

TABLE 3.1.7-3: STREAM CHANNEL AND HABITAT CHARACTERISTICS AT SELECTED STREAM CROSSINGS ALONG THE PROPOSED HIGHWAY, SEPTEMBER 2009													
Location	Stream Crossing No.	Water Temp. (°C)	Wetted Width (m)[1]	Total Width (m)[2]	Water Depth (cm)	Substrate	Overhead Cover		Instream Cover[3]		Habitat Type	Water Velocity (m/s)	Comments
							Type	%	Type	%			
													to an area just below the source lake (Stream Crossing 35a) for this stream. No ground-truthing was carried out at that site. However, the stream channel was observed from the air to be wider than at Stream Crossing 35 with considerably less overhead cover.
On PWC Route, no km marking	38	5	1.9	20	0.36	gravel/ cobble/ silt	willow	80	SWD	10	glide/ pool	0.13	Channel has sluggish flow, but may provide limited spawning/rearing habitat for upstream spawning migrants (grayling). Stream flows into a small lake and then into Husky Lakes. Subsequent to the field investigation, the crossing location was moved upstream to Stream Crossing 38a (not ground-truthed), located just downstream of a mid-size lake. Observations from the air suggest that the stream at that location is made up of a series of heavily overgrown, weedy pools. That habitat, in proximity to the lake, may be suitable for pike spawning, if the lake is of sufficient depth to provide overwintering.
KM 106	39	7	5.3	12	0.26	silt	willow	60	SWD	10	glide/ pool	0.15	Channel connects a large lake system to the Husky Lakes. Substrate varies with stream width and water velocity. Gravel dominates the area just downstream of the crossing site. Stream has good habitat potential. Stickleback observed.
KM 109.5	39a	6	0.7	11	0.11	gravel	willow	100	SWD	10	riffle/run	N/A	Potentially good habitat, with good flow. Flows into Husky Lakes. Subsequent to the field investigation, the crossing location was moved further upstream in the same drainage. That crossing is over a short length of stream connecting two small lakes. That section of stream was not ground-truthed, but shows to be a well-defined channel on a Google Earth image.

1. Wetted width was measured as the horizontal distance between the edge of water on both sides of the stream, measured perpendicular to the direction of flow.
2. Total width was measured between the tops of the banks on each side of the stream, measured perpendicular to the direction of flow. Top of bank was determined as a distinct change in gradient or by a change in vegetation.
3. LWD=large woody debris (dead wood >5 cm diameter over a minimum 2 m length; SWD=small woody debris (dead wood smaller than LWD).

Results of previous stream surveys along the proposed Highway were summarized in Rescan (1999a) and the Environmental Impact Statement (EIS) for Mackenzie Gas Project (IOL et al. 2004). Rescan (1999a) reported that fish had been sampled in Jimmy Creek (Stream Crossing 'N'), Hans Creek (Stream Crossing 30; Photo 3.1.7-5), and Zed Creek (also known as Parsons Creek; Stream Crossing 31; Photo 3.1.7-6). Sampled fish included lake whitefish, round whitefish, lake trout, Arctic grayling, ninespine stickleback, and slimy sculpin.

IOL et al. (2004) provided sampling results for Zed Creek, Hans Creek, Jimmy Creek, and in a stream crossed twice at stream crossings 'L' and 'M' along the original PWC 1977 route. That survey identified the following fish species as having the potential to utilize habitats in streams along the proposed route: northern pike, lake whitefish, round whitefish, Arctic grayling, lake trout, burbot, ninespine stickleback, and sculpin.

Photo 3.1.7-5
Stream Crossing 30, Hans Creek, looking upstream

Photo 3.1.7-6
Stream Crossing 31, Zed Creek, looking upstream

Actual species presence would be dependent on several habitat and watershed characteristics. As indicated earlier, it is unlikely that any of the stream locations along the Highway would provide overwintering habitat. Similarly, many of the small, shallow headwater lakes within the watersheds crossed by the proposed route would freeze either to the bottom or to a sufficient depth to preclude the possibility of overwintering, partly due to a diminishment of oxygen to lethal levels (Cott et al. 2008b).

Additional surveys were completed by Kiggiak-EBA over a four day period from June 8-11, 2010 (Kiggiak-EBA 2010). The spring 2010 aquatic field program involved sampling at stream crossing sites along the proposed Highway in two general areas (Figure 3.1.7-1). The first was the Inuvik segment occurring within 25 km north of Navy Road (just outside Inuvik) on June 8 and 9, 2010, and the second being the Tuktoyaktuk segment, extending 25 km south of Granular Source 177 (just south of Tuktoyaktuk) on June 10 and 11, 2010 (Figures 3.1.7-2 and 3.1.7-3 respectively). A total of 27 crossing locations were identified for habitat inventory; however, only 25 crossings were inventoried during the spring 2010 field program due to time and safety constraints. All 27 crossings were observed by either aerial reconnaissance or ground assessment (Table 3.1.7-4).

An initial aerial reconnaissance via helicopter was conducted along the preferred Highway alignment to assess watercourse conditions upstream and downstream of each crossing to identify lakes and potential obstructions. Height above the ground varied during the reconnaissance level assessment to maximize efficiency of data collection. Highway crossings and routing was identified using pre-existing GPS data and navigated using a hand held Garmin GPSMAP 60Cx. The habitat inventory of each crossing was conducted approximately 100 metres in the up and downstream directions.

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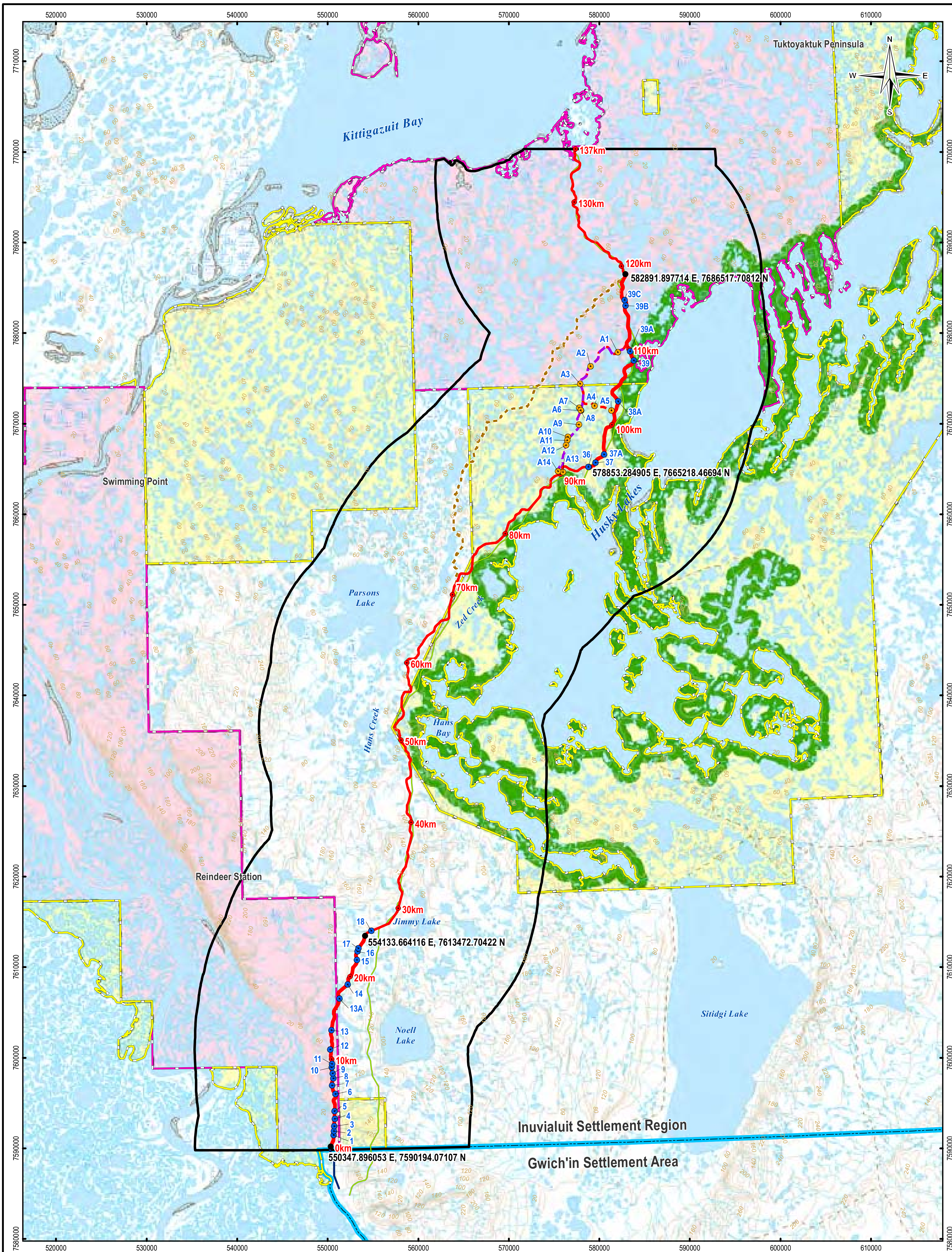

LEGEND

- 2010 Fish Program Sample Location
- A1 to A14 - Alternate Route Fish Sample Location
- Fish and Fish Habitat Sampling Program, 2010
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Spring 2010 Aquatic Field Program

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map034_Aquatics.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	CK	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.7-1

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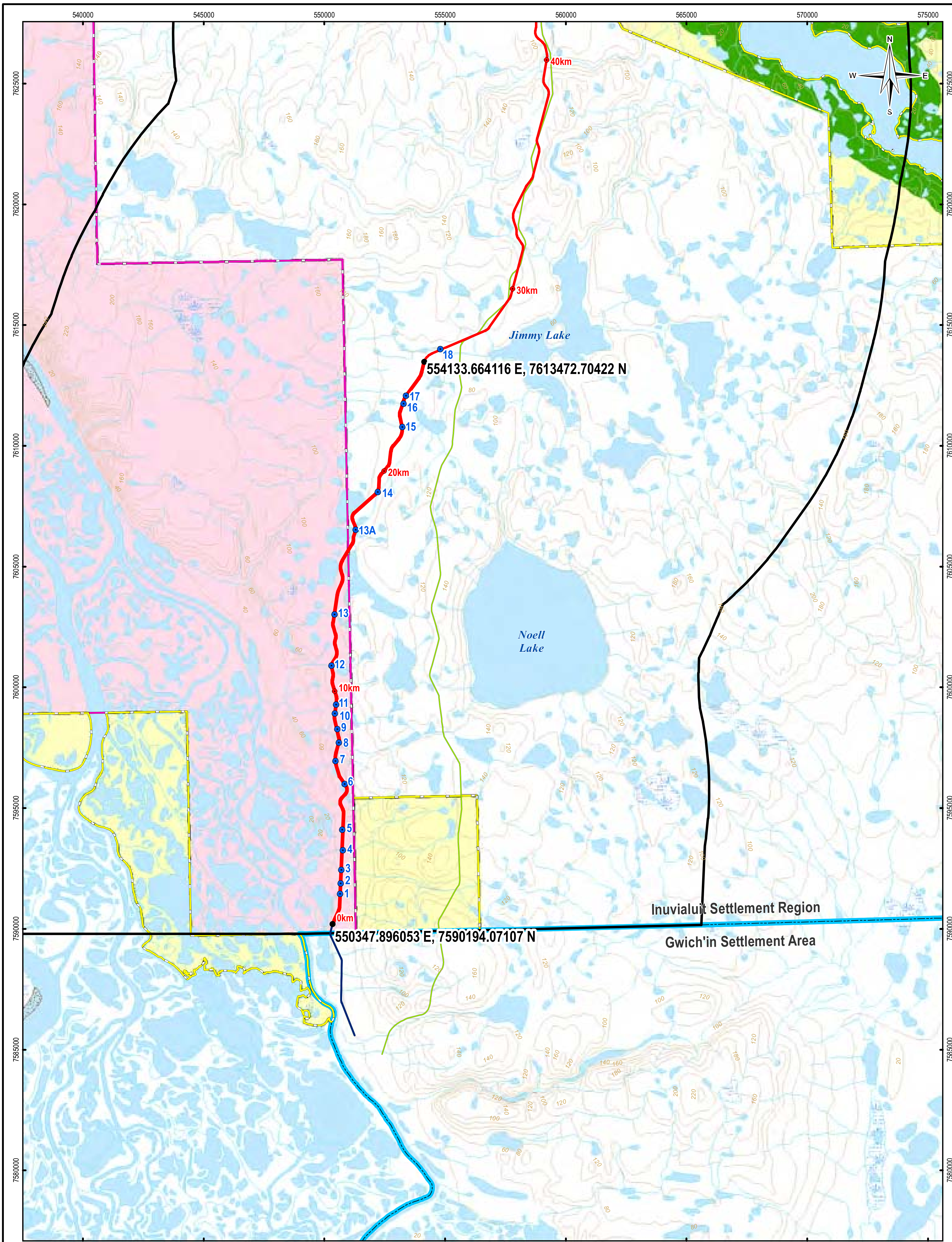

LEGEND

- 2010 Fish Program Sample Location
- Fish and Fish Habitat Sampling Program, 2010
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish and Fish Habitat Sampling Locations Inuvik Segment

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:150,000
1 0.5 0 1 2 3 4 5
Kilometres

FILE NO.
V23201322_EIS_Map035_AquaticsInuvik.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	CK	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.7-2

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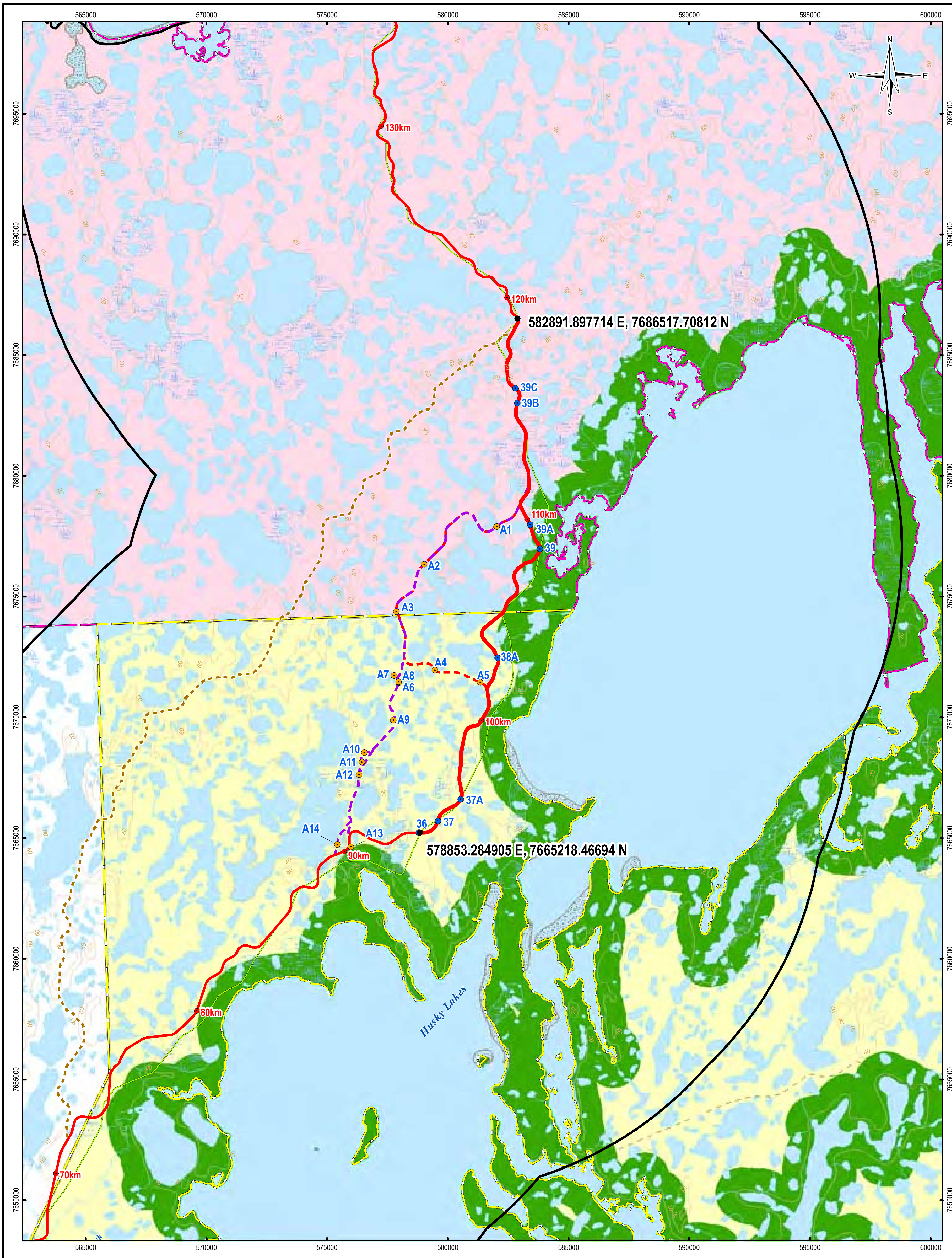

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish and Fish Habitat Sampling Locations Tuktoyaktuk Segment

PROJECTION				DATUM
UTM Zone 8				NAD83
Scale: 1:150,000				
FILE NO.				
V23201322_EIS_Map036_AquaticsTuk.mxd				
PROJECT NO.	DWN	CKD	REV	
V23201322	SL	CK	0	
OFFICE	DATE			
EBA-VANC	May 2, 2011			

Figure 3.1.7-3

Kiggiak-EBA also completed an aerial reconnaissance survey of two proposed alternate routes between approximately kilometre 90 and kilometre 110 markings (Figure 3.1.7-3). The purpose of the reconnaissance was to identify potential watercourse crossings and assess watercourse conditions as discussed above. The results of the alternate route reconnaissance have been used to determine feasibility of the alternate routes over the preferred route, where it currently abuts or enters the Husky Lakes management area.

TABLE 3.1.7-4: JUNE 2010 APPROXIMATE SAMPLING LOCATIONS INUVIK TO TUKTOYAKTUK HIGHWAY

Stream Crossing Number	Km Marker[1]	UTM Easting NAD 83, Zone 8	UTM Northing NAD 83, Zone 8
Southern 25 km Section			
1	1.3	550652	7591441
2	1.7	550676	7591876
3	2.3	550701	7592439
4	3.2	550738	7593313
5	3.9	550774	7594072
6	4.1	550843	7595987
7	7.0	550461	7596944
8	7.8	550600	759700
9	8.4	550528	7598258
10	9.1	550432	7598916
11	9.4	550486	7599285
12	11.1	550300	7600887
13	13.3	550416	7603031
13a	17.0	551299	7606550
14	19.1	552194	7608091
15	22.0	553225	7610775
16	23.0	553244	7611735
17	23.4	553385	7612049
18	26.1	554804	7613971
Northern 25 km section			
36a	94.1	578796	7665217
37	95.0	579579	7665695
37a	96.3	580529	7666601
38a	102.8	582062	7672454
39	108.7	583809	7676965
39a	109.8	583407	7677970
39b	115.1	582873	7683007
39c	115.8	582799	7683622

[1] KM marker is measured from the northern end of Navy Road.

Following aerial reconnaissance, each watercourse crossing was inventoried for fish and fish habitat attributes according to the Resources Inventory Committee (RIC) Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (RIC 2001), with modifications based on field conditions. Kiggiak-EBA navigated to each of the crossing locations by using a hand held GPS unit and conducted a habitat inventory at each crossing location. Riparian cover type, amount and location; physical water quality parameters; and morphological attributes such as channel and wetted widths and depth were assessed and recorded at each crossing location.

Additional measurements of channel width, wetted width and depth occurred at various distances from the watercourse crossing location, as the conditions of each channel allowed, to a maximum of 50 m up and downstream. The RIC 2001 standard stipulates six perpendicular measurements for channel and wetted width to be completed; however, each crossing did not fit this convention. Typically three or five perpendicular measurements were taken including the Highway crossing location. This allowed for channel characteristics to be assessed at one or two locations up and downstream of each crossing.

Where watercourse conditions allowed, Kiggiak-EBA also collected stream flow velocities using a Swoffer flow meter to determine discharge rates of the watercourses (Table 3.1.7-5). Determination of watercourse discharge rates normally requires no less than ten velocity stations along a transect spanning the width of a channel. The average velocity is then multiplied by a representative flow area to determine discharge rate of the watercourse. These methods had to be modified for most drainage crossings due to insufficient flow or obstructed channel obstructions.

The Inuvik segment between KM 0 and KM 25 included 18 stream crossing inventories, while the Tuktoyaktuk segment between KM 93 and KM 118 included eight stream crossing inventories (Table 3.1.7-5).

Fish assessments were conducted using a Smith-Root Inc. LR-24 backpack Electrofisher to determine potential fish presence. Watercourses were electrofished in a downstream to upstream direction and targeted cover areas such as deep pools and instream LWD or over-hanging vegetation. Captured fish were assessed only for species. Backpack electrofishing was conducted within six of the 27 crossings and included watercourses 3 (KM 2.3), 4 (KM 3.2), 13a (KM 17.0), 18 (KM 26.1), 38a (KM 102.8) and 39 (KM 108.7)(see Table 3.1.7-5). Key reasons for the low number of streams electrofished was due to low water, limited or difficult access, and safety considerations.

The fall 2009 aerial reconnaissance included assessment of 44 crossing locations of which 32 were assumed to be ephemeral with limited or no fish habitat and 12 were assumed to be permanent watercourses, which provide fish habitat year-round with exception of the winter. During the spring sampling program, Kiggiak-EBA confirmed 17 ephemeral drainages and 10 permanent watercourses as a result of the ground assessment within the two assessment areas (Table 3.1.7-4). Three watercourses identified as ephemeral (5, 12, and 39a) and one watercourse identified as permanent (37a) during the fall 2009 aerial reconnaissance were inconsistent with conditions observed during the 2010 spring habitat surveys. Their status has therefore been changed for the purpose of designing appropriate crossing structures according to observed habitat.

From the perspective of identifying engineering constraints for Highway construction, three categories of streams are recognized along the Highway route:

- *Ephemeral streams that are either not utilized by fish for any part of their life cycle or provide only seasonal access to fish.* These watercourses, which varied in size, typically were not observed to possess defined channels and were populated with dense grasses, willows and other vegetation throughout the drainage.

  In many cases flow was not observed or water existed intermittently through dense in-stream vegetation. In addition, most of these drainages were typically obscured by dense riparian overgrowth. Likewise, ground assessment during the spring 2010 field program identified these streams as small, ephemeral channels that generally drain terrestrial upland areas or small, shallow lakes or ponds, most of which are not likely to provide suitable fish habitat features. Following a decision regarding the final Highway alignment, culverts at each of these crossing locations will be sized and installed based on site-specific hydrologic and habitat characteristics. At a minimum, however, all such streams are considered to provide food and nutrients to downstream fish habitats and will be protected by implementing measures contained in the erosion and sediment control plan for this Project.

- *Perennial (except in winter) streams that are potentially utilized by one or more life cycle stages of fish for migration during open water periods or which contribute to downstream habitat quality.* Consultation with the Highway engineering team determined that given their relatively narrow channel width, these crossings will require appropriately sized culverts according to channel and stream flow characteristics, and to permit unimpeded fish passage.

- *Perennial (except in winter) streams that are utilized by one or more life cycle stages of fish for spawning, rearing and feeding during open water periods, in addition to migration.* Consultation with the Highway engineering team determined that these stream crossings will require a clear span bridge due to permanency and morphology of the watercourses and the terrain within which the watercourses exist.

Ephemeral Drainages

The ephemeral drainages mostly existed as tributaries to one another or to slightly larger drainages, and occasionally discharged directly into small, shallow lakes. In most cases, flow in the ephemeral drainages was not measureable and occurred intermittently through dense vegetation (willow, grasses). Discharge was only measurable within 5 of the 15 ephemeral drainages due to lack of water or flow rates being too low to register. Where measureable, discharge rates within the ephemeral drainages ranged from 0 L/s (several drainages) to 20 L/s (drainage 37a) and averaged approximately 5 L/s. The discharge rate observed within drainage 37a was taken approximately 100 m downslope of the watercourse crossing location.

In general most of the 17 ephemeral drainages were deemed to provide only a source of water, food and nutrients to downstream habitat. While no ephemeral drainage was observed to provide spawning or overwintering habitat, drainages 14 and 16 may provide limited migratory or rearing habitat, except during winter, as both are sourced from small headwater lakes.

Perennial Watercourses

Identified permanent watercourse characteristics are shown in Table 3.1.7-5. Of the perennial watercourses, fish were observed or captured in three watercourses: 13a, 39 and 39a. Numerous Arctic grayling were observed within 39 and 39a. The majority of the perennial watercourses were closely linked with a lake or existed as a channel between two lakes.

In general all 10 permanent watercourses identified provide perennial migratory, spawning, rearing and feeding habitat; however, none are expected to provide overwintering habitat. Rearing habitat was observed in areas of slow moving water with an abundance of over- or in-stream cover including vegetation, deep pools and woody debris. Good or excellent spawning habitat was observed within 5 of the permanent watercourses, particularly for species such as grayling, lake whitefish and least cisco: 3, 13a, 18, 39 and 39a where appropriate stream bed material within each watercourse included a component of gravels and cobbles. Watercourses 13a, 39 and 39a were confirmed fish-bearing during the spring 2010 aquatic field program.

Discharge rates within permanent watercourses ranged from 3 L/s (watercourse 14) to 400 L/s (watercourse 18) and averaged approximately 108 L/s.

TABLE 3.1.7-5: SPRING 2010 AQUATIC FIELD PROGRAM FISH,FISH HABITAT, AND IN-SITU WATER QUALITY SAMPLING RESULTS

	Crossing	Km Marker[1]	Feature Descriptor	Cover			Channel Morphology							Water Quality					
				Existing Cover Type (at crossing)[2]	Crown Closure (%)	Dominant Riparian Vegetation	Dominant/ Subdominant Stream Bed Material	Avg. Channel Width (m)[3]	Avg. Wetted Width (m)[4]	Max. Depth (m)	Gradient (%) and Discharge Rate (L/s)	Pattern	Right bank/ Left bank Shape	Temp (°C)[5]	pH[6]	Dissolved Oxygen (mg/L)[7]	Conductivity (µS/cm)[8]	Turbidity[9]	Comments
Southern 25 km section	1	1.3	Ephemeral, assessed from air	D:OV															Assessed from air, no channel characteristics were measured. Ephemeral watercourse is expected to be non-fish bearing. Provision of food and nutrients.
	2	1.7	Ephemeral, low flow drainage	D:OV, S: IV		Shrub	Organics/ fines	5.2. (3)	4.5	-	<3	Straight	Sloped	10	7.9	3.4	160	Clear	Low flow observed with dense willow shrub. Provision of food and nutrients.
	3	2.3	Perennial	D:OV; T: IV, DP, U, LWD and SWD	75	Shrub/ deciduous	Silt/ gravel	3.4 (5)	1.9	0.5	- 75 L/s	Sinuous	Vertical	10.5	8.4	5.3	134	Clear	252 seconds fishing effort; no captures. Dense cover and gravels observed within riffle-pool habitat. Provision of good migratory, spawning and rearing habitat.
	4	3.2	Perennial	D: OV, S: DP, T: SWD	75	Deciduous	Fines/ organics	3.6 (3)	2.3	1.6	<3 25 L/s	Sinuous	Vertical/ Sloped	7.0	8.2	3.6	148	Clear	90 second fishing effort, no captures. Provision of migratory and rearing habitat and moderate spawning habitat due to silt bed material.
	5	3.9	Perennial	D: OV, S: SWD, T: DP, IV	65	Grasses/ deciduous	Fines/ organics	2.2 (5)	1.1	0.8	<3 15 L/s	Irregular meandering	Vertical	7.0	7.6	**15.6**	152	Clear	Assumed permanent (low flow) but may become intermittent. Provision of limited migratory and rearing habitat.
	6	4.1	Ephemeral, low flow drainage	D: OV, S: IV	60	Shrub/ deciduous	Organics	0.3 (2)	0.3	0.1	10 u/s 3 d/s	Straight	-	-	6.5	2.9	280	-	Meltwater runoff channel on hill side towards lake. Provision of food and nutrients.
	7	7.0	Ephemeral, low flow	D: OV, S: IV	75	Shrub	Organics/ fines	5.2 (5)	4.0	0.2	<3 3 L/s	Straight	Sloped	8.6	6.6	4.1	160	Clear	Flow occurring over mosses and grasses within willow drainage. Provision of food and nutrients.
	8	7.8	Perennial, still partially frozen	D: OV, S: SWD, T: LWD, U, IV	40	Shrubs/ grasses	Fines/ organics	7.2 (5)	3.7	0.8	<3 40 L/s	Irregular meandering	Vertical/ Sloped	9.0	8.2	6.4	150	Clear	Numerous bank failures, still partly ice covered. Large cobbles within bed material and extensive LWD observed within riffle-pool habitat. Provision of good migratory and rearing habitat with limited spawning habitat due to high level of fines comprising bed material.
	9	8.4	Ephemeral, assessed from air	D: OV		Shrub													Ephemeral drainage, non-fish bearing. Provision of food and nutrients.
	10	9.1	Ephemeral	D: OV, S: IV, T: SWD	80	Shrubs	Organics/ fines	4.3 (3)	2.1	0.9	3 u/s 5 d/s 4 L/s	Straight	Sloped	4.1	8.3	**6.9**	160	Clear	Ephemeral drainage and swamp like at crossing with multiple drainage pathways and no headwater lake; however, potentially permanent downstream. No connection to a lake suggests no potential for migratory or rearing habitat downstream.

TABLE 3.1.7-5: SPRING 2010 AQUATIC FIELD PROGRAM FISH,FISH HABITAT, AND IN-SITU WATER QUALITY SAMPLING RESULTS

	Crossing	Km Marker[1]	Feature Descriptor	Cover			Channel Morphology							Water Quality					
				Existing Cover Type (at crossing)[2]	Crown Closure (%)	Dominant Riparian Vegetation	Dominant/ Subdominant Stream Bed Material	Avg. Channel Width (m)[3]	Avg. Wetted Width (m)[4]	Max. Depth (m)	Gradient (%) and Discharge Rate (L/s)	Pattern	Right bank/ Left bank Shape	Temp (°C)[5]	pH[6]	Dissolved Oxygen (mg/L)[7]	Conductivity (µS/cm)[8]	Turbidity[9]	Comments
	11	9.4	Ephemeral drainage	D: OV, S: IV	95	Shrub	Organics	8.3 (3)	6.1	0.9	<3 <1 L/s	Straight	Sloped	6.3	7.6	5.5	187	Clear	Very thick shrub, low flow drainage. Provision of food and nutrients.
	12	11.1	Perennial, with numerous beaver dams	D: OV, S: IV T: U, SWD	10	Shrub	Organics/ fines	14.4 (5)	14	3.0	<3 45 L/s	Sinuous	Sloped	11	8.0	<1.5	120	-	Numerous beaver dams; wide littoral area of upstream lake, low flow downstream. Provision of limited migratory habitat due to obstructions and high fines, moderate rearing habitat.
	13	13.3	Ephemeral, swampy area	Crossing at open swamp area.															Intermittent water flowing over land- no channels. Provision of food and nutrients.
	13a	17.0	Perennial connection between two lakes	D: OV, T: SWD, B, U	10	Shrub/ grass	Gravel/ cobbles	9.7 (5)	3.0	1.3	<3 75 L/s	Irregular meandering	Sloped	13	8.0	**8.9**	118	Clear	Captured stickleback electrofishing 120 seconds fishing effort. Provision of excellent migratory, spawning and rearing habitat.
	14	19.1	Ephemeral, low water	D: OV, S: IV	10	Shrub/ grass	Fines/ organics	8.1 (5)	1.2	0.7	3 u/s 3 d/s 3 L/s	Sinuous	Sloped	10.3	6.5	5.8	86	Clear	Wide low flow channel connects to n-s directed watercourse downstream of crossing. Provision of limited migratory and rearing habitat.
	15	22.0	Ephemeral	D: OV, S: IV	80	Shrub/ grass	Organics/ fines	19.1 (3)	14.3	0.7	<3 6 L/s	Straight	Sloped	12	8.2	2.2	49	Clear	Very wide drainage sourced from small headwater lake. Provision of food and nutrients.
	16	23.0	Ephemeral	D: IV, S: OV	-	Shrub/ grass	Organics	5.3 (5)	4.1	0.7	3 u/s 3 d/s < 1 L/s	Sinuous	Sloped	7.9	7.5	4.1	270	Clear	Lots of in-stream vegetation, drainage between small lakes. Provision of food and nutrients and potentially limited migratory habitat.
	17	23.4	Ephemeral	D: IV, S: OV	<5	Shrub/ grass	Fines	11.4 (5)	9.5	0.6	<3	Sinuous	Sloped	7.0	8.1	**7.2**	43	-	Iron rich with lots of organics. Provision of food and nutrients.
	18	26.1	Perennial	D: OV, S: IV, T: SWD, U	75	Shrub/ grass	Sand/ gravels	7.0 (5)	4.8	1.6	<3 400 L/s	Meandering	Sloped	9.0	8.9	86.2%	44	Clear	150 seconds of fishing effort. Provision of good migratory, spawning and rearing habitat. Tributary to Jimmy Lake.
Northern 25 km section	36a	94.1	Ephemeral, historical lake	No cover							<1 L/s								Apparent historical lake with no channels observed and intermittent wet areas. Provides no fisheries habitat, non-fish bearing.
	37	95.0	Ephemeral	D: OV, S: IV	35	Shrub/ grass	Organics/ fines	1.6 (3)	1.0	0.2	<3	Straight	Sloped	8.0	8.4	1.9	120	Clear	Small ephemeral drainage into lake. Non-fish bearing. Provision of food and nutrients.
	37a	96.3	Ephemeral	D: OV, S:IV	15	Shrub/ grass	Fines/ organics	3.3 (1)	3.3	0.5	<3 20 L/s	Straight	Sloped	12.8	7.2	2.0	121	-	Only one measurement taken – very wide (60 m) drainage with multiple "channels" making up larger drainage. Provision of food and nutrients.

TABLE 3.1.7-5: SPRING 2010 AQUATIC FIELD PROGRAM FISH,FISH HABITAT, AND IN-SITU WATER QUALITY SAMPLING RESULTS

	Crossing	Km Marker[1]	Feature Descriptor	Cover			Channel Morphology							Water Quality					
				Existing Cover Type (at crossing)[2]	Crown Closure (%)	Dominant Riparian Vegetation	Dominant/ Subdominant Stream Bed Material	Avg. Channel Width (m)[3]	Avg. Wetted Width (m)[4]	Max. Depth (m)	Gradient (%) and Discharge Rate (L/s)	Pattern	Right bank/ Left bank Shape	Temp (°C)[5]	pH[6]	Dissolved Oxygen (mg/L)[7]	Conductivity (µS/cm)[8]	Turbidity[9]	Comments
	38a	102.8	Perennial connection between two lakes	D: IV, T: OV, SWD	15	Shrub/ grass	Organics	24.9 (5)	21.2	1.0	<3 210 L/s	Straight	Sloped	8.0	7.6	2.6	122	Clear	Wide watercourse connecting two lakes with wide marshy edges, low sloped banks and low flow. 78 second fishing effort. Provision of migratory and rearing habitat; however, spawning habitat limited due to fine bed material.
	39	108.7	Perennial	D: OV, S: U T: DP, SWD	-	Shrub/ grass	Gravels/ cobbles	8.7 (5)	3.8	0.7	<3 210 L/s	Irregular meandering	Sloped/ Vertical	6.1	7.9	5.7	93	Clear	Observed 9 Arctic grayling, 1 captured electrofishing. 174 seconds fishing effort. Provision of excellent migratory, spawning and rearing habitat with riffles, runs and large deep pools.
	39a	109.8	Perennial connection between two lakes	D: OV, S: IV, T: U	10	Shrubs/ grass	Sand/ fines	4.3 (5)	3.4	0.9	<3 190 L/s	Straight	Vertical	7.8	7.9	5.3	90	Clear	5 Arctic grayling observed within watercourse connecting two large lakes. Provision of excellent riffle-run migratory, spawning and rearing habitat.
	39b	115.1	Ephemeral	D: OV, T: SWD, IV	65	Shrub	Fines/ organics	6.4 (5)	2.8	0.4	4 u/s 2 d/s 2.5 L/s	Straight	Sloped	5.6	8.2	4.3	48	Clear	Meltwater drainage to lake. Provision of food and nutrients to lake, expected non-fish bearing.
	39c	115.8	Ephemeral drainage	D: OV	-	Scrub birch and ledum	-	-	-	-	-	-	-	-	-	-	-	-	Numerous meltwater drainages mostly dry but intermittent water, no flow and vegetated throughout. No fish habitat observed.

1. Kilometre marker is measured from the northern end of the Navy Road (see Figure 3.1.7-2).
2. Cover type: D = dominant, S = subdominant and T = trace. OV = overhanging vegetation, IV = instream vegetation, DP = deep pools, U = undercut banks, LWD/SWD = large/small woody debris, B = boulders
3. Average channel width calculated from the number of perpendicular measurements noted.
4. Average wetted width calculated from the number of perpendicular measurements noted.
5. Recorded from YSI 550A Temperature/Conductivity field probe.
6. Recorded from WTW pH/Cond 340i field probe.
7. Recorded from YSI 550A Temperature/Conductivity field probe.
8. Recorded from WTW pH/Cond 340i field probe.
9. Turbidity based on observer visual estimate ranging from (C)lear – (L)ightly turbid – (M)oderately turbid – (T)urbid

In total, one ninespine stickleback (crossing 13A) and one Arctic grayling (crossing 39) were captured. Another 14 Arctic grayling were observed. The stickleback was approximately 5 cm in length; weight, sex and age were not determined. The Arctic grayling was approximately 34 cm in length, while weight, sex and age were not determined. Other grayling observed were visually estimated to be approximately 25 to 35 cm in length. Table 3.1.7-6 provides results of the fisheries assessment.

TABLE 3.1.7-6: FISHERIES ASSESSMENT RESULTS

Watercourse	Fishing Effort[1]	Catch and Observations
3	252 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	No catch; good migratory, spawning and rearing habitat observed.
4	90 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	No catch; good migratory and rearing habitat; moderate spawning habitat observed.
13a	120 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	Captured approximately 5 -7 cm ninespine stickleback. Excellent spawning, migratory and rearing habitat observed.
18	150 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	No catch. Good migratory, spawning and rearing habitat, tributary to known fish-bearing lake.
38a	78 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	No catch. Good migratory and rearing habitat; moderate spawning habitat observed.
39	174 seconds; 14% duty cycle; 4 ms pulse width and 35 Hz	1 Arctic grayling captured, 9 observed. Excellent migratory, spawning and rearing habitat observed.
39a	Did not electrofish due to observed Arctic grayling.	5 Arctic grayling observed. Excellent migratory, spawning and rearing habitat observed.

Source: Kiggiak-EBA 2010b

Note:

1. ms = Amount of time in milliseconds of electric pulse generated.

Alternate Route Watercourses

Kiggiak-EBA carried out aerial reconnaissance of 14 additional watercourse crossings along Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment); ground assessments were not conducted due to time constraints. Of the 14 watercourses observed, seven were assumed to be permanent while the remaining seven were assumed to be ephemeral (Table 3.1.7-7). Locations have been identified for future study, if necessary

TABLE 3.1.7-7: AERIAL RECONNAISSANCE OF ALTERNATE ROUTES (TUKTOYAKTUK SEGMENT)

Crossing Number*	Assumed Ephemeral	Assumed Permanent	Northing (UTM)	Easting (UTM)	Description
A1		✓	582020	7677885	Watercourse flows between two lakes, likely fish-bearing
A2	✓		579011	7676323	Wetted area between lakes
A3		✓	577863	7674377	Watercourse between two lakes with observed flow and inputs from melt water channels
A4		✓	579458	7671953	Watercourse connection between two lakes
A5		✓	581333	7671439	Watercourse connection between two lakes with dense vegetation
A6	✓		577977	7671432	Occurs between lakes but drainage narrows and becomes intermittent
A7	✓		577770	7671724	Wetland area
A8	✓		577954	7671470	Ephemeral
A9	✓		577748	7669874	Occurs between lakes and surrounded by wider wet area
A10	✓		576532	7668536	Wetland area
A11	✓		576435	7668140	Wetland area
A12		✓	576315	7667618	Connection between two lakes
A13		✓	757975	7664634	Appears permanent with lots of in stream vegetation
A14		✓	575417	7664716	Fish observed within permanent watercourse
TOTAL	**7**	**7**			

Note: * - A1 to A14 are located along Alternative 3 (2010 Minor Realignment), see Figure 3.1.7-3

Stream category will be a factor in determining, at a minimum, the type of structure at each stream crossing location that would avoid or minimize the harmful alteration, disruption, or destruction (HADD) of fish habitat, as prohibited by Section 35. (1) of the *Fisheries Act*. Table 3.1.7-8 provides general guidance in this regard, although site specific conditions may dictate alternative measures.

TABLE 3.1.7-8: GENERALIZED STREAM CROSSING STRUCTURE AND MITIGATION MEASURES	
Stream Category	**Mitigation**
Ephemeral non-fish bearing drainages	*Culvert*. Apply sediment and erosion control best management practices during construction. Construction is to occur in the winter.
Perennial Migratory channels	*Culvert*[1]. Sizing and placement of culvert is critical to avoid excessive velocities. Culvert should be set into the substrate to prevent erosion at downstream invert. Where possible, culvert should be installed in areas having a hard (gravel/cobble) bottom. Where culvert twinning is required, only one culvert should be set to permit fish passage at low flows. Apply sediment and erosion control best management practices during construction. Follow the DFO Operational Statement for Temporary Stream Crossings (DFO 2009b) where these are necessary.
Perennial Spawning/rearing/ feeding streams	*Clear span bridge*. Follow DFO Operational Statement for Clear Span Bridges (DFO 2009c). Apply sediment and erosion control best management practices during construction.

Note:

1. Open-bottom culverts are normally preferred where culverts must be installed in fish-bearing streams in lieu of clear span bridges; however, it is understood that open-bottom culverts must meet specific geotechnical criteria for installation.

Table 3.1.7-9 provides a summary of the proposed stream crossing structures at each crossing location, based solely on fish and fish habitat considerations. Ground surveys have provided information on fish and habitat presence or potential, and hence, the appropriate construction and environmental management measures that should be adopted at each site. Clear span bridges were recommended at 11 locations due to known fish presence and/or habitat quality identified (Figure 3.1.7-4).

The preliminary reconnaissance findings indicate that the majority of channels crossed by the proposed Highway are small, ephemeral streams that generally drain terrestrial upland areas or small, shallow lakes or ponds during periods of high water, most of which do not provide suitable fish habitat features. Appropriately sized culverts (800-900 mm diameter) installed at these locations will require the implementation of appropriate erosion and sediment control measures to protect downstream habitats.

Preliminary recommendations for proposed crossing structures based on stream and fish habitat characteristics are provided in Table 3.1.7-9. Specific fish habitat issues that will be considered as part of the regulatory approval process, in addition to general avoidance or mitigation measures to minimize adverse effects, are identified in Section 4.2.5, Fish and Fish Habitat Impact Assessment.

TABLE 3.1.7-9: PROPOSED STREAM CROSSING STRUCTURES BASED ON STREAM AND FISH HABITAT CHARACTERISTICS OR POTENTIAL

Crossing No.	Culvert (no fish habitat)	Culvert (moderate or seasonal fish habitat)	Bridge(good or known fish habitat)	Comments
01	✓			Ephemeral, no headwater lakes
02	✓			Ephemeral, very small drainage
03		✓		Permanent, good habitat, small watercourse.
04		✓		Permanent, good habitat. Similar to crossing #03.
05		✓		Permanent, very small headwater lakes
06	✓			Ephemeral, short runoff channel
07	✓			Ephemeral, short runoff channel
08			✓	Provision of good migratory and rearing habitat with limited spawning habitat
09	✓			Ephemeral drainage, assessed from air.
10	✓			Ephemeral, no headwater lakes
11	✓			Ephemeral, no headwater lakes
12		✓		Small, flowing channel.
13	✓			Ephemeral, no channel observed.
13a			✓	Short, wide migration channel between lakes. Likely migration corridor.
14		✓		Ephemeral, very short drainage channel draining small headwater lake.
15	✓			Ephemeral. Drains small upstream headwater lake.
16		✓		Ephemeral. Drains small upstream headwater lake with potential seasonal migratory habitat.
17	✓			Ephemeral. Very small drainage.
18			✓	Good habitat. Tributary to Jimmy Lake.
19	✓			Ephemeral drainage channel.
20	✓			Ephemeral drainage channel.
21a	✓			Ephemeral. Drains small lakes in upper portion of watershed.
23a (KM 40)			✓	Good perennial habitat. Trail Valley Creek
24a	✓			Ephemeral. Very small drainage.
25	✓			Ephemeral. Very small drainage. No lakes upstream.
26	✓			Ephemeral. Very small drainage.
27a	✓			Ephemeral. Very small drainage. Only one small pond upstream.

TABLE 3.1.7-9: PROPOSED STREAM CROSSING STRUCTURES BASED ON STREAM AND FISH HABITAT CHARACTERISTICS OR POTENTIAL

Crossing No.	Culvert (no fish habitat)	Culvert (moderate or seasonal fish habitat)	Bridge(good or known fish habitat)	Comments
27b	✓			Short drainage channel.
28a		✓		Short connection channel between lakes. Migration corridor.
29	✓			Short runoff channel in headwaters.
29a (KM 55.5)			✓	Drains small headwater lake. Tributary to Hans Creek.
30a (KM 56.5)			✓	Hans Creek. Known fish habitat.
31 (KM 67.5)			✓	Zed Creek. Known fish habitat.
32	✓			Ephemeral. Headwater tributary to Zed Creek.
33		✓		Small perennial stream. Known fish habitat (fish observed).
34a	✓			Ephemeral drainage channels from small headwater lakes.
34b	✓			Not shown in map book. NW of KM 89 on alternate route. Appears to be ephemeral on Google Earth.
34e	✓			Ephemeral, short channel draining very small upstream lakes.
35a (KM 89.5)			✓	Good habitat, perennial flow.
37	✓			Ephemeral drainage source to lake.
37a	✓			Ephemeral large, wide drainage.
38a			✓	Perennial stream. Moderate habitat conditions.
39			✓	Good habitat. Perennial stream, large drainage with observed fish presence.
39a			✓	Good habitat. Short, wide channel between 2 lakes with observed fish presence.
39b	✓			Ephemeral drainage to lake.
39c	✓			Intermittent water, no channels observed.
A1*		✓		Small, flowing channel. Requires field check
A2	✓			Wetland like area, appears ephemeral. Requires field check.
A3		✓		Small, flowing channel. Requires field check
A4		✓		Small, flowing channel. Requires field check

TABLE 3.1.7-9: PROPOSED STREAM CROSSING STRUCTURES BASED ON STREAM AND FISH HABITAT CHARACTERISTICS OR POTENTIAL

Crossing No.	Culvert (no fish habitat)	Culvert (moderate or seasonal fish habitat)	Bridge(good or known fish habitat)	Comments
A5		✓		Small, flowing channel. Requires field check
A6	✓			Small assumed ephemeral drainage with intermittent water. Requires field check
A7	✓			Small assumed ephemeral drainage with intermittent water. Requires field check
A8	✓			Small assumed ephemeral drainage with intermittent water. Requires field check
A9	✓			Small assumed ephemeral drainage with intermittent water. Requires field check
A10	✓			Wetland like area, appears ephemeral. Requires field check
A11	✓			Wetland like area, appears ephemeral. Requires field check
A12		✓		Small, flowing channel between small lakes. Requires field check
A13		✓		Small, flowing channel. Requires field check
A14			✓	Large permanent watercourse with observed fish presence.

Note: * - A1 to A14 are located along Alternative 3 (2010 Minor Realignment), see Figure 3.1.7-3

Future investigation of the 14 crossings along Alternative 1 (2009 Minor Realignment) and Alternative 3 (2010 Minor Realignment) is required to determine appropriate crossing types and avoidance and mitigation measures should these routes be considered as feasible alternatives.

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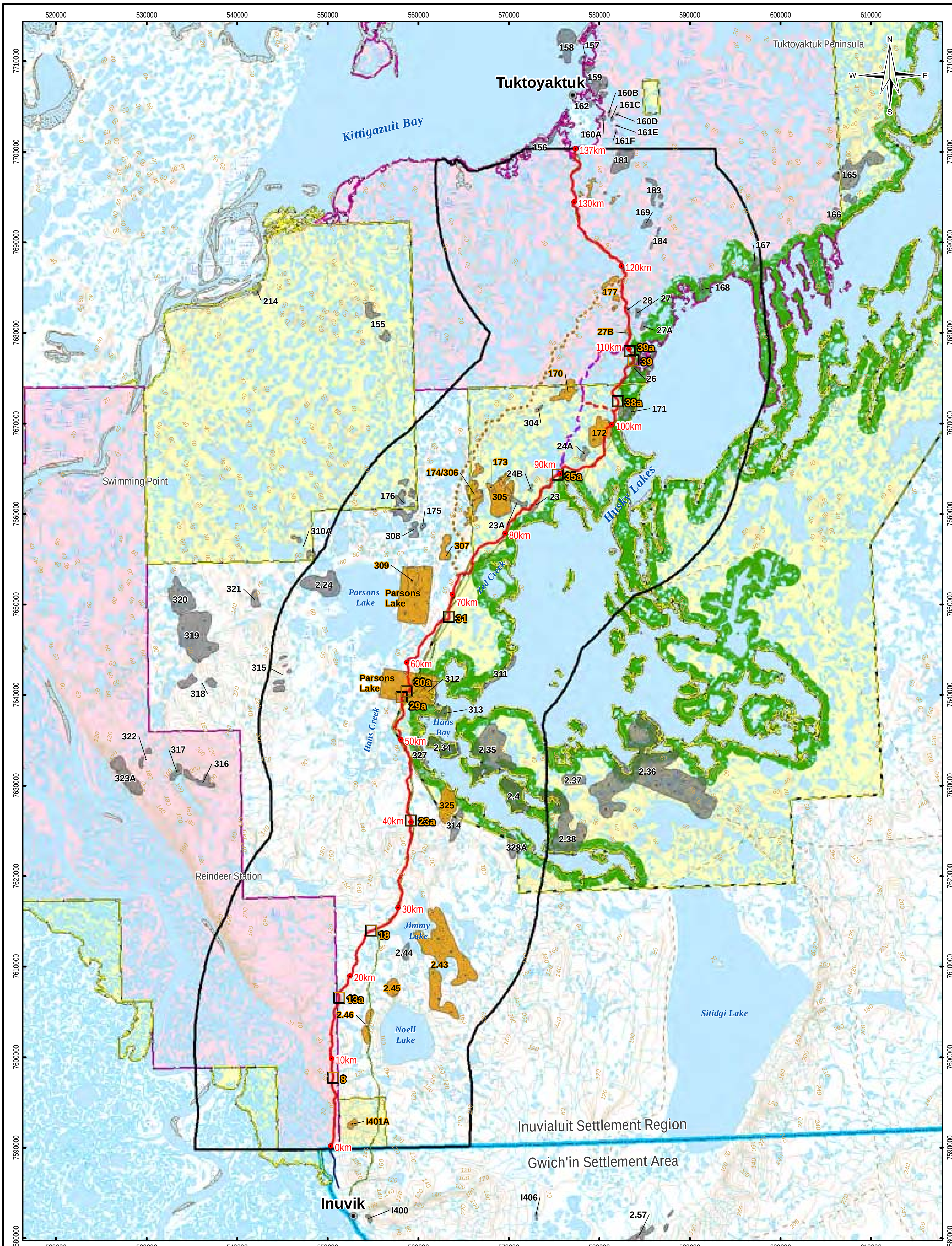


LEGEND

- Clear Span Bridge Crossing
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Potential Bridge Crossing Locations Based on Fisheries Assessment

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000

Kilometres

FILE NO.
V23201322_EIS_Map006_Fish_StreamX.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	CK	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.7-4

ISSUED FOR USE

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

3.1.8 Vegetation

3.1.8.1 Ecoregion Classification

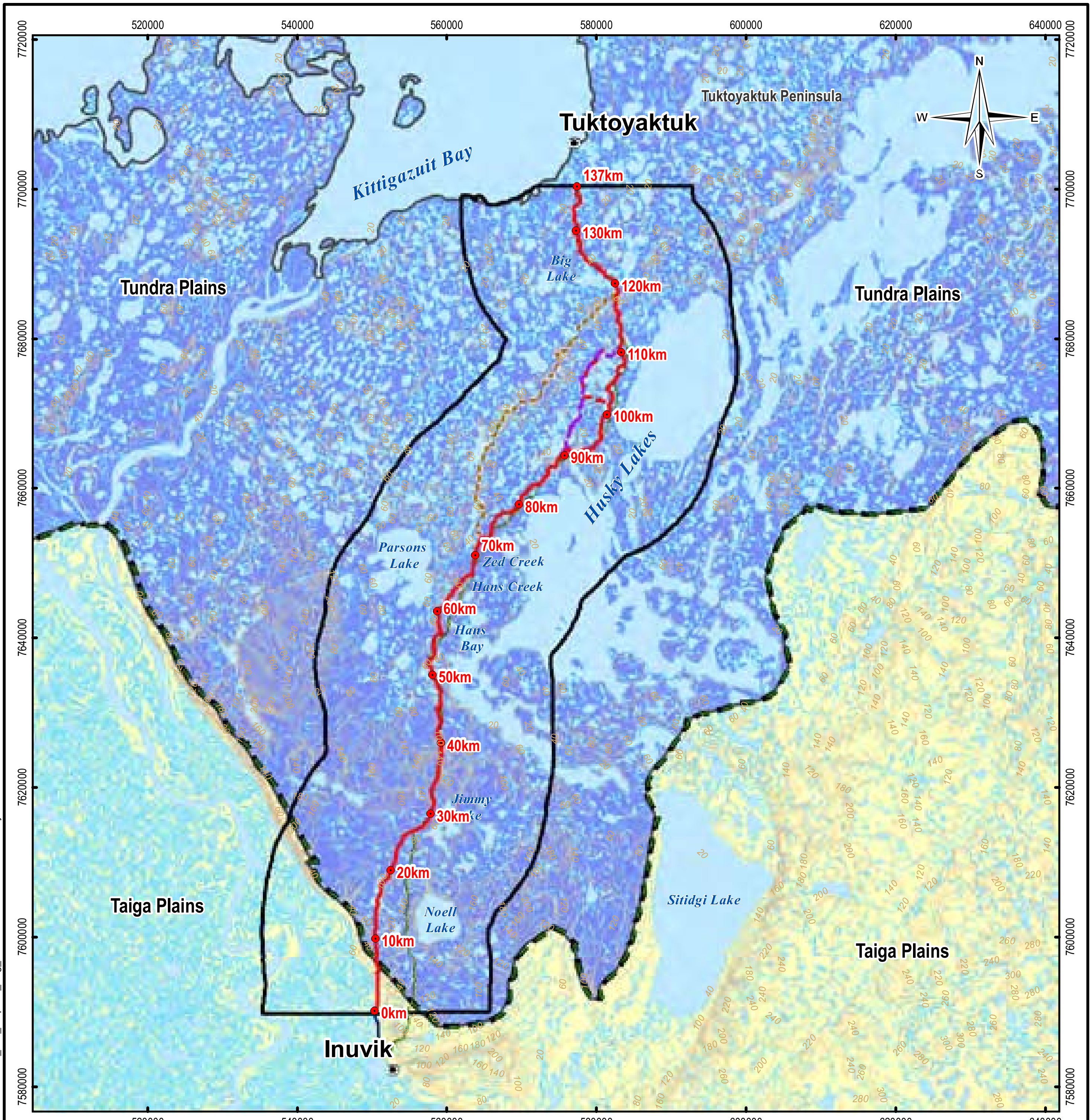
The GNWT is currently classifying the Northwest Territories into ecological land units based on regional climate, regional to local physiography, vegetation, and permafrost patterns. The approach integrates the Canadian ecozone classification (Ecological Stratification Working Group 1996) with the Ecological Regions of North America. The NWT classification effort currently applies to the first four levels of the continental framework. The GNWT completed the classification of the Taiga Plains Ecoregion in 2007 (Ecosystem Classification Group 2007, revised 2009) and is currently completing a similar classification of the Tundra Plains Ecoregion.

Level I Ecoregions in the NWT are comparable to biomes. Three occur in the NWT including Tundra, Taiga, and Northwest Forested Mountains.

Level II Ecoregions, equivalent to the Canadian 'ecozone', represent large generalized ecological land units that are characterized by distinctive regional ecological factors including climate, physiography, vegetation, soils, water, fauna, and land use (Ecosystem Classification Group 2007, revised 2009). The proposed Inuvik to Tuktoyaktuk Highway Project is located primarily in the Tundra Plains Level II Ecoregion (equivalent to the western part of the Southern Arctic Ecozone) with a very minor portion occurring within the Taiga Plains Level II Ecoregion (equivalent to the Taiga Plains Ecozone) (Figure 3.1.8-1; Table 3.1.8-1).

TABLE 3.1.8-1: NWT ECOREGIONS CROSSED BY THE PROPOSED INUVIK TO TUKTOYAKTUK HIGHWAY

Highway Corridor	Level I Ecoregion	Level II Ecoregion	Level III Ecoregion	Level IV Ecoregion
2.8 km	Taiga	Taiga Plains	Taiga Plains High Subarctic	Mackenzie Delta High Subarctic
3.8 km	Taiga	Taiga Plains	Taiga Plains High Subarctic	Sitidgi Plain High Subarctic
46.6 km	Tundra	Tundra Plains	Tundra Plains Low Arctic (north)	Caribou Hills Low Arctic (north)
83.8 km	Tundra	Tundra Plains	Tundra Plains Low Arctic (north)	Tuktoyaktuk Coastal Plain Low Arctic (north)



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LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Treeline
- Contour
- Watercourse
- Waterbody
- Wetland

Level II Ecoregions

- Tundra Plains
- Taiga Plains

NOTES

Base data source: NTS 1:250,000
Ecoregions: Ecosystem Classification Group (GNWT 2011)

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Level II Ecoregions

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

10 5 0 10 20

Kilometres

FILE NO.
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PROJECT NO.	DWN	CKD	REV
V23201322	SL	TP	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 3.1.8-1

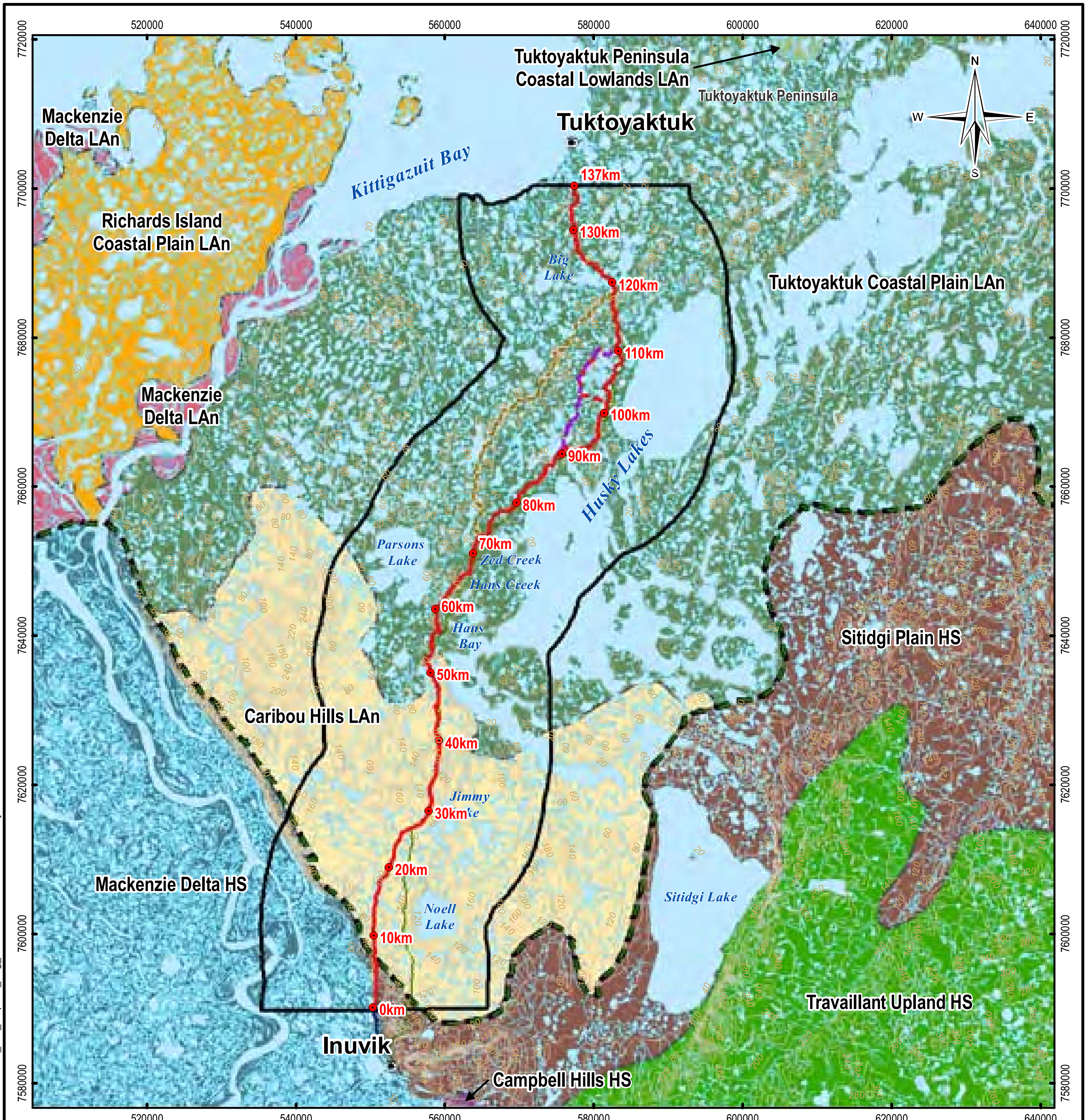
The Tundra Plains Level II Ecoregion is a cold, treeless northern extension of the mainly level to undulating and mostly forested Taiga Plains landscape. It is generally covered by variably-textured till with a relatively high proportion of wetlands. It is affected by coastal and continental climates, and includes coastal and upland plains, plateaus, and hill systems. The boundary between the Tundra Plains and Taiga Plains Level II Ecoregions also represents the approximate extent of the treeline (Figure 3.1.8-1), and while it is shown as a sharp line, it is in actuality a more gradual transition zone several kilometres wide.

Approximately 13,009 ha of the LSA and 348,915 ha of the RSA for the proposed Inuvik to Tuktoyaktuk Highway are within the Tundra Plains Level II Ecoregion (Table 3.1.8-2). The remaining minor portions of the LSA (648 ha) and RSA (28,044 ha) are located within the Taiga Plains Level II Ecoregion.

Level III Ecoregions are characterized by regional climatic differences that provide an organizing framework for subsequent Level IV Ecoregions. The extreme south end of the proposed Highway corridor crosses the Level III Taiga Plains High Subarctic Ecoregion, which is characterized by very cold winters, short cool summers and somewhat higher precipitation than the Level III Tundra Plains Low Arctic (north) Ecoregion.

The Level III Tundra Plains Low Arctic (north) Ecoregion, where the majority of the Highway alignment is located, has a growing season that is too short to allow for the establishment and growth of conifer woodlands.

Level III Ecoregions are further subdivided into Level IV Ecoregions according to regionally characteristic ecological factors such as climate, physiography, water, soil, vegetation, and fauna (Ecosystem Classification Group 2007, revised 2009). In the NWT, detailed vegetation, soil, and surficial geology information is generally limited. However, there is sufficient information to delineate and describe Level IV Ecoregions using existing ecological, soils, and surficial geology maps, good-quality satellite imagery, digital elevation models, and photographs as well as through observed relationships between permafrost forms, forest cover, tree species distribution, and climatic conditions. Figure 3.1.8-2 shows the spatial distribution of Level IV Ecoregions in the Project area.



LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Treeline
- Contour
- Watercourse
- Waterbody
- Wetland

Level IV Ecoregions

- Campbell Hills HS
- Caribou Hills LAn
- Mackenzie Delta HS
- Mackenzie Delta LAn
- Richards Island Coastal Plain LAn
- Sitidgi Plain HS
- Travaillant Upland HS
- Tuktoyaktuk Coastal Plain LAn
- Tuktoyaktuk Peninsula Coastal Lowland LAn

NOTES

Base data source: NTS 1:250,000
Ecoregions: Ecosystem Classification Group (GNWT 2011)

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Level IV Ecoregions

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map030_Veg_Eco4.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TP	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.8-2

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3.1.8.2 Characteristics of Level IV Ecoregions within the Project Study Area

The proposed alignment for the Inuvik to Tuktoyaktuk Highway crosses four Level IV Ecoregions, the distributions of which are outlined in Table 3.1.8-2 and Figure 3.1.8-2. Starting at KM 0, at the boundary of the Inuvialuit Settlement Region, the first 2.8 km of the proposed Project pass through the extreme eastern edge of the Mackenzie Delta High Subarctic Ecoregion. The next 3.8 km cross the Sitidgi Plain High Subarctic Ecoregion. These Level IV Ecoregions form the most northerly extent of the Level II Taiga Plains Ecoregion.

TABLE 3.1.8-2: LEVEL IV ECOREGION DISTRIBUTION WITHIN THE PROPOSED INUVIK TO TUKTOYAKTUK HIGHWAY PROJECT AREA

Level IV Ecoregion[1]	LSA (ha)			RSA[2] (ha)
	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Mackenzie Delta High Subarctic	261.7	261.7	261.7	25,973.7
Sitidgi Plain High Subarctic	386.8	386.8	386.8	2,069.9
Caribou Hills Low Arctic (north)	4,618.5	4,618.5	4,618.5	113,200.9
Tuktoyaktuk Coastal Plain Low Arctic (north)	8,391.3	8,161.4	8,228.0	235,714.4
Total	**13,658.3**	**13,428.4**	**13,495.0**	**376,958.9**

[1]The route alignment options only occur within the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion; therefore, all other Ecoregion calculations are the same for all alternatives.
[2]All route options.

The vegetation along the southern portion of the Highway corridor represents a transition zone between the forests of the Taiga Plains and the tundra plant communities of the Tundra Plains (Photos 3.1.8-1 to 3.1.8-3). As such, the vegetation in this transition zone is a mixture of stunted open spruce woodlands, tall shrublands, and tundra vegetation, distributed in response to differences in local elevation, microsite topography, and aspect.

Photo 3.1.8-1
The northern edge of the Level II Taiga Plains Ecoregion is dominated by slow growing spruce forest

Photo 3.1.8-2
The forest surrounding Inuvik is predominantly spruce; however, it quickly changes to deciduous forest and shrub closer to the treeline

Photo 3.1.8-3
At the treeline, deciduous forest is increasingly replaced by shrubs

The next 46.6 km cross through the Caribou Hills Low Arctic Ecoregion of the Tundra Plains (GNWT ENR 2011d). The Caribou Hills Ecoregion has a pronounced rolling and undulating terrain. Numerous small lakes and streams occur in the Ecoregion, with Noell Lake being the largest lake. Shallow pothole ponds, often with shrubby shorelines, are dominant features of lowlands (Photo 3.1.8-4). Low shrub tundra, often dominated by dwarf birch, is common and extensive. Cotton-grass tussock tundra is also prevalent throughout the Caribou Hills Ecoregion.

Photo 3.1.8-4
General appearance of the gently undulating Tuktoyaktuk Peninsula with numerous pothole lakes surrounded by dwarf birch-dominated shrub tundra on uplands and sedge tussock fens

The remaining 83.7 km pass through the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion (GNWT ENR 2011d). This Ecoregion is composed of level to rolling terrain, rising from sea level to approximately 150 m at Parsons Lake, and 100 m above sea level at Granular Source 177 near Tuktoyaktuk. Numerous lakes, ponds, and streams also occur across this Ecoregion, with the most significant body of water being the Husky Lakes. Shallow pothole ponds, often with discontinuous narrow shrub belts along their shorelines, are dominant features of lowlands in the gently undulating to rolling landscapes of the Tuktoyaktuk Peninsula.

Sphagnum and other wetland mosses dominate high-centre and low-centre polygons that are associated with low-lying, poorly drained terrain. Drier areas support shrub and sedge tundra that includes bog birch, willow, dwarf shrubs, *Dryas* spp., sedges, mosses, and lichens. Low shrub tundra is less common from the eastern edge of the Caribou Hills to Tuktoyaktuk. Riparian communities along streams and around ponds and seepage zones on lower slopes include wet sedge – cotton-grass communities and taller shrubs.

3.1.8.3 Vegetation Types

The major vegetation types present within the Inuvik to Tuktoyaktuk Highway Project study area have been described in the Environmental Impact Statement for the Mackenzie Gas Project (IOL et al. 2004) and as such have been applied here as well. The spatial distribution of vegetation types within the Inuvik to Tuktoyaktuk Highway study area draws from broad ecological mapping of the area by the Earth Observation for Sustainable Development of Forests (EOSD) initiative of the Canadian Forest Service (Wulder et al. 2004). The EOSD land cover classes represent a broader scale of vegetation assemblage that may not be directly analogous to the vegetation types described for the Mackenzie Gas Project, but they are generally representative.

Table 3.1.8-3 identifies the vegetation types described by IOL et al. (2004) that are most common within each of the Ecoregions present in the proposed Highway area. Each vegetation type has also been assigned to a representative EOSD land cover class (as described in Wulder et al. 2004). Ecologically the vegetation of the portion of the Taiga Plains crossed by the proposed Highway is transitional to the Tundra Plains; as such, some vegetation types are found in both the Taiga Plains and Tundra Plains Ecoregions.

TABLE 3.1.8-3: VEGETATION TYPES BY ECOREGION ALONG THE PROPOSED INUVIK TO TUKTOYAKTUK HIGHWAY

Level II Ecoregion	Level IV Ecoregion	Vegetation Type[2]	EOSD Land Cover Class[3, 4]
Taiga Plains	Mackenzie Delta High Subarctic[1]	Upland Alaska Birch – Spruce	Shrub Tall, Mixedwood, Broadleaf
		Black Spruce/Ground Birch	Coniferous
		Upland Shrub	Shrub Low
	Sitidgi Plain High Subarctic[1]	Upland Alaska Birch – Spruce	Shrub Tall, Mixedwood, Broadleaf
		Black Spruce/Ground Birch	Coniferous
		Upland Shrub	Shrub Low
Tundra Plains	Caribou Hills Low Arctic	Black Spruce/Ground Birch	Coniferous
		Dry Saxifrage Tundra	Exposed/Barren Land
		Dwarf Shrub Heath	Shrub Low, Bryoids
		Upland Shrub	Shrub Low
		Cotton-grass Tussock	Wetland-herb, Herbs
		High-Center Polygons	Wetland-herb, Herbs
		Low-Center Polygons	Wetland-herb, Wetland-shrub
		Riparian Shrub	Shrub Tall, Wetland-treed, Mixedwood, Broadleaf
		Riparian Sedge-Cotton-grass	Wetland-herb, Herbs
		Riparian Black Spruce/Shrub	Coniferous, Mixedwood, Broadleaf
		Fresh Water	Water
	Tuktoyaktuk Coastal Plain Low Arctic	Black Spruce/ground birch	Coniferous
		Dry Saxifrage Tundra	Exposed/Barren Land
		Dwarf Shrub Heath	Shrub Low, Bryoids
		Upland Shrub	Shrub Low
		Cotton-grass Tussock	Wetland-herb, Herbs
		High-Center Polygons	Wetland-herb, Herbs
		Low-Center Polygons	Wetland-herb, Wetland-shrub
		Riparian Shrub	Shrub Tall, Wetland-treed, Mixedwood, Broadleaf
		Riparian Sedge-Cotton-grass	Wetland-herb, Herbs
		Riparian Black Spruce/Shrub	Conifer, Mixedwood, Broadleaf
		Fresh Water	Water

[1]Only the vegetation types found along the estimated 7 km of proposed Highway that occur within the Mackenzie Delta High Subarctic and Sitidgi Plain High Subarctic Ecoregions are described.
[2]As per IOL et al. (2004)
[3]As per Wulder et al. (2004)
[4] Mixedwood includes 'Dense' and 'Open'; Broadleaf includes 'Dense' and 'Open'; Coniferous includes 'Dense', 'Open', and 'Sparse'.

Vegetation types characteristic of the Mackenzie Delta High Subarctic and Sitidgi Plains High Subarctic Ecoregions include Upland Alaska Birch-Spruce, Black Spruce/Ground Birch, and Upland Shrub., which could be represented by Shrub Low, Shrub Tall, and Coniferous (Dense, Open, Sparse), Mixedwood (Dense, Open), and Broadleaf (Dense, Open) EOSD land cover classes (Table 3.1.8-4; Figure 3.1.8-3).

TABLE 3.1.8-4: DISTRIBUTION OF LAND COVER CLASSES WITHIN THE INUVIK TO TUKTOYAKTUK HIGHWAY STUDY AREAS

Level IV Ecoregion	EOSD Land Cover Class[1]	LSA[2] (ha) Primary 2009 Route	LSA[2] (ha) Alternative 2 (Upland Route)	LSA[2] (ha) Alternative 3 (2010 Minor realignment)	RSA[3] (ha)
Mackenzie Delta HS	Water	1.7	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	9,092.9
	Not Classified (Cloud)	29.3			2,783.0
	Coniferous Dense	1.3			2,776.9
	Broadleaf Dense	95.0			2,440.0
	Mixedwood Dense	55.2			2,160.0
	Wetland Shrub	4.2			1,246.4
	Exposed/Barren Land				1,112.0
	Wetland Herb	0.2			1,095.2
	Coniferous Sparse	31.3			854.0
	Coniferous Open	2.7			513.8
	Broadleaf Open	39.5			375.5
	Mixedwood Open	0.1			332.1
	Wetland Treed				326.1
	Shrub Tall	0.7			301.5
	Bryoids				293.6
	Shrub Low	0.4			245.4
	Herbs				24.9
	Rock/Rubble				0.2
Mackenzie Delta HS Total		**261.7**			
Sitidgi Plain HS	Broadleaf Dense	142.7	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	916.8
	Mixedwood Dense	99.9			466.9
	Coniferous Sparse	62.1			260.9
	Broadleaf Open	49.6			218.4
	Not Classified (Cloud)	0.1			76.1
	Water	10.2			34.8
	Coniferous Dense	6.2			33.4
	Coniferous Open	5.7			25.8
	Wetland Shrub	4.8			13.0
	Shrub Low	2.4			11.7
	Herbs	0.2			3.6
	Wetland Herb	0.4			3.0
	Wetland Treed	0.7			2.8
	Bryoids	1.0			1.0
	Shrub Tall	0.4			0.8
	Exposed/Barren Land	0.4			0.4
	Mixedwood Open				0.2
Sitidgi Plain HS Total		**386.8**			

TABLE 3.1.8-4: DISTRIBUTION OF LAND COVER CLASSES WITHIN THE INUVIK TO TUKTOYAKTUK HIGHWAY STUDY AREAS

Level IV Ecoregion	EOSD Land Cover Class[1]	LSA[2] (ha)			RSA[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor realignment)	
Caribou Hills LA	Bryoids	1,244.5	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	25,917.2
	Coniferous Sparse	446.7			17,208.5
	Shrub Low	684.7			16,832.6
	Water	343.6			14,309.3
	Exposed/Barren Land	448.5			9,092.8
	Mixedwood Dense	255.5			6,986.7
	Shrub Tall	276.3			4,801.5
	Broadleaf Dense	370.8			4,179.7
	Coniferous Open	73.0			2,885.2
	Herbs	95.6			1,886.0
	Coniferous Dense	49.8			1,853.3
	Wetland Herb	53.9			1,694.3
	Broadleaf Open	84.2			1,665.9
	Wetland Shrub	87.9			1,660.5
	Rock/Rubble	68.7			1,009.7
	Not Classified (Cloud/Shadow)	16.4			608.7
	Wetland Treed	13.3			395.0
	Mixedwood Open	5.2			214.1
Caribou Hills LA Total		**4,618.5**			
Tuktoyaktuk Coastal Plain LA	Water	1,426.4	1,377.6	1,540.2	109,974.7
	Bryoids	2,370.7	1,789.9	2,126.1	39,434.5
	Shrub Low	2,238.3	2,457.8	2,200.8	38,586.9
	Shrub Tall	960.2	1,105.8	992.4	16,871.8
	Wetland Herb	311.7	354.2	305.0	7,728.5
	Wetland Shrub	346.5	299.3	331.5	6,435.3
	Exposed/Barren Land	270.2	171.0	247.0	5,886.4
	Herbs	232.4	297.9	250.2	4,477.8
	Coniferous Sparse	86.8	109.1	86.6	2,673.8
	Coniferous Open	69.0	112.2	69.0	1,650.3
	Wetland Treed	25.5	43.5	26.4	959.1
	Rock/Rubble	39.1	26.2	38.2	513.6
	Mixedwood Open	13.4	15.5	13.4	242.5
	Mixedwood Dense	1.1	1.3	1.1	157.8
	Coniferous Dense				78.0
	Broadleaf Open				22.0
	Not Classified (Cloud/Shadow)				17.0
	Broadleaf Dense				4.3
Tuktoyaktuk Coastal Plain LA Total		**8,391.3**	**8,161.4**	**8,228.0**	**235,714.4**
Grand Total		**13,658.3**	**13,428.4**	**13,494.9**	**376,958.9**

[1]As per Wulder et al. (2004)
[2]The route alignment options only occur within the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion; therefore, all other Ecoregion calculations are the same for all alternatives.
[3]All route options

In the Caribou Hills Low Arctic Ecoregion, the most prevalent EOSD land cover classes present include Bryoids, Coniferous Sparse, and Shrub Low (Table 3.1.8-4) which are likely representative of the Dwarf Shrub Heath, Upland Shrub, Black Spruce/Ground Birch, and Riparian Black Spruce/Shrub vegetation types (Table 3.1.8-3). The Coniferous Sparse land cover class dominates the southern and eastern portions of the Caribou Hills Low Arctic Ecoregion, which is also near the treeline (Figure 3.1.8-3). The presence of sparse conifer cover could reflect the transition from the treed Taiga Plains Ecoregion to treeless Tundra Plains.

Land cover classes that are not extensive in the Caribou Hills Low Arctic Ecoregion (i.e., occupy less than 1% of the Ecoregion) include Wetland Treed and Mixedwood Open (Table 3.1.8-4), which could support Riparian Shrub and Riparian Black Spruce/Shrub vegetation types.

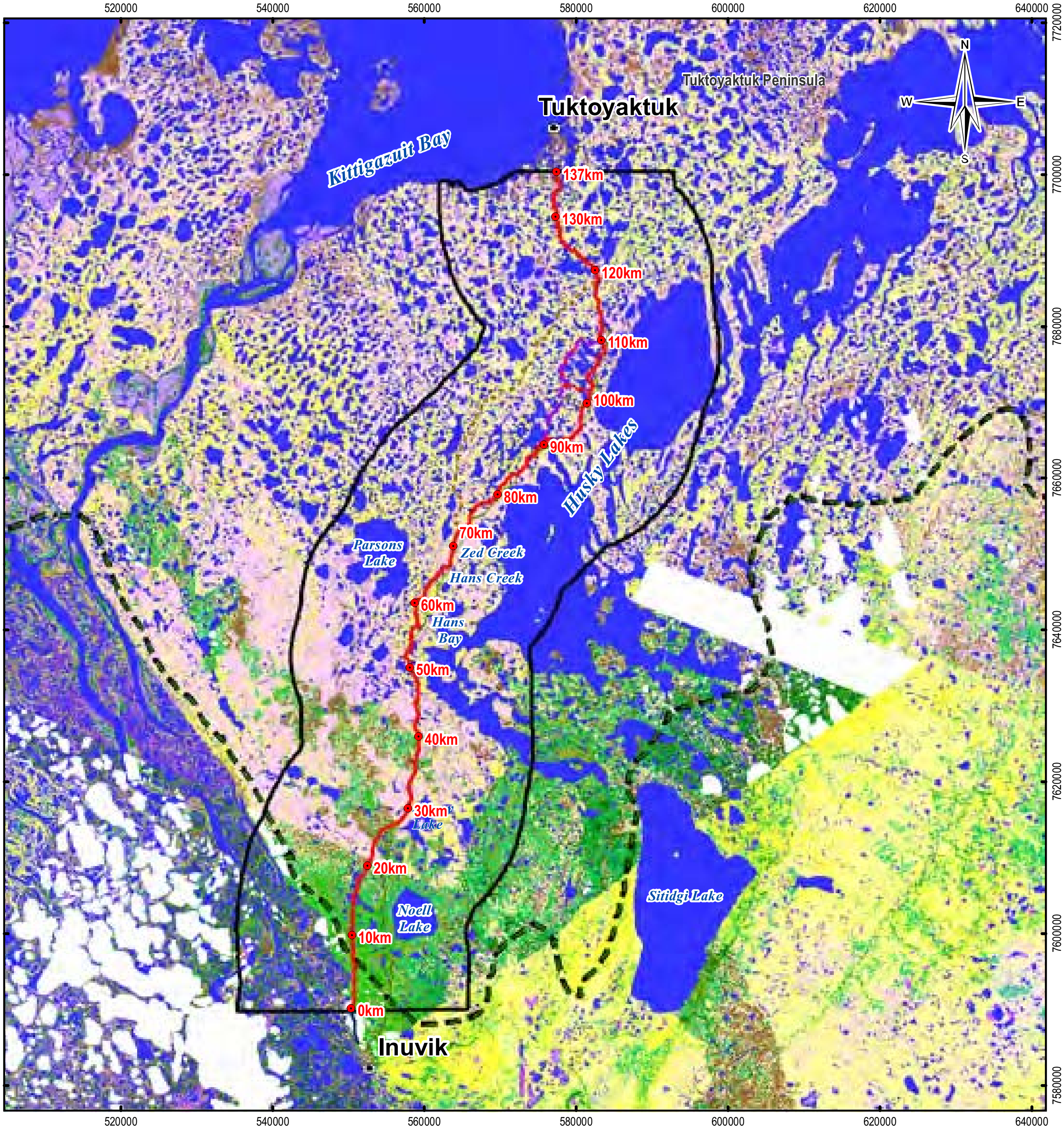
Land cover classes characteristic of the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion include Bryoids, Shrub Low, and Shrub Tall (Table 3.1.8-4), which likely represent the Dwarf Shrub Heath, Upland Shrub, and Riparian Shrub vegetation types (Table 3.1.8-3). Coniferous (Sparse, Open, and Dense), Wetland-Treed, Mixedwood (Open and Dense), and Broadleaf (Open and Dense) land cover classes, which could represent the Black Spruce/Ground Birch, Riparian Shrub, and Riparian Black Spruce/Shrub vegetation types (Table 3.1.8-3), cover less than 1% of the Ecoregion overall.

Upland Alaska Birch – Spruce Vegetation Type

This vegetation type is found scattered throughout upland terrain. Alaska birch is dominant or co-dominant in the tree canopy along with smaller quantities of black spruce and white spruce. Understory species include blue-green willow, Alaska birch, mountain cranberry, and soapberry (IOL et al. 2004).

Plant species commonly found in this vegetation type near Inuvik include:

Species	Scientific Name
Alaska Birch	*Betula neoalaskana*
Black Spruce	*Picea mariana*
White Spruce	*Picea glauca*
Mountain Cranberry	*Vaccinium vitis-idaea*
Soapberry	*Shepherdia Canadensis*



LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minro Realignment)
- PWC 1977
- Navy Road
- Treeline

- Not Classified
- Water
- Rock/Rubble
- Exposed/Barren Land
- Bryoids
- Shrub Tall
- Shrub Low
- Wetland-Treed
- Wetland-Shrub

- Wetland-Herb
- Herbs
- Coniferous Dense
- Coniferous Open
- Coniferous Sparse
- Broadleaf Dense
- Broadleaf Open
- Mixedwood Dense
- Mixedwood Open

NOTES
Land cover: EOSD - Canadian Forest Service (Wulder et al. 2004)

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

EOSD Land Cover Map

PROJECTION: UTM Zone 8
DATUM: NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.: V23201322_EIS_Map014_Veg_Landcover.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TP	0

OFFICE: EBA-VANC
DATE: May 2, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.1.8-3

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Black Spruce/Ground Birch Vegetation Type

This vegetation type occurs on mid to lower slope positions and frequently intergrades with tundra upland shrub vegetation. Black spruce forms a scattered tree canopy and also appears in the shrub layer. The dominant component of this vegetation type is the taller shrub layer composed of ground birch and willows. The average tree height is 5.8 m in the tree canopy. Shrubs such as northern Labrador tea, bog bilberry, mountain cranberry, and black crowberry are common. Mosses and sedges also frequently occur.

This vegetation type occurs predominantly on flat to gently sloping morainal landforms. Drainage ranges from imperfect to very poor and can be further characterized by the presence of linked hollows, closed basins, or blanket slopes. Mineral soils are commonly Turbic Cryosols, including Orthic Eutric or Dystric Turbic Cryosols and Gleysolic Turbic Cryosols. Permafrost processes such as peat plateaus and patterned ground can be present within this vegetation type (IOL et al. 2004).

Plant species commonly found in this vegetation type near Inuvik include:

Species	Scientific Name
Black Spruce	*Picea mariana*
Ground Birch	*Betula glandulosa*
Mountain Cranberry	*Vaccinium vitis-idaea*
Bog Bilberry	*Vaccinium uliginosum*
Northern Labrador Tea	*Ledum decumbens*

Upland Shrub Vegetation Type

The upland shrub vegetation type commonly occurs on slopes in both the Taiga and Tundra Ecoregions. Vegetation structure is a mix of dwarf and tall shrubs that form a scattered to open canopy (Photo 3.1.8-5). Willows are often dominant and are usually represented by grayleaf willow (*Salix glauca*) when present. Other indicator species of this vegetation type, in addition to willow, include Arctic sweet coltsfoot, bistort, and lousewort.

Photo 3.1.8-5

Upland shrub represents another common vegetation type and is dominated by willow

The upland shrub vegetation type occurs on morainal or lacustrine landforms with fine silty clay and loamy textures. Most sites have a hygric to subhydric moisture regime with moderate to poor drainage and fairly level to gently rolling topography. Soils are often Orthic Eutric Static and Turbic Cryosols. The upland shrub vegetation type also grows on coarse glaciofluvial sediments with a loamy sand to sandy loam parent material texture. At these particular locations, this vegetation type more commonly occupies mid to lower landscape positions where drainage is restricted by permafrost. Sites with upland shrub vegetation can also have thermokarst subsidence or occasional but poorly developed ice-wedge polygons. A veneer of peat is often present over mineral deposits, but is usually thinner than 40 cm. Sites with upland shrub have a poor nutrient regime and a subhygric to hygric moisture regime. The active layer depth ranges from 25 to 67 cm (IOL et al. 2004).

Plant species found within this vegetation type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana* (*B. glandulosa, Betula × eastwoodiae*)
Grayleaf willow	*Salix glauca* (*S. cordiflora* ssp. *callicarpea* and *glauca* ssp.)
Green Alder	*Alnus viridis* (including *A. crispa*)
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Red Bearberry	*Arctostaphylos rubra*
Arctic Sweet Coltsfoot	*Petasites frigidus* (including *P. arcticus, P. hyperboreus, P. palmatus, P. sagittatus*, and P. *vitifolius*)
Meadow Bistort	*Bistorta plumosa* (*Polygonum bistorta* ssp. *plumosum*)
Tilesius Wormwood	*Artemisia tilesii*
Black Crowberry	*Empetrum nigrum*
Steven Meadow-sweet	*Spiraea stevenii* (*S. beauverdiana*)

Non-vascular plant species likely to be found in this vegetation type include reindeer lichens, *Cetraria* spp., and club lichens.

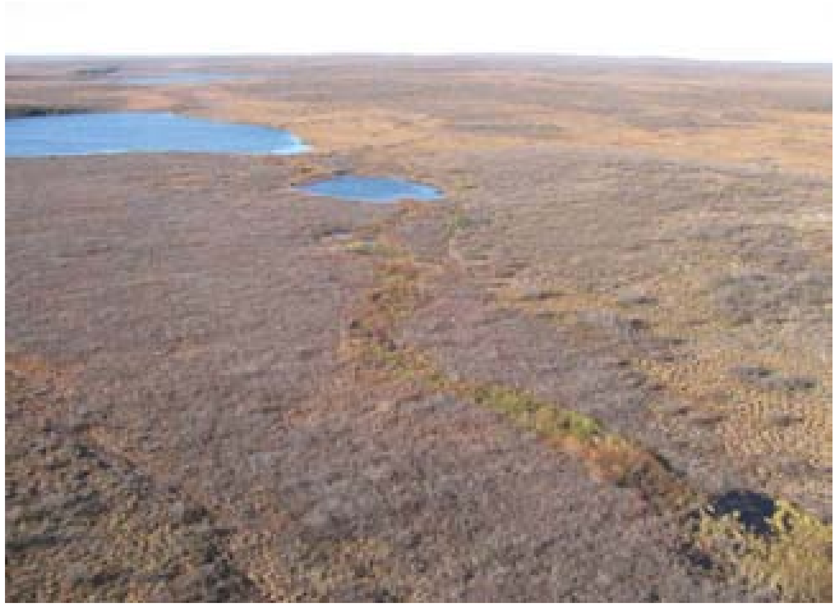


Photo 3.1.8-6
The dominant vegetation along the proposed Highway alignment is characterized by shrubby tundra vegetation, consisting of dwarf birch and willow

Dry Saxifrage Tundra Vegetation Type

The dry saxifrage tundra vegetation type is found on dry, upland areas of the tundra of the Tuktoyaktuk Peninsula, often on sparsely-vegetated granular sites. Particularly representative examples of this vegetation type occur near Parsons Lake and North Storm Hills. Vascular species include ground birch, locoweed species, red bearberry, black crowberry, bog bilberry, mountain cranberry and willows. The indicator species are alpine holy grass and prickly saxifrage. Haircap moss is the most common bryophyte and *Cetraria*, *Alectoria*, and *Cladina* are frequent lichens. This vegetation type also has a high likelihood of supporting the rare Yukon stitchwort (*Minuartia yukonensis*), which was found on sandy to gravelly eskers in the Parsons Lake field development area (IOL et al. 2004).

The dry saxifrage tundra vegetation is characteristic of dry, warm soils. It is common on crests and upper slopes with well drained shallow soils with scarce organic material. It is associated with gravelly deposits such as hummocky glaciofluvial outwash (such as that directly east of Parsons Lake), kames or eskers, or weathered surfaces of poorly lithified sedimentary rocks (IOL et al. 2004).

Signs of active cryoturbation are often visible at the surface as frost boils, localized patterned ground features formed by the seasonal expansion of ice lenses and the upward movement of soil during annual freeze thaw cycles. Soils are typically Orthic or Brunisolic Turbic Cryosols. Depth to permafrost is difficult to assess in these soils as they have very little to no ice content. Soil textures are gravely sand to sandy gravel with a sandy loam to loamy sand matrix. The active layer is generally greater than 30 cm (IOL et al. 2004).

Plant species found within this vegetation type include:

Species	Scientific Name
Ground Birch	*Betula glandulosa*
Locoweed species	*Oxytropis sp.*
Prickly Saxifrage	*Saxifraga tricuspidata*
Alpine holy grass	*Hierochloe alpina* ssp. *alpina*
Lichen	*Cetraria* sp.

Dwarf Shrub Heath Vegetation Type

Dwarf shrub heath is the most common tundra vegetation type occurring on the Tuktoyaktuk Peninsula (Photo 3.1.8-7) and is characterized by narrow leaved Labrador tea and alpine bilberry. This vegetation type is widespread throughout flat and rolling terrain and is associated with glaciofluvial, morainal, and colluvial surficial materials. Soils are usually moderately to imperfectly drained, but can be poorly drained in lower landscape positions, as the shallow permafrost table controls drainage. A veneer of peat is often present over mineral deposits, but is usually thinner than 50 cm. Sites with dwarf shrub heath are usually located in crest, upper to mid-slope positions and less commonly in depressions (IOL et al. 2004).

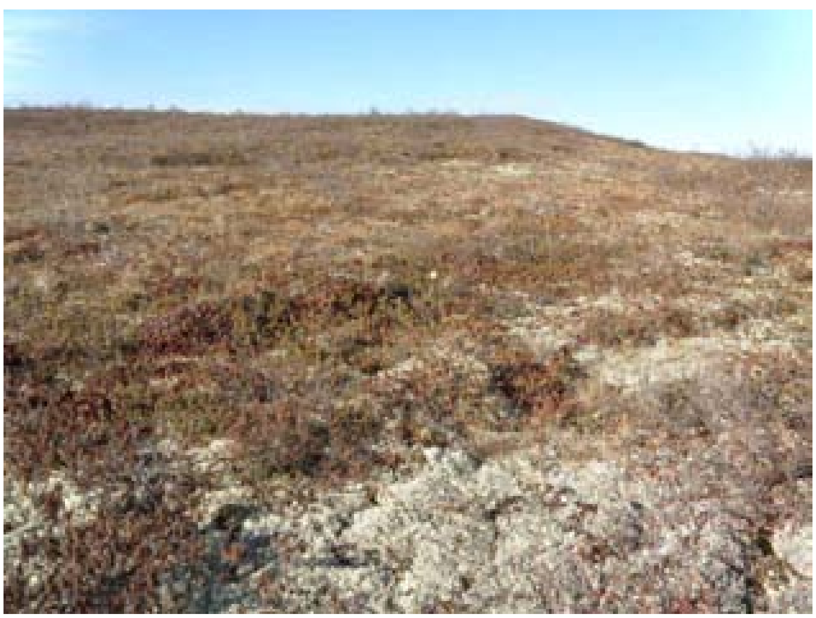


Photo 3.1.8-7
Dwarf shrub heath is a common tundra vegetation type occurring on Tuktoyaktuk Peninsula, and is characterized by narrow-leaved Labrador tea and alpine bilberry

Permafrost features, such as thermokarst subsidence or frost boils, are often present. Topography is undulating with slopes up to 5%. Soils are often Terric Fibric Organic Cryosols and Orthic Eutric or Dystric Turbic Cryosols. The nutrient regime is generally poor and the moisture regime ranges from mesic to hygric. The active layer depth ranges from 18 to 200 cm (IOL et al. 2004).

Plant species commonly occurring within this vegetation type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana* (*B. glandulosa, Betula × eastwoodiae*)
Green Alder	*Alnus viridis* (including *A. crispa*)
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre* ssp. *decumbens* (*L. decumbens*)
Arctic Sweet Coltsfoot	*Petasites frigidus* (including *P. arcticus, P. hyperboreus, P. palmatus, P. sagittatus*, and P. *vitifolius*)
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Red Bearberry	*Arctostaphylos rubra*
Alpine Bilberry	*Vaccinium uliginosum*

Non-vascular plant species likely to be found in the area include reindeer lichens, *Cetraria* spp., and peat moss. *Peltigera* species, when present, occur in low abundance.

Cotton-Grass Tussock Vegetation Type

The cotton-grass tussock vegetation type is found on lower slopes and lowlands where groundwater and seepage create a hygric to subhydric soil moisture regime (Photo 3.1.8-8). These conditions are particularly prevalent in the valley between the Storm Hills.

The cotton-grass tussock vegetation type is associated mostly with fine-textured morainal and lacustrine landscapes. Drainage is usually imperfect to poor. Peat is often present as a thin veneer over mineral deposits. Sites with cotton-grass tussock can be subject to inundation or permafrost, and demonstrate features such as thermokarst subsidence and frost heave. Microtopography is hummocky, with regional slopes less than 10%. Soils are typically either Terric Fibric or Mesic Organic Cryosols when there is more than 40 cm of organic material, or Orthic Eutric Turbic Cryosols when there is less than 40 cm of organic material at the surface. The nutrient regime in this vegetation type is typically poor with a moisture regime ranging from hygric to subhydric. The active layer depth ranges from 11 to 75 cm (IOL et al. 2004).

Photo 3.1.8-8
Cotton-grass tussock vegetation types are found on lower slopes and lowlands where groundwater creates hygric to subhydric soil conditions

Sheathed cotton-grass (*Eriophorum vaginatum*) is the dominant species in this vegetation type. It forms dense tussocks along with two sedges, *Carex lugens* and *C. consimilis*. *Sphagnum* species occupy areas in between the tussocks. Shrub species are less abundant in these areas due to higher moisture levels. Cloudberry is also present in the ground cover.

Species potentially found within this vegetation type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana* (*B. glandulosa, Betula x eastwoodiae*)
Tussock Cotton-grass	*Eriophorum vaginatum*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre* ssp. *decumbens* (*L. decumbens*)
Bigelow's Sedge	*Carex bigelowii* (*C. consimilis, C. lugens, C. cyclocarpa, C. yukonensis, C. anguillata*)
Diamond-leaved Willow	*Salix planifolia* (including S. *tyrrellii*)
Black Crowberry	*Empetrum nigrum*
Cloudberry	*Rubus chamaemorus*

Non-vascular plant species likely to be found in the area, *Cladonia* and *Cetraria* lichen species are sometimes present.

High-center Polygons Vegetation Type

High-center polygons occur in localized depressions and flats on the Tuktoyaktuk Peninsula, and have characteristic vegetation consisting of narrow-leaved Labrador tea and rock cranberry. They form a large net-like pattern with high centers surrounded by water-filled channels with ice at the bottom (Photo 3.1.8-9). The center of each polygon develops a dome of peat and is vegetated with upland species similar to the dwarf shrub heath vegetation type (IOL et al. 2004). They develop over long periods, and typify the later stages of Arctic peatland genesis.

In many high-center polygons, a thick layer of strongly cryoturbated, mixed organic and mineral soil underlies surface peat deposits. The polygons are usually located in poorly drained areas that occupy low landscape positions such as depressions associated with thermokarst lakes or ponds, pingos, hollows, or channel-like features. Sites with high-center polygons occur in ice-rich, fine-grained soils with a silty clay loam to clay loam texture on morainal landforms and small lacustrine basins. The organic layer on these soils is usually less than 50 cm thick. Soils are typically Terric Mesic Organic Cryosols and Orthic Dystric and Brunisolic Dystric Turbic Cryosols. The nutrient regime in areas with high-center polygons is poor, and the moisture regime ranges from subhygric to hydric. The active layer depth ranges from 29 to 40 cm (IOL et al. 2004).

Photo 3.1.8-9
High-centered polygons displaying net-like pattern with high center surrounded by water-filled troughs with ice bottoms

Plant species found within this vegetation type include:

Species	Scientific Name
Narrow-leaved Labrador Tea	*Ledum palustre* ssp. *decumbens* (*L. decumbens*)
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Red Bearberry	*Arctostaphylos rubra*

Non-vascular plant species likely to be found in this vegetation type include reindeer lichens along with *Cetraria* species and club lichens.

Low-center Polygons Vegetation Type

On the Tuktoyaktuk Peninsula, low-center polygon vegetation types are typically found adjacent to standing water, localized in depressional areas and drained lake basins (Photo 3.1.8-10). Characteristic species for this vegetation type includes dwarf birch, diamond-leaved willow, and tussock cotton-grass. Low-center polygons often occur adjacent to high-center polygons and are usually similar in pattern size. The centers of the polygons are depressed, often containing pond water and covered with wetland vegetation (predominantly peat moss). The surrounding ridges are generally drier and support dwarf shrub heath vegetation (IOL et al. 2004). They represent the earlier stages in the genesis of Arctic peatlands, and given enough time, will develop into high-center polygons.

Photo 3.1.8-10
Low-centered polygon vegetation types are localized in depression areas and drained lake basins on the Tuktoyaktuk Peninsula, typically adjacent to areas of standing water

Polygons are bordered by soil ridges pushed up by ice wedges that are formed in cracks and develop during freeze-thaw cycles. Surface peat deposits are typically less than 60 cm thick, and are underlain by a thick layer of strongly cryoturbated, mixed organic and mineral soil. Leatherleaf is an indicator plant of this vegetation type; however, it has a low percent cover value, being restricted to the outer soil ridges (IOL et al. 2004).

Polygons are usually located in poorly-drained areas that occupy low landscape positions such as depressions associated with thermokarst lakes or ponds, pingos, hollows or channel-like features. Sites with low-center polygons occur in ice-rich, fine-grained soils with a silty clay loam to clay loam texture on the morainal landforms and small lacustrine basins. The organic layer on these soils is usually less than 50 cm thick. Soils are typically Terric Mesic Organic Cryosols and Orthic Dystric or Eutric Turbic Cryosols, and occasionally, Gleyed Turbic Cryosols. This vegetation type is nutrient poor and has a moisture regime ranging from subhygric to hydric. The active layer depth ranges from 11 to 50 cm (IOL et al. 2004).

Plant species found within this vegetation type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Diamond-leaved Willow	*Salix planifolia* (including *S. tyrrellii)*
Green Alder	*Alnus viridis* (including *A. crispa)*
Tussock Cotton-grass	*Eriophorum vaginatum*
Alpine Bilberry	*Vaccinium uliginosum*
Bigelow's Sedge	*Carex bigelowii* *(C. consimilis, C. lugens, C. cyclocarpa, C. yukonensis, C. anguillata)*
Narrow-leaved Labrador Tea	*Ledum palustre* ssp*s decumbens (L. decumbens)*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Pumpkin-fruited Sedge	*Carex rotundata*

Non-vascular plant species likely to be found in the area, common lichen species include *Cetraria* spp. and reindeer lichens.

Riparian Shrub Vegetation Type

The riparian shrub vegetation type is found on terraces and levees along streams and drainage basins in the southern portion of the proposed Highway corridor, and is composed of taller shrubs such as diamond-leaved willow, Arctic dwarf birch, and green alder (Photo 3.1.8-11). This vegetation type commonly occurs on silty and sandy fluvial deposits associated with small streams. Topography is subdued and concave, with slopes up to 5%. Soils are usually moderately well to poorly drained, with shallow permafrost and a water table near the surface. Seasonal or occasional flooding results in the deposition of fresh silt and fine sand layers on adjacent surfaces (IOL et al. 2004).

Soils are commonly Regosolic Static Cryosols and occur close to the active river channel. Peat can be present as a veneer over mineral deposits in the areas above the flooding zone. Riparian shrub sites tend to have a poor to medium nutrient regime and a fluctuating moisture regime from hygric to hydric. The active layer depth ranges from 18 to 90 cm (IOL et al. 2004).

Species found within this vegetation type include:

Species	Scientific Name
Diamond-leaved Willow	*Salix planifolia* (including *S. tyrrellii)*
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Green Alder	*Alnus viridis* (including *A. crispa)*
Water Sedge	*Carex aquatilis*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre* ssp. *decumbens (L. decumbens)*
Marsh Cinquefoil	*Comarum palustre (Potentilla palustris)*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*

Photo 3.1.8-11
Riparian shrub vegetation types are found along streams and drainage basins in the southern portion of the proposed Highway corridor

Riparian Sedge – Cotton-Grass Vegetation Type

The riparian sedge – cotton-grass vegetation type is characteristic of the perimeters of some small lakes and ponds (Photo 3.1.8-12). It also occurs, though less commonly, along small streams on the Tuktoyaktuk Peninsula. The dominant plant species is water sedge (*Carex aquatilis*). Other indicator species for this vegetation type include water horsetail and buckbean. Peat moss is the most prominent non-vascular plant present (IOL et al. 2004).

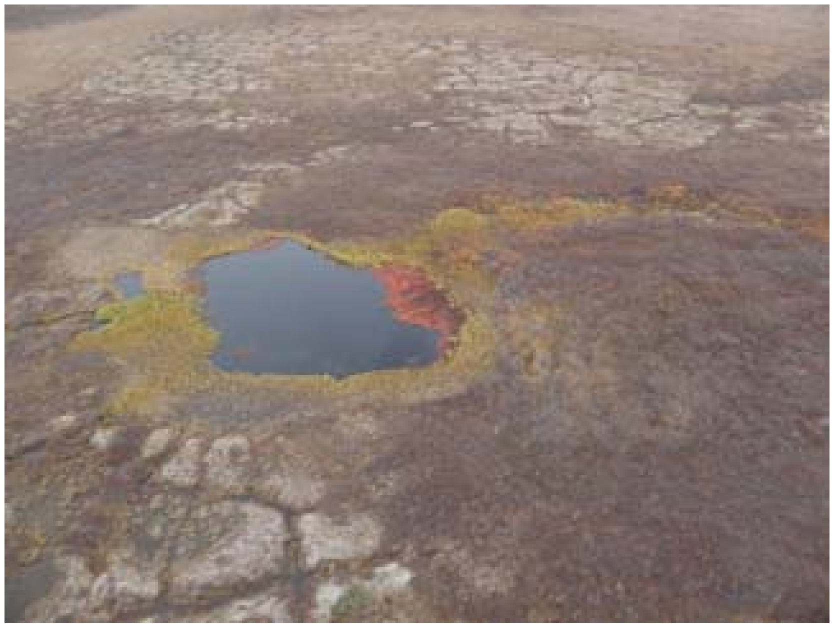


Photo 3.1.8-12
Riparian sedge – cotton-grass vegetation types form the perimeter of small lakes and ponds

The riparian sedge – cotton-grass vegetation type is most common on silty and sandy deposits. Topography is subdued with slopes up to 5%. Soils are usually imperfectly to very poorly drained with shallow permafrost. Seasonal or occasional flooding deposits fresh silt sand fine sand layers on the surface of the soils and there is little to no organic material present. Soils are most commonly Regosolic Static Cryosols, Gleyed Static or Turbic Cryosols. Parent material textures typically range between silty clay loam and loam. Sites with riparian sedge – cotton-grass have a poor nutrient regime and a moisture regime that ranges from subhydric to hydric. The active layer depth ranges from 15 to 45 cm (IOL et al. 2004).

Species found within this vegetation type include:

Species	Scientific Name
Water Sedge	*Carex aquatilis*
Water Horsetail	*Equisetum fluviatile*
Bog Buckbean	*Menyanthes trifoliata*

Riparian Black Spruce/Shrub Vegetation Type

The riparian black spruce/shrub vegetation type is located in the Holmes Creek and Hans Creek valleys (Photo 3.1.8-13). This is the only forested vegetation type within this area of the Tundra Plains Ecoregion and is a northern outlier of High Subarctic Ecoregion forest located approximately 30 km to the south. The shrub layer is dominated by widely spaced low-growing black spruce, flat-leaved willow, and grayleaf willow. Ground cover includes black crowberry, prickly rose, northern Labrador tea, mountain cranberry, Kentucky bluegrass, and sweet coltsfoot. Black spruce in the tree layer and prickly rose in the ground cover are indicator species (IOL et al. 2004).

This vegetation type is found exclusively along the floodplain and terraces of larger streams where soil drainage and nutrient availability promote the establishment and growth of isolated treed stands on terraces and south or west-facing valley slopes. Soils are generally Regosols with a loamy sand to sandy texture, or occasionally gravelly loamy sand (IOL et al. 2004).

Plant species found within this vegetation type include:

Species	Scientific Name
Black Spruce	*Picea mariana*
Flat-leaved willow	*Salix planifolia* ssp. *planifolia*
Grayleaf willow	*Salix glauca*
Black crowberry	*Empetrum nigrum*
Prickly rose	*Rosa acicularis*
Mountain cranberry	*Vaccinium vitis-idaea*

Photo 3.1.8-13
Hans Creek (crossing 30A)

3.1.8.4 Rare Plants

Rare plants are often defined as being uncommon on the landscape within either an ecological region or jurisdiction. They are frequently considered to be "ecological specialists" that are found in particular microhabitats or under specific ecological conditions (Talbot et al. 1999). In the NWT and other Arctic regions, some rare plant species may be remnants of the drier steppe environment of the last ice age or may be re-colonizing areas from ice-free glacial refugia (Talbot et al. 1999) (i.e., a region that has remained unaltered by a climatic change affecting surrounding regions and that therefore forms a haven for relict fauna and flora) in the Yukon and Alaska.

Various information sources were reviewed to determine the potential for rare plant species occurrences within the local and regional study areas of the proposed Inuvik to Tuktoyaktuk Highway. Information sources included data provided by GNWT, information contained within the EIS prepared for the Mackenzie Gas Project (IOL et al. 2004), the NWT Species Monitoring Infobase, and various published flora outlining rare species and species distributions within the NWT and Canadian Arctic (e.g., McJannet et al. 1995; McJannet et al. 1993; and Porsild and Cody 1980).

Several rare plant species or species groups were found to occur within the regional study area (Figure 3.1.8-4) and include Yukon stitchwort (*Minuartia yukonensis*), alternate-flowered water milfoil (*Myriophyllum alterniflorum*), willows (*Salix* spp.), Gmelin's Orache (*Atriplex gmelinii*), and sedges (likely of the genus *Carex*).

Yukon stitchwort was identified within the RSA and is currently listed as Sensitive within the NWT. While Sensitive species are not considered at risk of extinction or extirpation, they do warrant special consideration to prevent them from becoming at risk. In the RSA, Yukon stitchwort was found on sandy and gravely soils, usually in association with the Dry Saxifrage Tundra vegetation type (IOL et al. 2004; Figure 3.1.8-4). This particular vegetation type could be represented by the Exposed/Barren Land EOSD land cover class (Table 3.1.8-4; Figure 3.1.8-3) which occupies approximately 719 ha (5.3%) and 16,092 ha (4.3%) of the LSA and RSA, respectively.

Both the Dry Saxifrage Tundra vegetation type and the Exposed/Barren Land land cover class could also be indicative of potential borrow source locations. Activities associated with borrow source extraction, as well as those resulting from development of the Parsons Lake area as part of the Mackenzie Gas Project, could result in potential future disturbance to any plants present, or their habitat.

Alternate-flowered water milfoil (*Myriophyllum alterniflorum*) was also identified just west of the proposed Inuvik to Tuktoyaktuk Highway LSA during vegetation surveys conducted as part of the Mackenzie Gas Project (IOL et al. 2004; Figure 3.1.8-4). Alternate-flowered water milfoil is an aquatic plant found in ponds, shallow lakes, and slow-moving streams. It is currently listed as "May Be At Risk" within the NWT which is the highest rank that can be assigned using the General Status Ranking system. This species would be a potential candidate for a future detailed risk assessment to further understand its rarity in the NWT. Given its aquatic nature, however, it is unlikely to be affected by disturbances associated with the development of the proposed Inuvik to Tuktoyaktuk Highway.

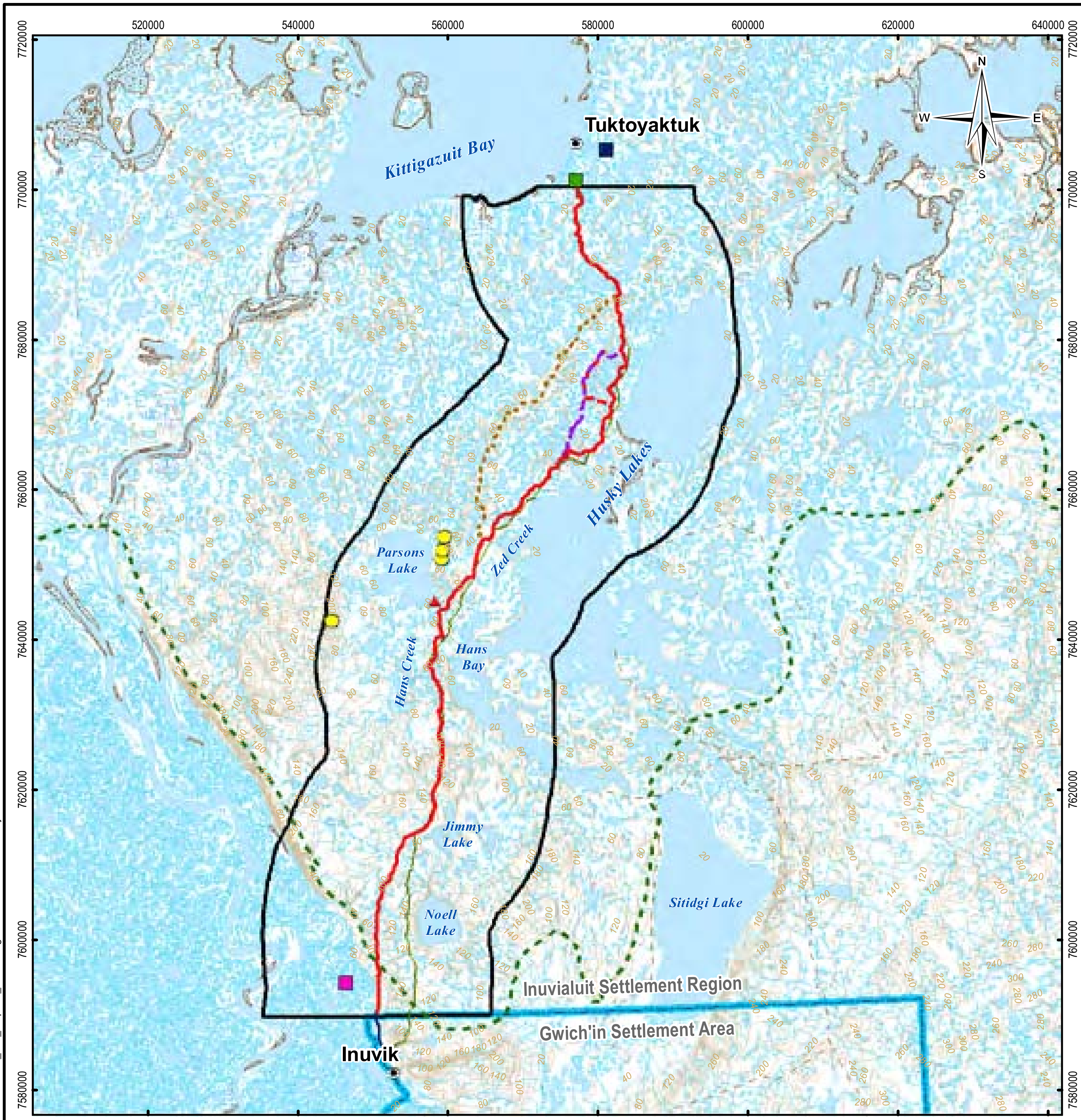
One unspecified willow species is present in the southernmost portion of the RSA, approximately 5 km west of the proposed Inuvik to Tuktoyaktuk Highway alignment (Figure 3.1.8-4). Similarly, Gmelin's Orache and a species of sedge (likely of the genus *Carex*) were identified just beyond the northern boundary of the RSA, south and east of Tuktoyaktuk, respectively.

Table 3.1.8-5 summarizes the locations of plant species of concern identified within the RSA.

TABLE 3.1.8-5: PLANT SPECIES OF CONCERN IDENTIFIED IN THE RSA[1]

Scientific Name	Common Name	NWT Rank	Global Rank	Location
Minuartia yukonensis	Yukon stitchwort	Sensitive	G3/G4	12 locations in Parsons Lake Development Field and Yaya esker
Myriophyllum alterniflorum	Alternate-flowered water milfoil	May Be At Risk	G5	4 locations near Parsons Lake, Eskimo Lakes Basin including smaller lakes
Salix spp.	Willows	Various	Various	West of proposed alignment near KM 5
Atriplex gmelinii	Gmelin's Orache	Various	Various	Just north of RSA boundary and proposed alignment
Carex spp. (likely)	Sedges	Various	Various	Northeast of RSA boundary and east of Tuktoyaktuk

[1]Source: IOL et al. (2004); IOL et al. (unpublished data); GNWT ENR (unpublished data))



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LEGEND

At Risk Plant Groups

- Gmelin's Orache
- Sedges
- Willows
- Milfoil
- Stitchwort

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road

- Gwich'in / Inuvialuit Boundary
- Treeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
At Risk Plant Locations: GNWT-ENR, January 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

At Risk Plant Locations

PROJECTION		DATUM	
UTM Zone 8		NAD83	
Scale: 1:750,000 (10 5 0 10 20 Kilometres)			
FILE NO. V23201322_EIS_Map051_AtRiskVeg.mxd			
PROJECT NO. V23201322	DWN SL	CKD TS	REV 0
OFFICE EBA-VANC	DATE May 2, 2011		

Figure 3.1.8-4

3.1.8.5 Vegetation Types of Concern

Vegetation types are distinct assemblages of plant species, often found under particular environmental conditions (Allen 2003). Vegetation types that occupy unique or uncommon landforms, occur under unique ecological conditions, are at the extent of their range, or have been isolated from a larger population often have restricted distributions on the landscape, and as such can be considered rare. Oftentimes vegetation types with restricted distributions have unique habitat features that support distinct assemblages of plant species, including species of conservation concern.

In the proposed Inuvik to Tuktoyaktuk Highway study area, the Dry Saxifrage Tundra and Riparian Black Spruce/Shrub vegetation types were identified as being vegetation types of concern. During the studies conducted for the Mackenzie Gas Project (IOL et al. 2004), the Dry Saxifrage Tundra vegetation type was identified as being of concern due to its potential to support rare plant species (Yukon stitchwort in particular) and its association with crests and steep-sloped gravel deposits and rock outcrops. This particular vegetation type could be represented by the Exposed/Barren Land EOSD land cover class (Table 3.1.8-4; Figure 3.1.8-3). Gravel deposits are uncommon on the tundra and would be targeted as potential borrow sources for construction materials. The potential for these areas to provide rare plant habitat could result in the disturbance of rare plant species, should they be present.

The Riparian Black Spruce/Shrub vegetation type was only identified in the vicinity of Holmes Creek and Hans Creek, and represents the only forested vegetation type and the northern extent of black spruce in the Tundra Plains Ecoregion. This vegetation type could be represented by the Coniferous, Mixedwood, Broadleaf EOSD land cover class (Table 3.1.8-4; Figure 3.1.8-3). Because Project stream crossings are limited, it is not expected that this community type will be disturbed.

3.1.8.6 Harvested Plants

The Inuvialuit harvest several plants and berries for consumption and trade (ICC et al. 2006). Plants and berries that are important to the Inuvialuit include salmonberry, blackberry (or crowberry), blueberry, cranberry, and cloudberry. Edible plants include wild rhubarb, arctic sorrel, edible roots (“Masut”), mushrooms, and lichen.

In addition to the plant species listed above, several species are used by the Inuvialuit for medicinal purposes. Examples of medicinal plants include gum and needles from spruce trees, sticky red willow, Labrador tea, mushrooms, moss, green willow, and driftwood (ICC et al. 2006).

With the exception of spruce, which has a limited distribution in the Project area, these plants occur throughout the proposed Inuvik to Tuktoyaktuk Highway RSA; however, some may be more restricted to particular vegetation types.

3.1.8.7 Merchantable Timber

A small portion of the Highway study area is located below the treeline near Inuvik. However, forests in this area do not contain sufficient quantities of merchantable timber (i.e., of the size, quality and condition) for typical commercial use. The area below the treeline is dominated by slow growing spruce and deciduous species.

The NWT Forest Inventory does not extend into the Inuvialuit Settlement Region. An approximation of the extent and location of treed areas in the LSA and RSA has been derived using EOSD land cover classes (Table 3.1.8-6; Figure 3.1.8-3). As expected, tree cover drops noticeably with increasing latitude.

TABLE 3.1.8-6: DISTRIBUTION OF TREED AREAS WITHIN THE INUVIK TO TUKTOYAKTUK HIGHWAY STUDY AREAS

Level IV Ecoregion	Grouped EOSD Land Cover Class[1]	LSA[2] (ha)			RSA[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Mackenzie Delta HS	Treed	225.1	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	9,452.3
	Non-treed	36.6			16,521.4
Mackenzie Delta HS Total		**261.7**			**25,973.7**
Sitidgi Plain HS	Treed	366.2			1,922.5
	Non-treed	20.6			147.4
Sitidgi Plain HS Total		**386.8**			**2,069.9**
Caribou Hills LA	Treed	1,285.1			34,993.4
	Non-treed	3,333.4			78,207.5
Caribou Hills LA Total		**4,618.5**			**113,200.9**
Tuktoyaktuk Coastal Plain LA	Treed	170.3	238.1	170.1	4,828.8
	Non-treed	8,221.0	7,923.3	8,057.9	230,885.6
Tuktoyaktuk Coastal Plain LA Total		**8,391.3**	**8,161.4**	**8,228.0**	**235,714.4**
Grand Total		**13,658.3**	**13,428.4**	**13,494.9**	**376,958.9**

[1] Coniferous, Mixedwood, and Broadleaf EOSD land cover classes comprise the "treed" class; all other classes comprise the "non-treed" class
[2] The route alignment options only occur within the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion; therefore, all other Ecoregion calculations are the same for all alternatives.
[3] All route options

3.1.8.8 Baseline Contaminant Concentrations

Contaminants, whether from natural or anthropogenic sources, can affect plants by being taken up into the plant itself, though physical deposition onto surfaces such as stems and leaves, or through modifying actions on the surrounding environment (e.g., alteration of soil or water pH). Substance uptake in plants is driven partially by plant physiology, which can differ between species, as well as by environmental conditions such as pH or temperature of the surrounding water or soil.

The Northern Contaminants Program (NCP), established in 1991 in response to concerns surrounding human exposure to elevated levels of contaminants in country foods important to the diets of northern Aboriginal peoples, studies three main categories of contaminants. These include heavy metals (such as mercury, cadmium, and lead, persistent organic pollutants (or POPs, such as polychlorinated biphenyls), and radionuclides (such as cesium). Most of these contaminants arrive in the North on air and ocean currents from southern agricultural and industrial sources. These contaminants may be found in northern waters, soils, sediments, snow, rain, ice, and in the air.

While studies of contaminant levels in Canadian Arctic vegetation are minimal, the NCP reports that plants and berries in northern Canada contain only low levels of POPs and heavy metals. Exceptions have been noted in plants assessed near localized contaminant sources such as mines (INAC 2003).

3.1.8.9 Invasive Plants

Invasive plants (weeds), have been defined in many ways, but generally refer to plant species (native or introduced) that have the ability to out-compete native species when introduced into a particular environmental setting (Haber 1997). Plants classified as invasive generally tend to have adaptations that allow them to aggressively establish and spread quickly.

The presence of invasive or non-native plant species in the NWT is currently not considered to be high (GNWT ENR 2009a). Invasive species are typically found near residential areas/communities, and in developed or disturbed areas such as road corridors, cut-lines, pipelines, and mine sites. Of a reported 106 non-native plant species documented in the NWT in 2006, few appear able to invade natural habitats.

Table 3.1.8-7 lists the invasive plant species common to NWT (GNWT ENR 2009a). White and yellow sweet clovers, found in the upper Mackenzie River area, are becoming more common and have reportedly been found outside of areas disturbed by human influence (GNWT ENR 2009a).

TABLE 3.1.8-7: INVASIVE PLANT SPECIES COMMON TO NWT

Species Name	Introduction Notes	Habitat or Occurrence Notes	Predicted Invasiveness
White sweet clover (*Melilotus alba*)	Introduced from Eurasia	Roads, increasingly common in upper Mackenzie River, some sites along pipeline to Norman Wells. Taiga Shield and Taiga Plains.	Moderate
Yellow sweet clover (*Melilotus officinalis*)	Introduced from Eurasia	Recent in waste places, road sides in southernmost Mackenzie River, along pipeline to Norman Wells. Taiga Shield and Taiga Plains (south).	Moderate
Alfalfa (*Medicago sativa*)	Introduced from Eurasia	Widespread along NWT highways, and at least 1 site along pipeline to Norman Wells. Taiga Plains (south).	Low/Potential

TABLE 3.1.8-7: INVASIVE PLANT SPECIES COMMON TO NWT

Species Name	Introduction Notes	Habitat or Occurrence Notes	Predicted Invasiveness
Siberian peashrub (*Caragana arborescens*)	Introduced	Fort Smith, Fort Liard, Liard River at Petitot River, probably other places, escaped from gardens. Taiga Plains (south).	Low/Potential
Awnless brome (*Bromus inermis*)	Introduced from Eurasia	Cultivated and found on roads and waste places. Taiga Shield and Taiga Plains.	Moderate/Low
Reed canary grass (*Phalaris arundinacea*)	Presence of exotic genotypes among NWT sites is uncertain	Sites in southern NWT and 14 sites along the pipeline to Norman Wells, part of seed mix applied in 1984. Taiga Shield and Taiga Plains (south).	Moderate/low
Crested Wheat Grass (*Agropyron cristatum* spp. *pectinatum*)	Introduced from Russia (or Europe)	Introduction near waste sites and townsites in south Mackenzie River area. Taiga Shield and Taiga Plains.	Low/potential
Flat-stem Blue Grass (*Poa compressa*)	Introduced from Eurasia	Fort Simpson, Liard Trail (Hwy 7), west of Yellowknife, maybe elsewhere near southern Mackenzie River. Taiga Shield and Taiga Plains (south).	Minor/potential
Kentucky blue grass (*Poa pratensis*)	Forms in the NWT are probably not native and introduced as lawn grass	Near settlements roads and one site on the pipeline to Norman Wells. Taiga Shield and Taiga Plains.	Minor/potential
Hoary False-alyssum (*Berteoa incana*)	Introduced from Eurasia	First site discovered in 2006 along Hwy. 3. Taiga Shield.	Low
Creeping Thistle (*Cirsium arvense*)	Introduced from Eurasia	Fort Simpson, Hay River, Fort Providence near highway; Yellowknife. Taiga Shield and Taiga Plains (south).	Moderate/ Low
Common tansy (*Tanacetum vulgare*)	Introduced from Eurasia	Along roads in southern NWT, as well as in Inuvik. Taiga Shield and Taiga Plains.	Potential

Source: GNWT ENR (2009a)

3.1.8.10 Forest and Tundra Fire Frequency

Relatively few fires have occurred in the Project area. Figure 3.1.8-5 identifies three fires that occurred in 1968, 1974, and 2007, with the largest occurring in 1968 below the treeline near Inuvik. The post-fire land cover of the area is shown in Figure 3.1.8-3 above.

Several points of fire ignition from 1988 to 2007 are also identified on Figure 3.1.8-5. The primary cause of ignition is lightning, followed by resident, recreation, and unknown. It should be noted that although there are several points of fire ignition shown, these did not all become fires. Very few fires were documented in the RSA, likely as most of the RSA is located above the treeline and tundra fires are relatively rare.

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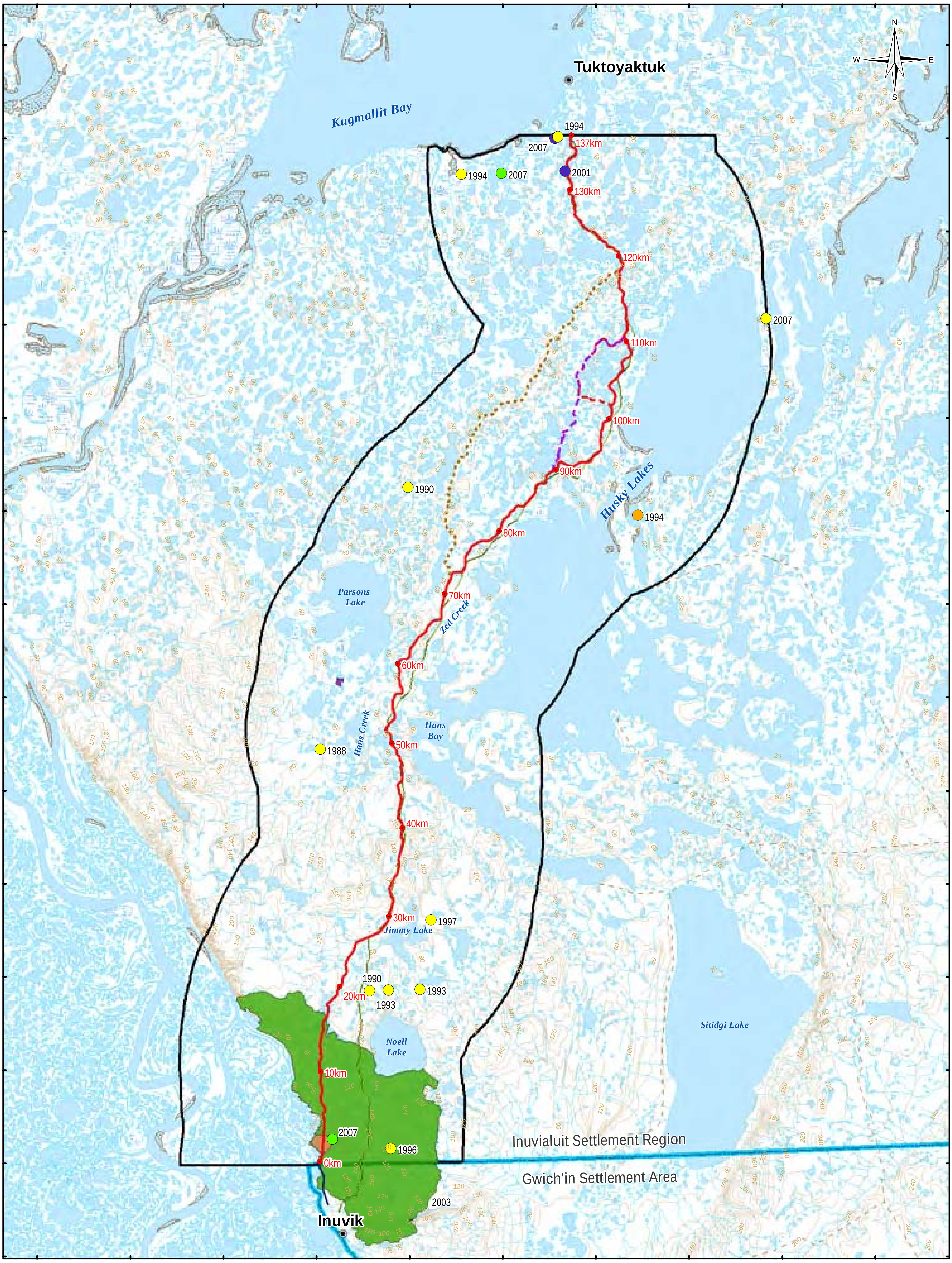

LEGEND

Fire Ignition Cause	Historical Fires		
Lightning	1968	Regional Study Area (15 km buffer)	Gwich'in / Inuvialuit Boundary
Recreation	1974	Primary 2009 Route	Trail
Resident	2007	Alternative 1 (2009 Minor Realignment)	Contour
Unknown		Alternative 2 (Upland Route)	Watercourse
		Alternative 3 (2010 Minor Realignment)	Waterbody
		PWC 1977	Wetland
		Navy Road	Sand

NOTES
Base data source: NTS 1:250,000
Fire Iginition and Historical Fire: GNWT ENR - FMD, February 2011

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Historical Fires and Fire Ignition Causes within the Regional Study Area

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map037_FireIgnition.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.8-5

3.1.9 Wildlife and Wildlife Habitat

This section of the document focuses on terrestrial mammals likely to be found within the local and regional study area and is based on a review of background information and traditional knowledge as well as the results of field studies.

As defined under the IFA, "wildlife" means all fauna in a wild state other than reindeer. Section 3.1.9 considers terrestrial mammals and Section 3.1.10 considers birds.

3.1.9.1 Terrestrial Mammals

There are 34 species of terrestrial mammals potentially occurring in the Regional Study Area for the proposed Highway (Table 3.1.9-1). The local and regional abundance and distribution of these species varies considerably depending on habitat availability and access to terrain suitable for various life history phases, such as calving and denning. No terrestrial mammal species were assessed as "at risk" under the NWT General Status Ranking Program (GNWT ENR 2011a).

TABLE 3.1.9-1 TERRESTRIAL MAMMALS POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA

Common Name	Scientific Name	NWT General Status Rank
Cinereus Shrew (Masked Shrew)	*Sorex cinereus*	Secure
Dusky Shrew	*Sorex monticolus*	Secure
Arctic Shrew	*Sorex arcticus*	Secure
Tundra Shrew	*Sorex tundrensis*	Undetermined
Barren-ground Shrew	*Sorex ugyunak*	Undetermined
Snowshoe Hare	*Lepus americanus*	Secure
Arctic Hare	*Lepus arcticus*	Secure
Arctic Ground Squirrel	*Spermophilus parryii*	Secure
Red Squirrel	*Tamiasciurus hudsonicus*	Secure
Beaver	*Castor canadensis*	Secure
Northern Red-backed Vole	*Myodes rutilus (Clethrionomys rutilus)*	Secure
Meadow Vole	*Microtus pennsylvanicus*	Secure
Root Vole (Tundra Vole)	*Microtus oeconomus*	Secure
Taiga Vole (Chestnut-cheeked vole)	*Microtus xanthognathus*	Secure
Common Muskrat	*Ondatra zibethicus*	Secure
Nearctic Brown Lemming	*Lemmus trimucronatus (sibiricus)*	Secure
Nearctic Collared Lemming	*Dicrostonyx groenlandicus*	Secure
Coyote	*Canis latrans*	Secure
Gray Wolf	*Canis lupus*	Secure
Arctic Fox	*Vulpes lagopus (Alopex lagopus)*	Secure
Red Fox	*Vulpes vulpes*	Secure
American Black Bear	*Ursus americanus*	Secure
Grizzly Bear	*Ursus arctos*	Sensitive

TABLE 3.1.9-1 TERRESTRIAL MAMMALS POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA

Common Name	Scientific Name	NWT General Status Rank
Polar Bear	*Ursus maritimus*	Sensitive
American Marten	*Martes americana*	Secure
Ermine (Stoat)	*Mustela erminea*	Secure
Least Weasel	*Mustela nivalis*	Secure
American Mink	*Neovison vison (Mustela vison)*	Secure
Wolverine	*Gulo gulo*	Sensitive
North American River Otter	*Lontra canadensis (Lutra canadensis)*	Secure
Canadian Lynx	*Lynx canadensis*	Secure
Moose	*Alces americanus (Alces alces)*	Secure
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	Sensitive
Woodland Caribou (Boreal)	*Rangifer tarandus caribou*	Sensitive

Sources: Banfield (1974), Hayssen (2011), and Working Group on General Status of NWT Species (2011a).

3.1.9.2 Non-native Species

All terrestrial mammal species are indigenous to the RSA except for reindeer and domestic animals.

In addition to the herds of indigenous barren-ground caribou, a privately owned reindeer herd has historically used portions of the upper Tuktoyaktuk Peninsula and Richards Island. According to Lloyd Binder, the custodian of the herd, the current population of the herd is around 3,000 animals. The herd typically summers in the Richards Island area from about April to late November. During the over-wintering period, the herd is moved south to an area of Crown Land extending from Jimmy and Noell Lake area to north of Parsons Lake.

3.1.9.3 Species at Risk

The federal *Species at Risk Act* (SARA) was adopted in 2002 and the territorial *Species at Risk (NWT) Act* came into effect in 2010. The purpose of these Acts is to: prevent wildlife species from being extirpated or becoming extinct; to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity; and, to manage species of special concern to prevent them from being endangered or threatened.

Schedule 1 of the federal SARA provides lists of wildlife species at risk that include mammals, birds, reptiles, amphibians, fish, lepidopterans, plants, lichens, mosses and molluscs. Species listed as Threatened under Schedule 1 must have recovery strategies prepared for the conservation of the species and its habitat within three years of listing while species of Special Concern must have management plans prepared.

Within the RSA, Boreal Woodland Caribou are currently listed under SARA as Threatened; however, grizzly bear and wolverine have been assessed by the COSEWIC as Special Concern (COSEWIC 2009). These species are discussed further in Sections 3.1.9.10, 3.1.9.7, and 3.1.9.8, respectively.

3.1.9.4 Valued Components

Valued Components (VCs) are typically selected to represent the range of important biological conservation values existing within the RSA. Beanlands and Duinker (1983) have stated that it is impossible for an analysis to address all potential environmental components. Therefore, an essential step in selection and analysis of issues is the identification of important VCs. This process requires selecting indicator species to serve as VCs.

VCs can be defined as "the environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic or aesthetic value" (Sadar 1994).

Selection of wildlife species as VCs in this EIS was based on the following criteria:

- Species listed on Schedule 1 of SARA;
- Species assessed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC);
- Species rated as high importance subsistence for country foods;
- Species rated as moderate to high value as furbearers; and/or
- Species rated as high importance to outfitters or tourism guides.

The VCs identified in Table 3.1.9-2 form the basis of the wildlife baseline discussion. Additional species of interest or importance to the region are also included.

Table 3.1.9-2 identifies the mammal VCs selected for this EIS. For each VC, the risk status is stated, as listed on Schedule 1 of the SARA or assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (GNWT ENR 2010f). Table 3.1.9-2 also includes species identified as important to subsistence harvesters, guiding or outfitting industries.

TABLE 3.1.9-2: SELECTION OF TERRESTRIAL MAMMALS AS VALUED COMPONENTS

Common Name	SARA (Schedule 1)	COSEWIC Status	Importance to Subsistence Harvesters	Importance to Guides or Outfitters
Barren-ground Caribou	n/a	n/a	High	Moderate
Moose	n/a	n/a	High	Low
Grizzly Bear	No Status	Special Concern	High	High
Wolverine	No Status	Special Concern	Moderate	Moderate
Furbearer (Arctic Fox/ Red Fox)	n/a	n/a	High/ Moderate	Low

3.1.9.5 Barren-ground Caribou

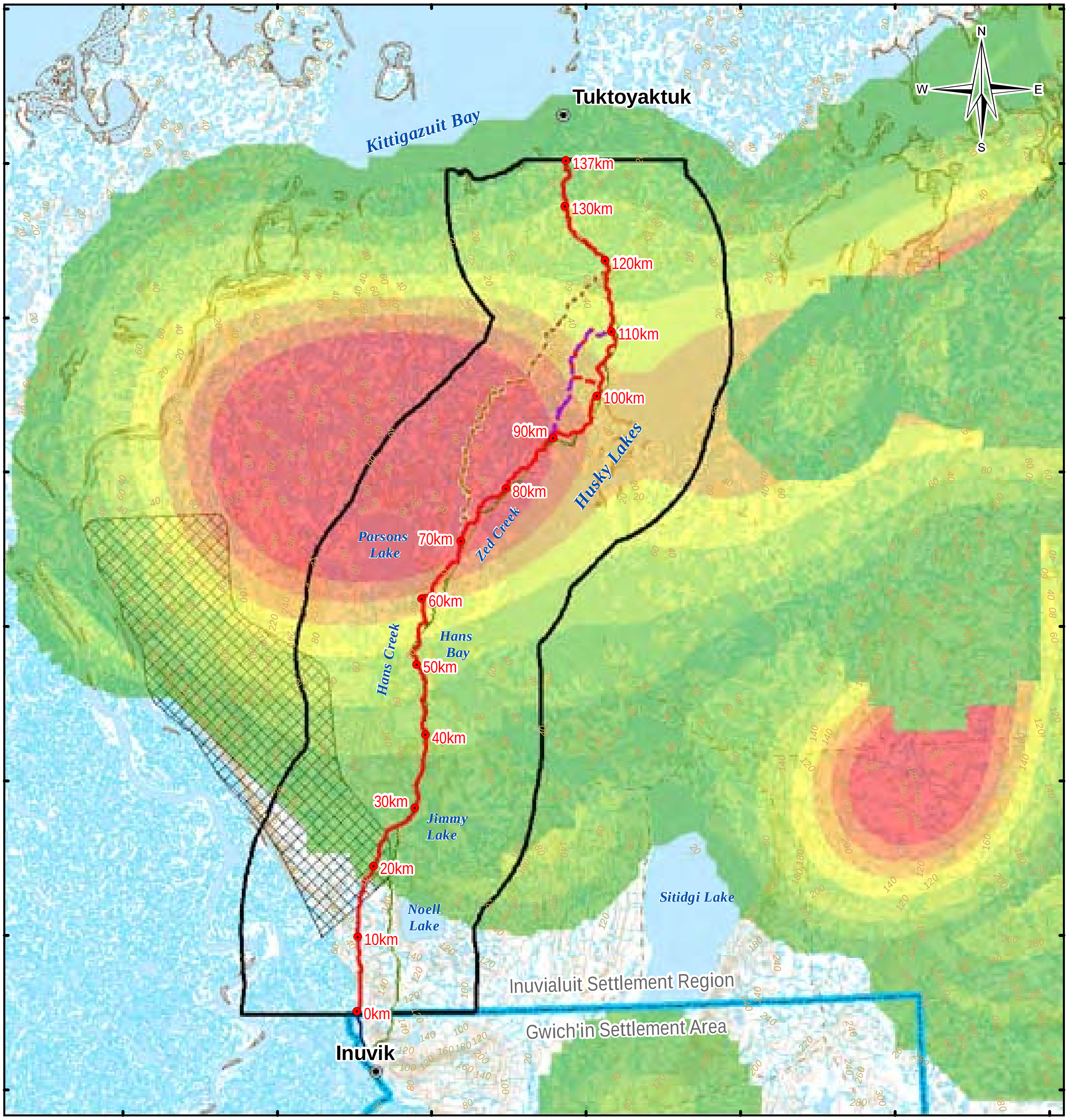
Population Status and Distribution

Barren-ground caribou herds within the NWT are identified by the location of their calving grounds (Thomas 1969; Gunn and Miller 1986). Barren-ground caribou are migratory and occupy different habitats during different seasons. Part of the annual range of the Cape Bathurst and Bluenose-West barren-ground caribou herds overlap with the proposed Project area (Nagy et al. 2005a). Recent evidence shows the upper part of the Project area is also used by a herd of caribou called the Tuktoyaktuk Peninsula Herd.

The Cape Bathurst barren-ground caribou (Photo 3.1.9-1) herd utilizes the Cape Bathurst and Tuktoyaktuk peninsulas and the range extends into the regional study area (Figure 3.1.9-1). The Cape Bathurst herd was first identified as a distinct herd in 2000. Data obtained during photocensus surveys in 1987, 1998, and 2000 on the "Bluenose" herd were re-analyzed to estimate population trends. The population in 1992 was estimated at approximately 17,500 animals. A photocensus conducted during the summer of 2005 showed the herd had declined to an estimate of 2,400 animals and, by July 2006, had declined further to an estimated 1,800 animals. A July 2009 survey indicated a stable trend from 2006 to 2009 (Adamczewski et al. 2009). Table 3.1.9-3 describes the annual population estimates and ranges.

Photo 3.1.9-1

Caribou were periodically seen during the aerial reconnaissance survey along the proposed Highway alignment. Three bull caribou were seen grazing on sedges.



LEGEND

Probability Distribution of the Cape Bathurst Caribou Herd

- 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 95
- 96 - 99

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road

- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Probability Distribution: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Cape Bathurst Caribou Herd Ranges

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map039_CapeBathurst.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-1

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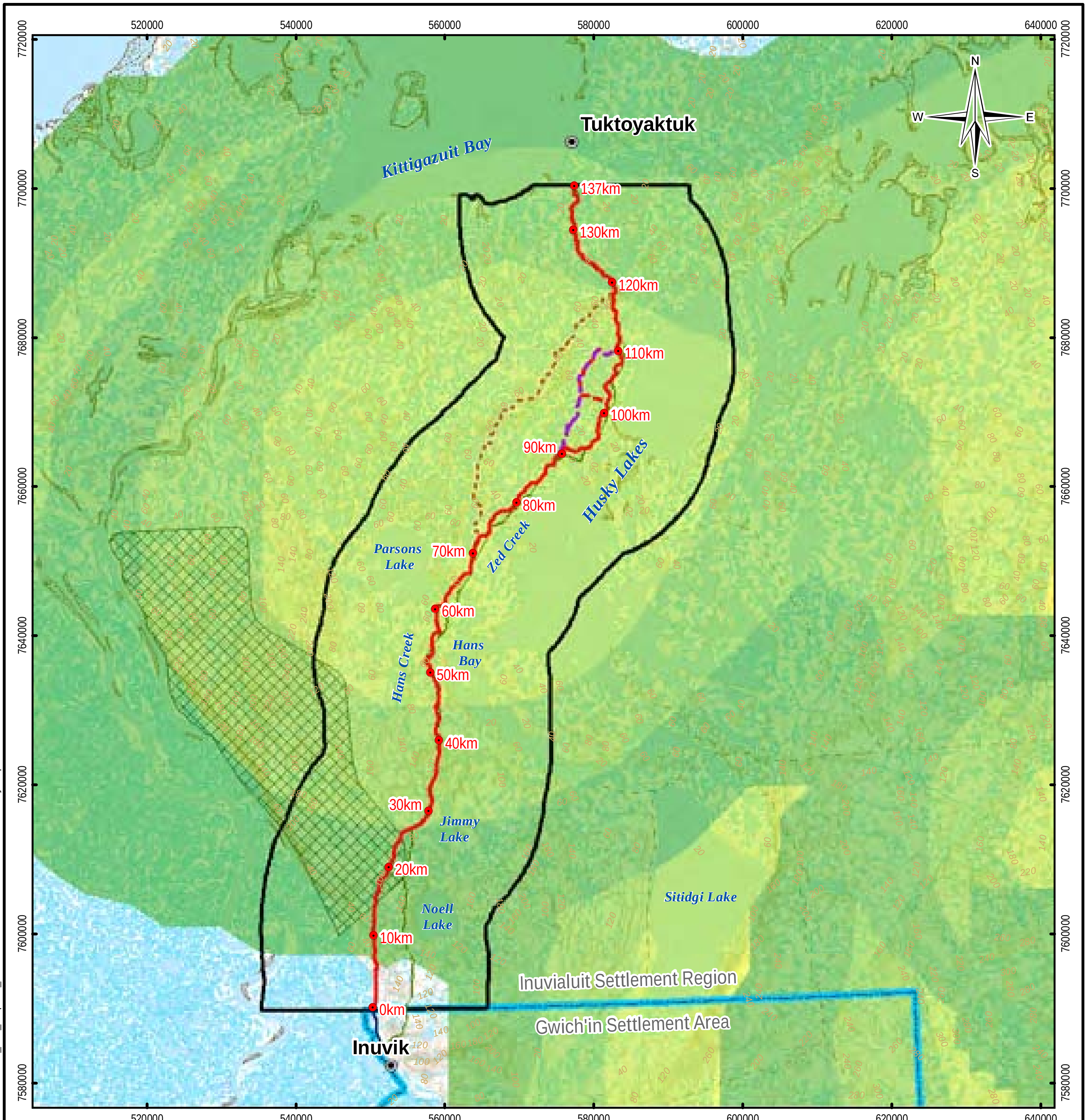
TABLE 3.1.9-3: CAPE BATHURST HERD CENSUS		
Year	**Population Estimate (non calf)**	**Range (95% CI)**
1987	12,512	9,012 - 16,020
1992	19,278	13,881 - 24,675
2000	11,089	9,333 - 12,845
2005	2,434	2,178 - 2,691
2006	1,821	1,672 - 1,971
2009	1,934	1,585 - 2,283

Source: GNWT ENR (2011a)

Based on comments during community consultations on the 2005 survey, ENR deployed collars on caribou on the lower Tuktoyaktuk peninsula in March and these animals used calving grounds on the upper part of the Tuktoyaktuk Peninsula in June 2006 (Nagy and Johnson 2006). This herd, the Tuktoyaktuk Peninsula herd, was surveyed for the first time in July 2006 and estimated at 3,078 non-calf animals (Nagy and Johnson 2006). A portion of this herd is considered to be feral reindeer that escaped from a semi-domestic reindeer herd and, at the request of the Inuvialuit Game Council and the Wildlife Management Advisory Council (NWT), is managed separate from the Cape Bathurst herd. The movements of this herd have been monitored using collared animals since March 2006 and a new population estimate of 2,752 + 276 (95% CI) non-calf caribou was obtained in July 2009. The range of this herd, based on collared bulls and cows between 2006 and 2010, overlapped with the local and regional study area between October and May (ENR Unpublished Data).

The Bluenose-West herd is the largest herd which overlaps the proposed Highway (Figure 3.1.9-2). The herd was estimated at 112,360 in 1992 but declined by 84% to 18,050 by 2006 (Table 3.1.9-4). A July 2009 survey indicated a stable trend from 2006 to 2009 (17,897) (GNWT ENR 2011a).

The patterns of decline in the Bluenose-West herd in the early 2000s were similar to the patterns of decline in the Cape Bathurst herd during the same period. Late calving and low calf: cow ratios on the calving ground indicated that the caribou were nutritionally limited and likely would have been declining naturally without hunting (Nesbitt and Adamczewski 2009).



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LEGEND

Probability Distribution of the Bluenose West Caribou Herd

- 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 95
- 96 - 99

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road

- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Probability Distribution: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Bluenose West Caribou Herd Ranges

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map038_BluenoseWest.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.1.9-2

TABLE 3.1.9-4: BLUENOSE-WEST HERD CENSUS		
Year	Population Estimate (non calf)	Range (95% CI)
1987	106,887	102,233 - 111,542
1992	112,360	86,794 - 137,926
2000	76,376	62,029 - 90,723
2005	20,800	18,760 - 22,840
2006	18,050	17,523 - 18,578
2009	17,897	16,587 - 19,207

Source: GNWT ENR (2011a)

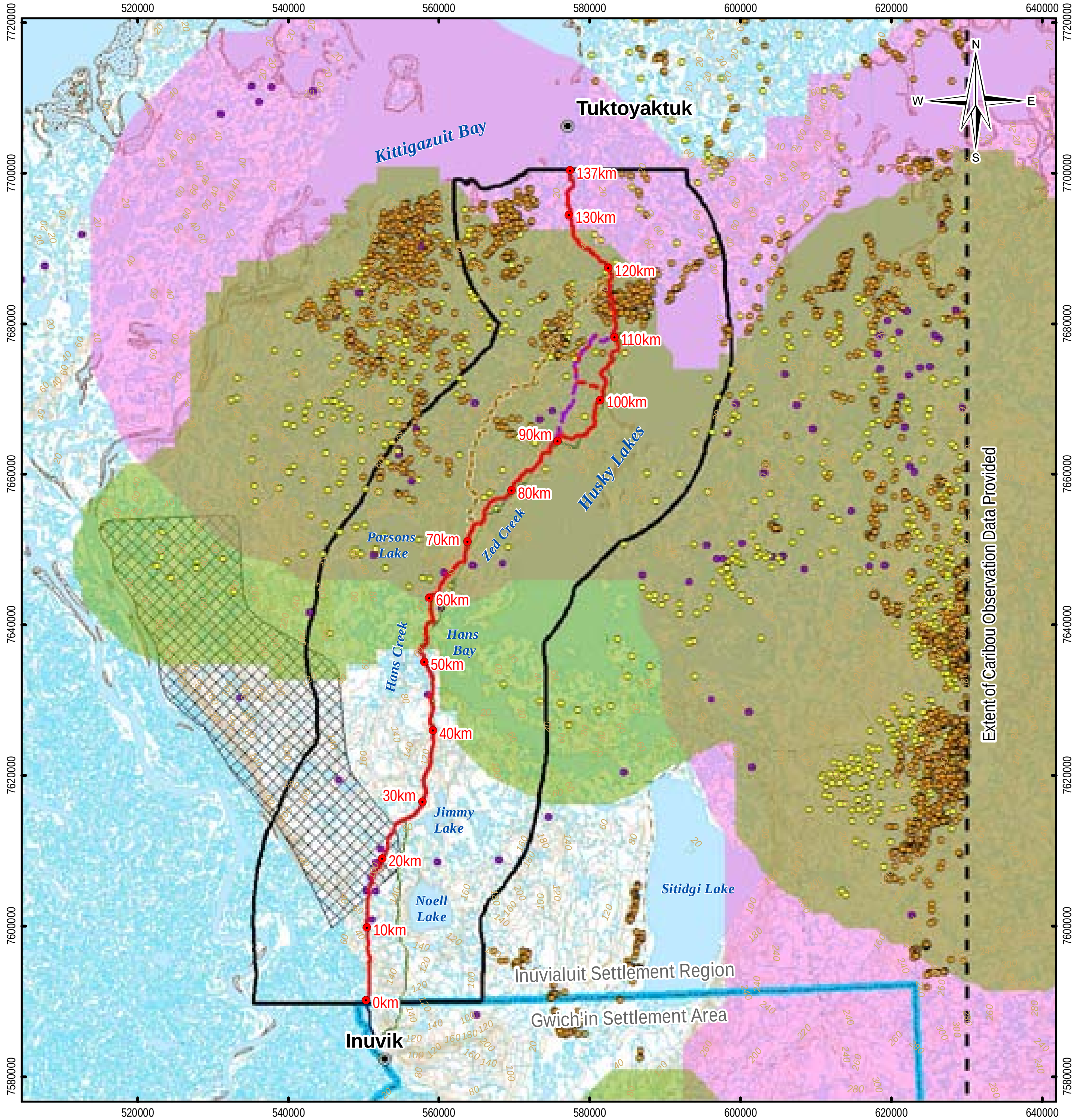
Important Habitat and Habitat Requirements

Barren-ground caribou typically overwinter in forested areas, within the treeline east, northeast and southeast of Inuvik (Figure 3.1.9-3; GNWT ENR 2011a; Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). Wind-swept areas that provide feeding opportunities in winter or relief from insects in summer are also important.

Caribou migrate to the north in spring towards calving grounds (Figure 3.1.9-4). Calving areas are non-forested and characteristic of high, rocky areas where there is little shelter from wind and driving snow. The Cape Bathurst herd calves and spends early summer on the Bathurst and Nicolson Peninsula. The Bluenose-west herd calves and spends early summer in the Brock, Hornaday and Horton River area (Figures 3.1.9-5 and 3.1.9-6; Community of Tuktoyaktuk et al. 2008). The Tuktoyaktuk Peninsula herd calves and spends early summer on the northern end of the Tuktoyaktuk Peninsula. Early to late summer caribou herd ranges are east of the Husky Lakes (Figures 3.1.9-6 to 3.1.9-9). The distance between calving and overwintering areas can be as great as 700 km. Fall rut and post rut ranges are shown on Figures 3.1.9-9 and 3.1.9-10.

Important habitat for barren-ground caribou occurring in the region include:

- Bluenose-West herd - Hornaday, Brock and Horton Rivers area for calving (Tuktut Nogait National Park);
- Cape Bathurst herd – Bathurst peninsula for calving and insect relief; winter habitat northeast of Inuvik; and
- Tuktoyaktuk Peninsula herd – north end of Tuktoyaktuk peninsula for calving and insect relief (Community of Tuktoyaktuk et al. 2008l; Community of Inuvik et al. 2008).



LEGEND

- Bluenose West Herd
- Cape Bathurst Herd
- Both Herds

Barren-ground Caribou Observations

- GPS Telemetry
- Satellite Telemetry
- Spring Composition Surveys
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Watercourse
- Contour
- Sand
- Wetland
- Waterbody

NOTES

Base data source: NTS 1:250,000

Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Projects 02, 44, & 46).

Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Winter Caribou Observations and Herd Ranges (December 1 to March 31)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

10 5 0 10 20

Kilometres

FILE NO.
V23201322_EIS_Map044_Car_Winter.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 3.1.9-3

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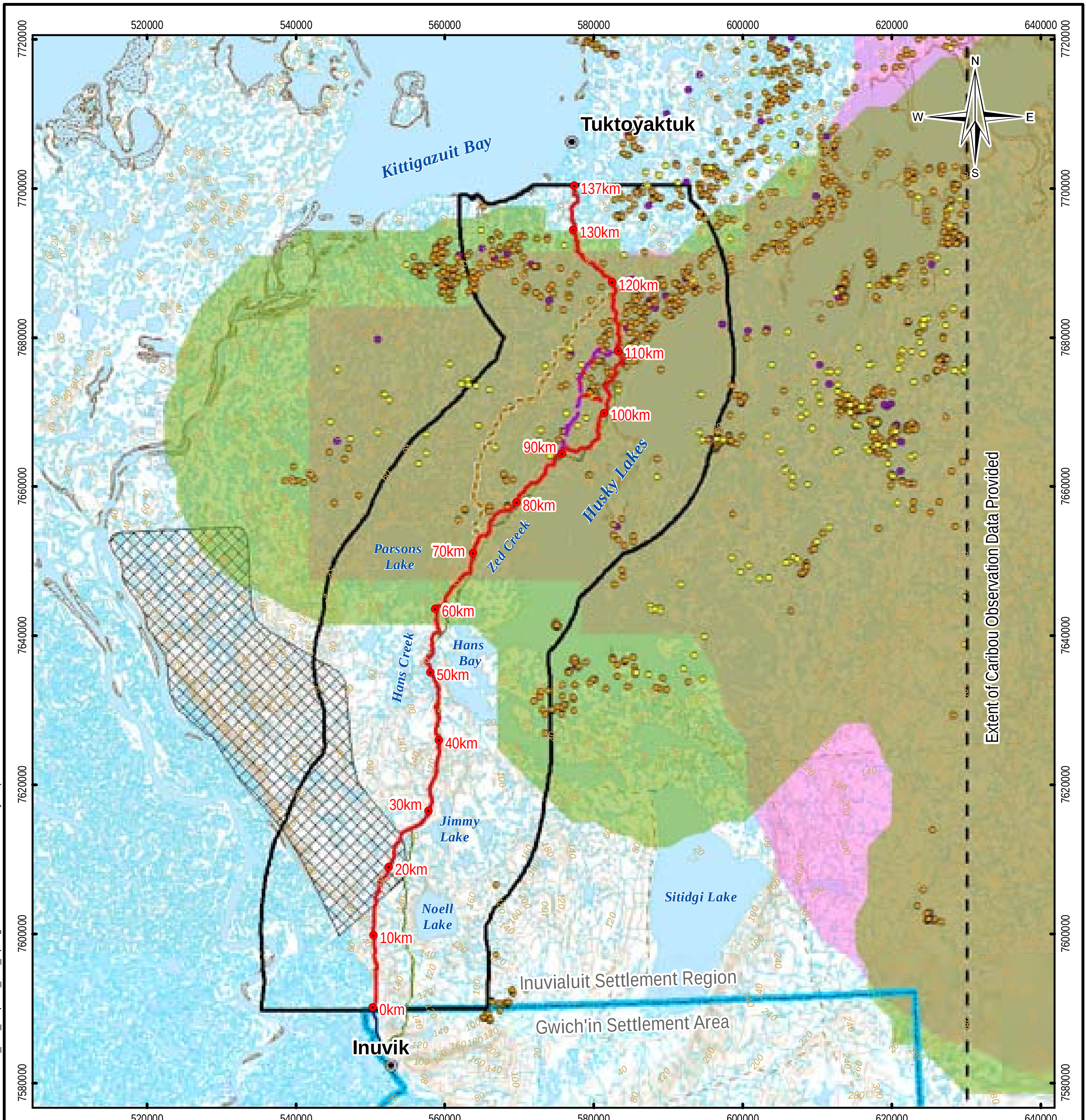

LEGEND

- Bluenose West Herd
- Cape Bathurst Herd
- Both Herds

Barren-ground Caribou Observations

- GPS Telemetry
- Satellite Telemetry
- Spring Composition Surveys
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Projects 44, 46, 133, & 191).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Spring, Spring Migration and Pre-Calving Caribou Observations and Herd Ranges (April 1 to May 31)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map045_Car_Spring.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-4

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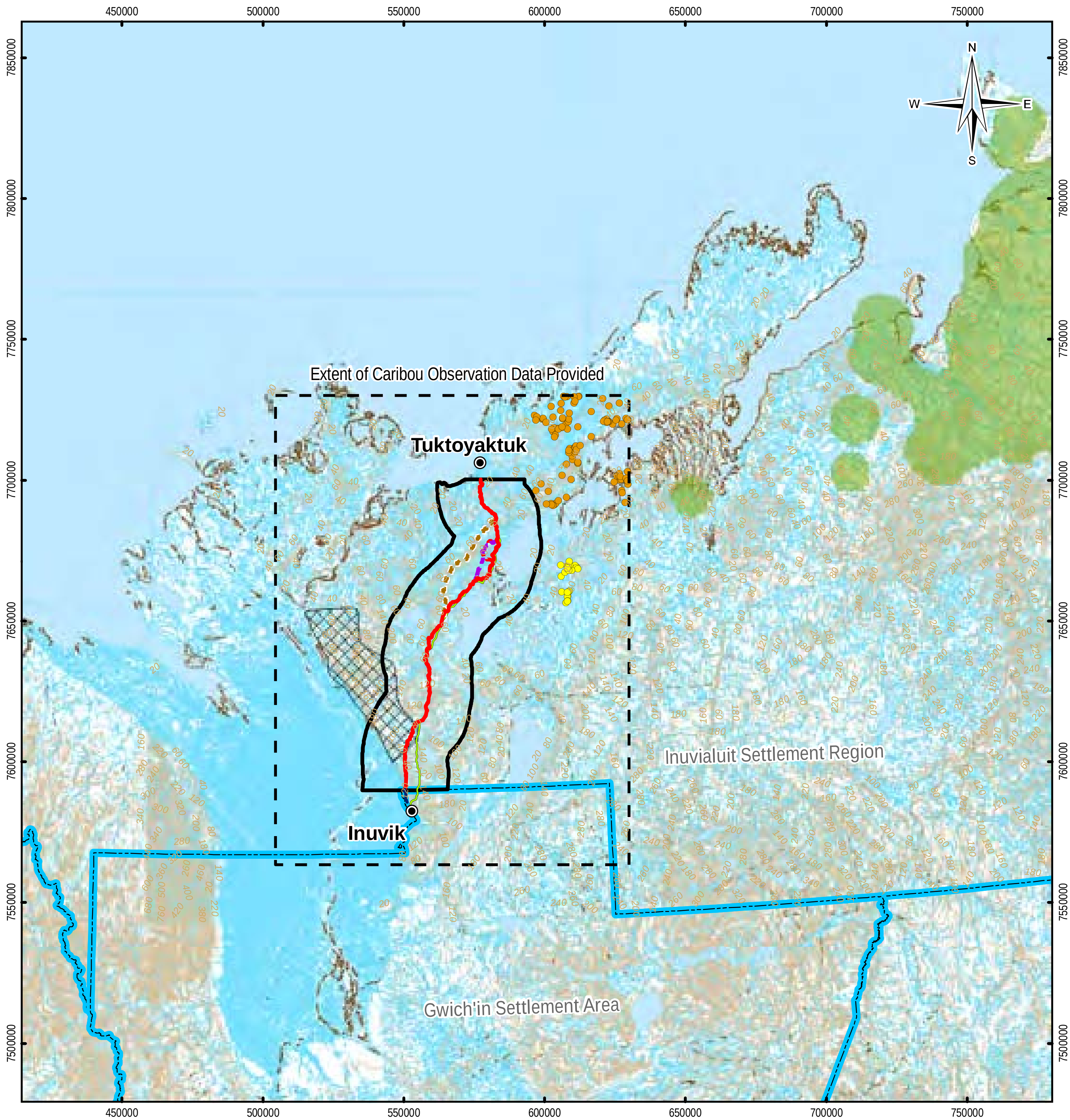

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LEGEND

- Cape Bathurst Herd
- Barren-ground Caribou Observations
  - GPS Telemetry
  - Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Projects 44 & 46).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Calving/Post Calving Caribou Observations and Herd Ranges (June 1 to 25)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:2,000,000
25 12.5 0 25 50
Kilometres

FILE NO.
V23201322_EIS_Map052_Car_Calving.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.1.9-5

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LEGEND

- Cape Bathurst Herd
- Barren-ground Caribou Observations
  - Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Project 44).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

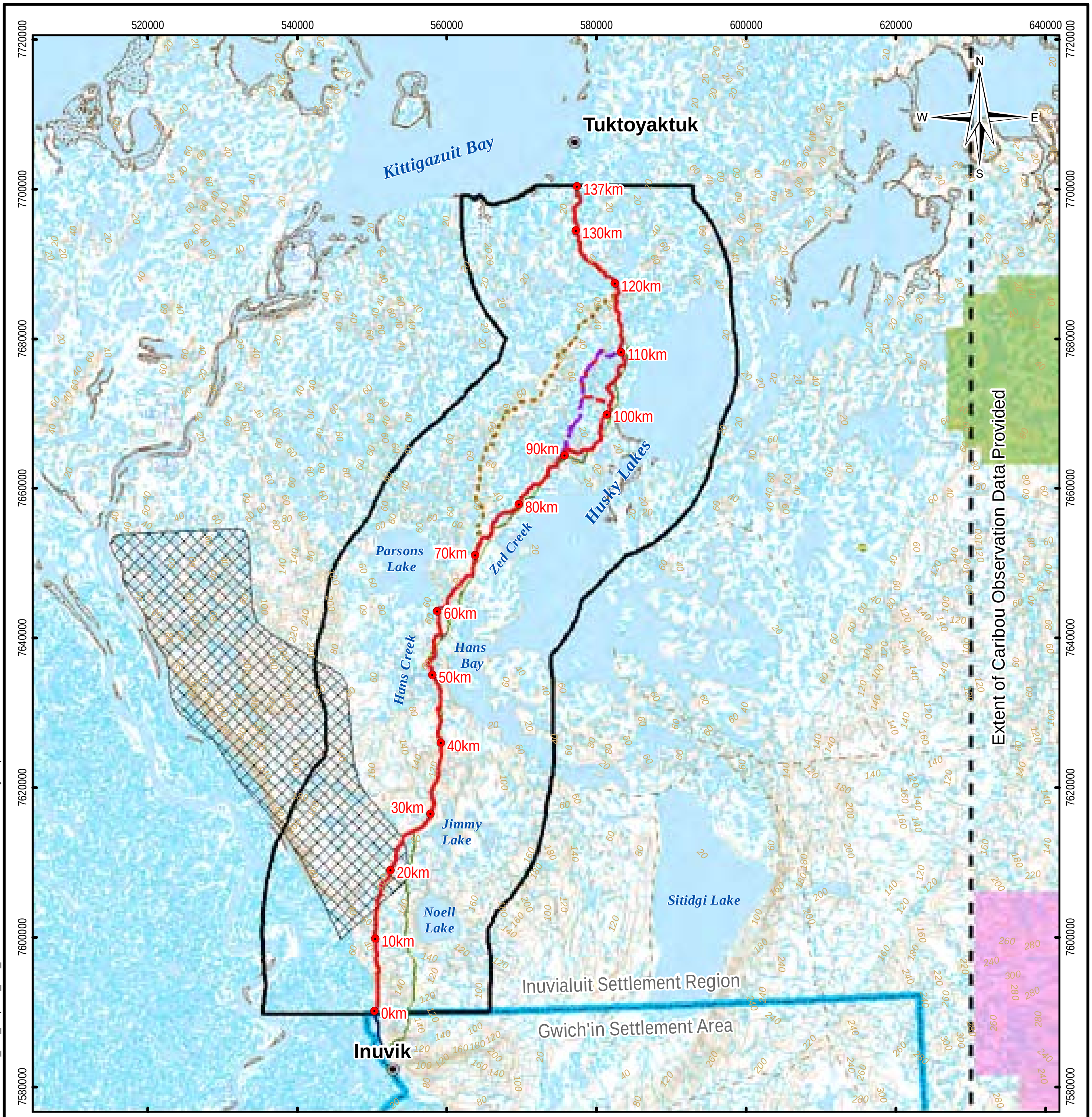
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Early Summer Caribou Observations and Herd Ranges (June 26 to July 15)

PROJECTION: UTM Zone 8		DATUM: NAD83	
Scale: 1:2,000,000 (25, 12.5, 0, 25, 50 Kilometres)			
FILE NO.: V23201322_EIS_Map053_Car_EarlySummer.mxd			
PROJECT NO.: V23201322	DWN: SL	CKD: TS	REV: 0
OFFICE: EBA-VANC	DATE: May 19, 2011		

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.1.9-6



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LEGEND

- Bluenose West Herd
- Cape Bathurst Herd

Barren-ground Caribou Observations

- Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES

Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Project 44).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Mid Summer Caribou Observations and Herd Ranges (July 16 to August 7)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

10 5 0 10 20

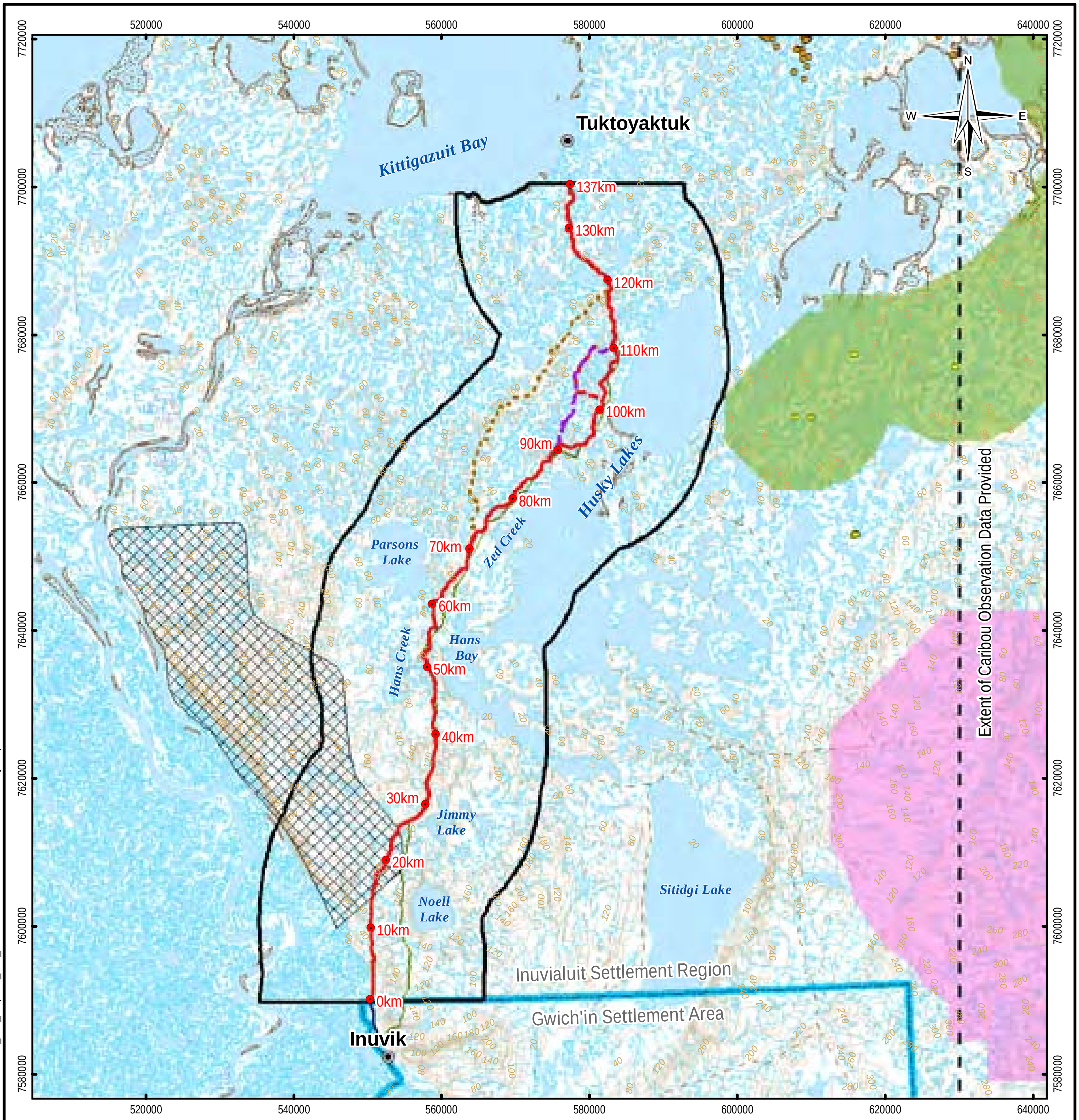
Kilometres

FILE NO.
V23201322_EIS_Map040_Car_MidSummer.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-7



LEGEND

- Bluenose West Herd
- Cape Bathurst Herd

Barren-ground Caribou Observations

- GPS Telemetry
- Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Widlife Management Information System (Projects 44 & 46).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Late Summer Caribou Observations and Herd Ranges (August 8 to October 7)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map041_Car_LateSummer.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-8

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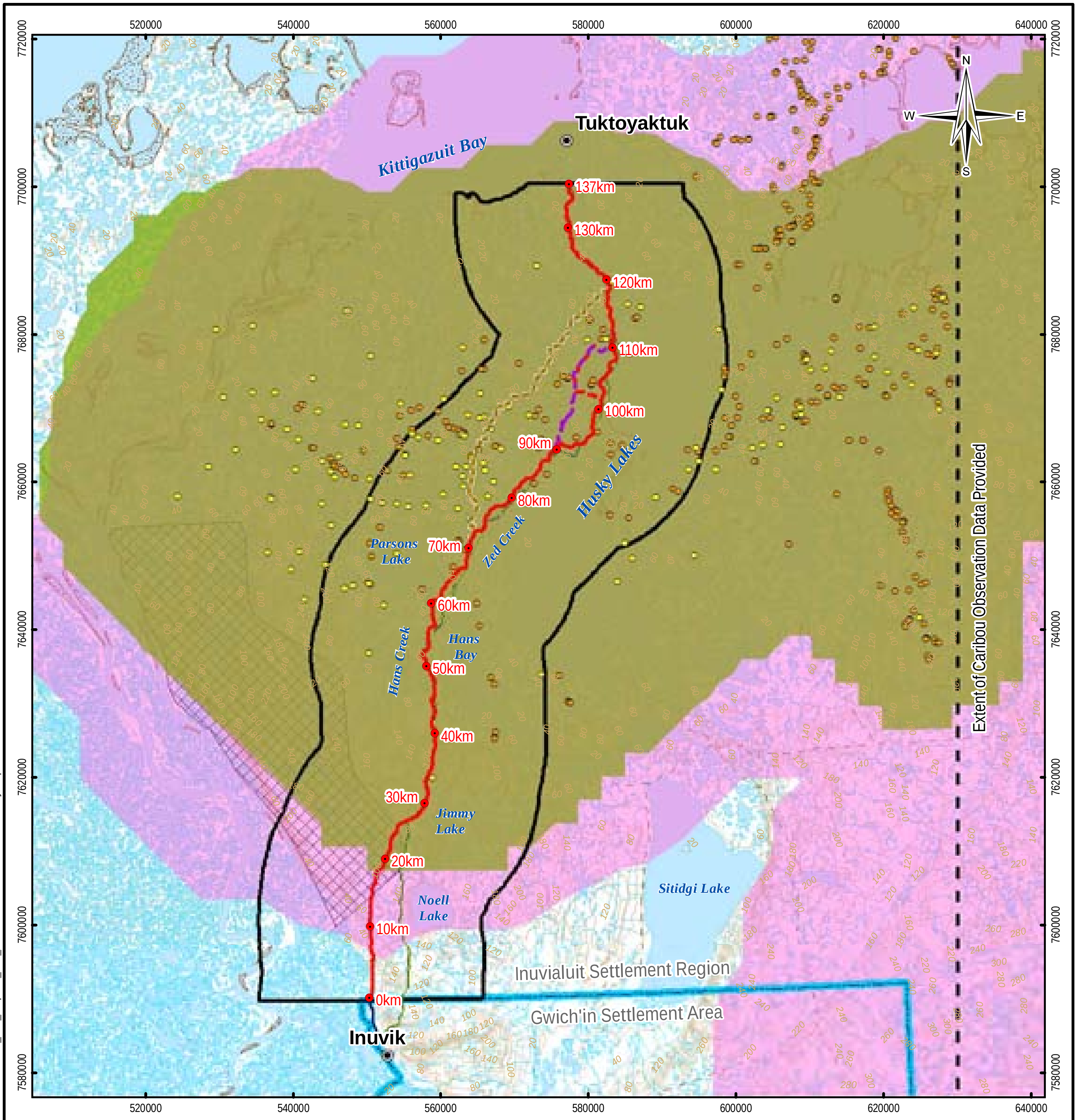

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LEGEND

- Bluenose West Herd
- Cape Bathurst Herd
- Both Herds

Barren-ground Caribou Observations

- GPS Telemetry
- Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Projects 44 & 46).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Fall/Rut
Caribou Observations and Herd Ranges
(October 8 to 31)

PROJECTION	DATUM
UTM Zone 8	NAD83

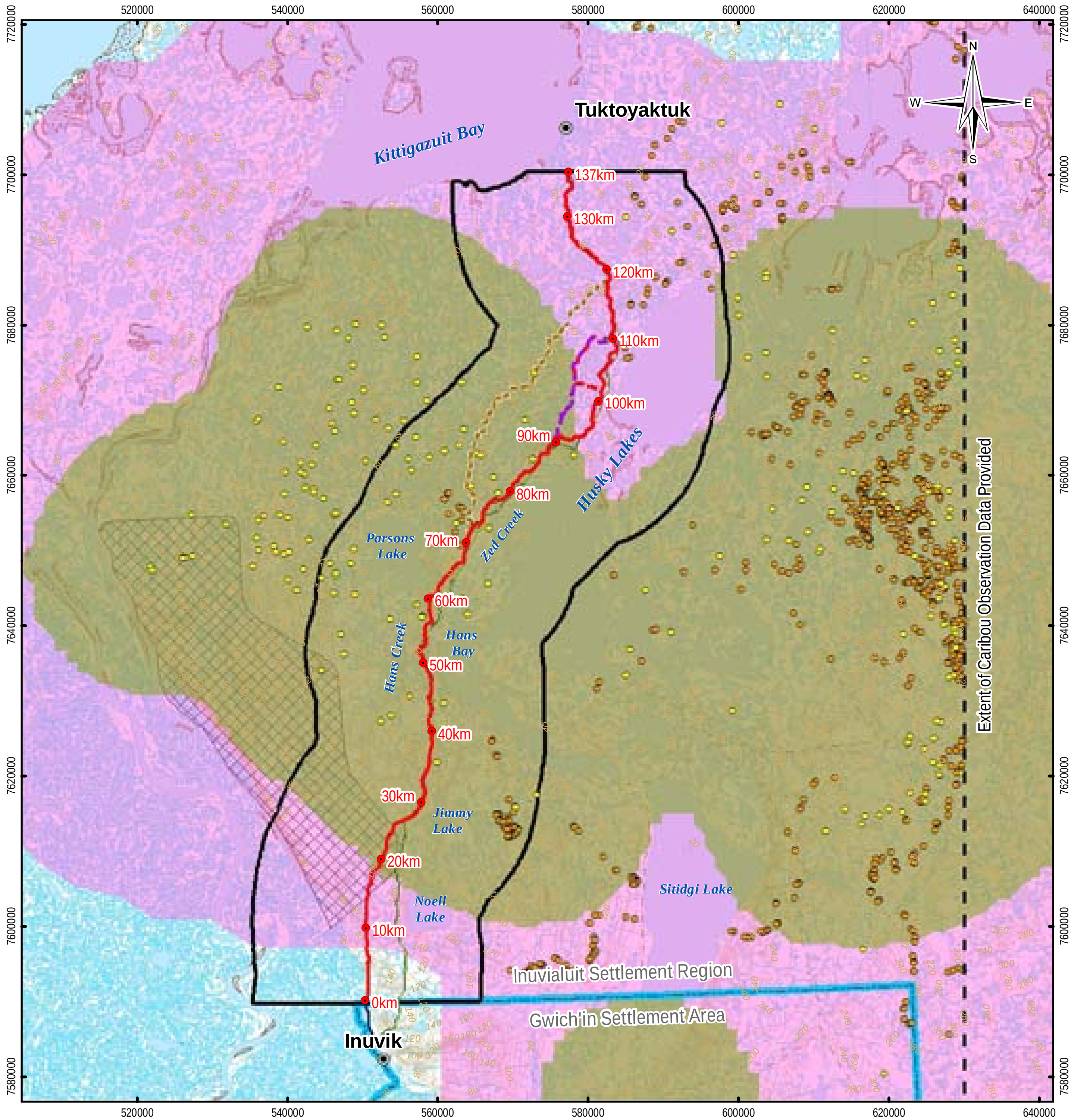
Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map042_Car_FallRut.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-9



LEGEND

- Bluenose West Herd
- Cape Bathurst Herd
- Both Herds

Barren-ground Caribou Observations

- GPS Telemetry
- Satellite Telemetry
- Extent of Caribou Observation Data
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Caribou Observations: GNWT ENR 2011. NWT Wildlife Management Information System (Projects 44 & 46).
Caribou Herd Ranges: GNWT ENR, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Fall/Post Rut Caribou Observations and Herd Ranges (November 1 to 30)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map043_Car_FallPostRut.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-10

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Seasonal Movements

Figures 3.1.9-11 to 3.1.9-12 show the seasonal distribution of the Cape Bathurst and Bluenose-west herds during the fall (rut and post rut) and winter.

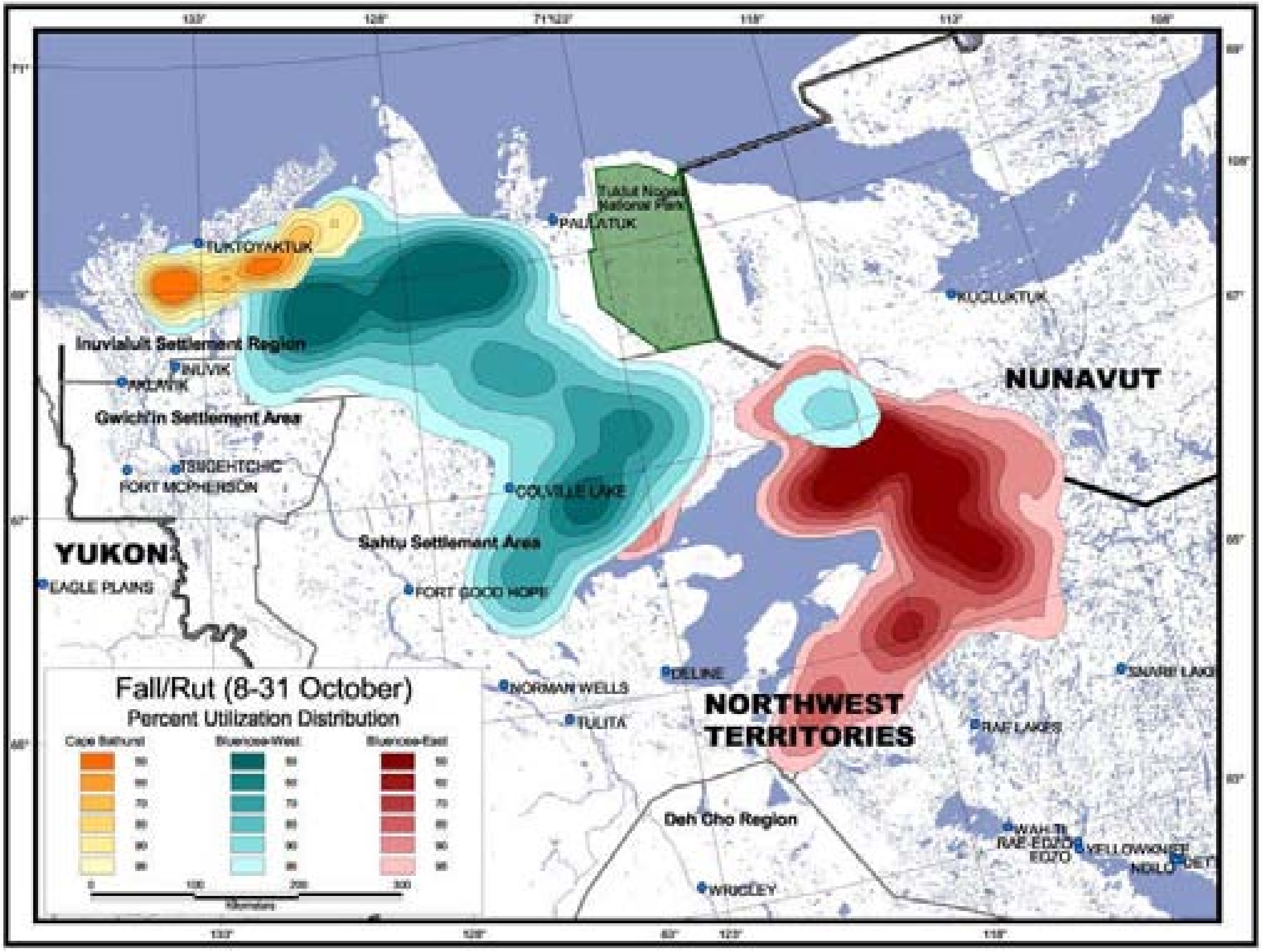
Satellite tracking data obtained for female barren-ground caribou (Cape Bathurst herd) from March 1996 to May 2004 provide an estimate of the seasonal and cumulative ranges (Nagy et al. 2005b). The herd calves (June 1 to 25) and summers (June 26 to August 7) in the Cape Bathurst area. During late summer (August 8 to October 7), the herd moves southwest along Cape Bathurst but remains east of the Husky Lakes. The rutting/early fall range (October 8 to 31) occurs in concentrated areas east and west of Husky Lakes, while the post rut and late/fall ranges (November 1 to 30) increases the separation with a portion of the herd moving west of the southern Husky Lakes in the area of the proposed Project. The herd's winter range (December 1 to March 31) stretches from the Tuktoyaktuk Peninsula to the Mackenzie River in the west and the Husky Lakes in the south (Figure 3.1.9-13). Barren-ground caribou spring migration to calving grounds in Cape Bathurst (April 1 to May 31) results in the herd moving out of the proposed Project area typically by early April.

In comparison to the Cape Bathurst herd, the annual range of the Bluenose-West herd is very large. The calving grounds are located in the western Melville Hills in Tuktut Nogait National Park, with high calving densities in the area west of the Hornaday River south to the Little Hornaday River.

The post calving range of Bluenose-West herd includes the Melville Hills from the coastal areas near Paulatuk, east to Bluenose Lake, south to the Little Hornaday River, and in the areas east of the Hornaday River. Rutting occurs in this area and as far west as the Kugaluk River and south to the Simpson and Horton lakes areas. The winter range of this herd includes the area from Husky Lakes and the Anderson River to the north and Colville and Great Bear lakes and Fort Good Hope to the south.

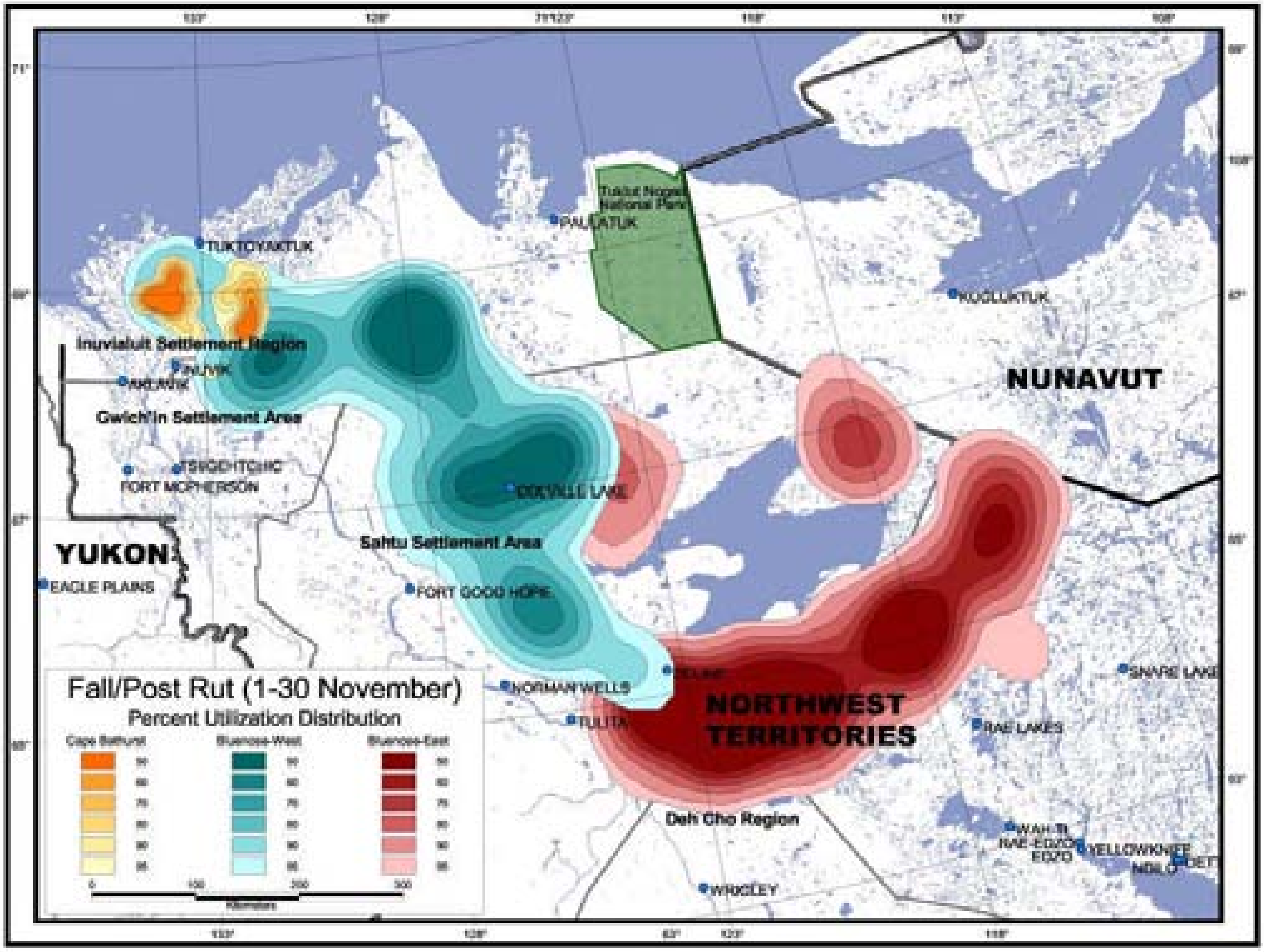
Sensitive Time Periods

There are three time periods where specific guidelines may be required: typically May 15 to October 15 (spring migration, calving, post calving), the winter periods, and year-round (INAC 2011c). Different mitigations will apply for specific sensitive time periods, year-round and winter sensitivity.



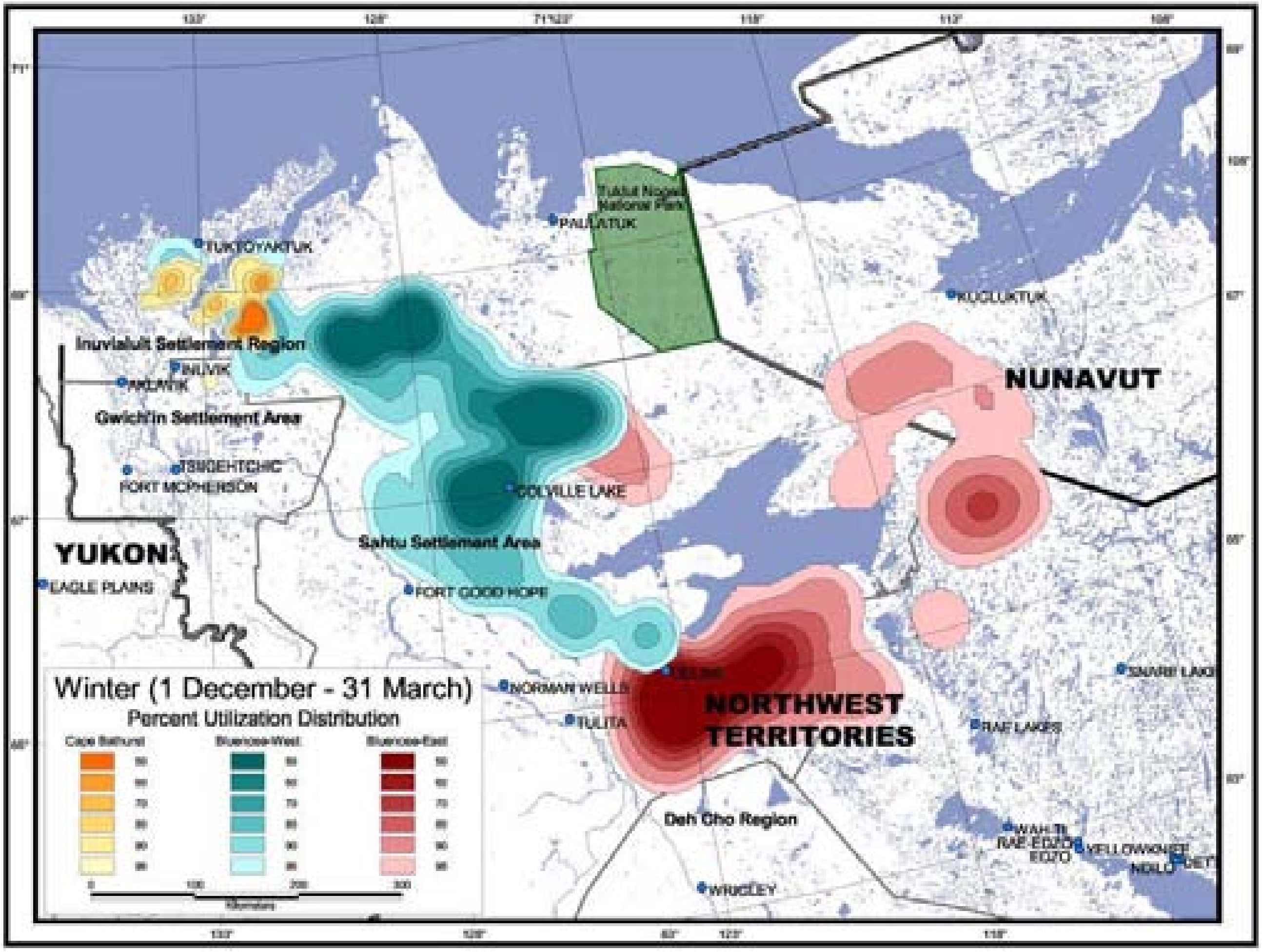
Source: Nagy et al. (2005b)

Figure 3.1.9-11
Percent Utilization and Distribution of Cape Bathurst, Bluenose-West, and Bluenose-East Caribou in NWT during the Fall (Rut)



Source: Nagy et al. (2005b)

Figure 3.1.9-12
Percent Utilization and Distribution of Cape Bathurst, Bluenose-West, and Bluenose-East Caribou in NWT during the Fall (Post Rut)



Source: Nagy et al. (2005b)

Figure 3.1.9-13
Percent Utilization and Distribution of Cape Bathurst, Bluenose-West, and Bluenose-East Caribou in NWT during the Winter

Harvest Pressures

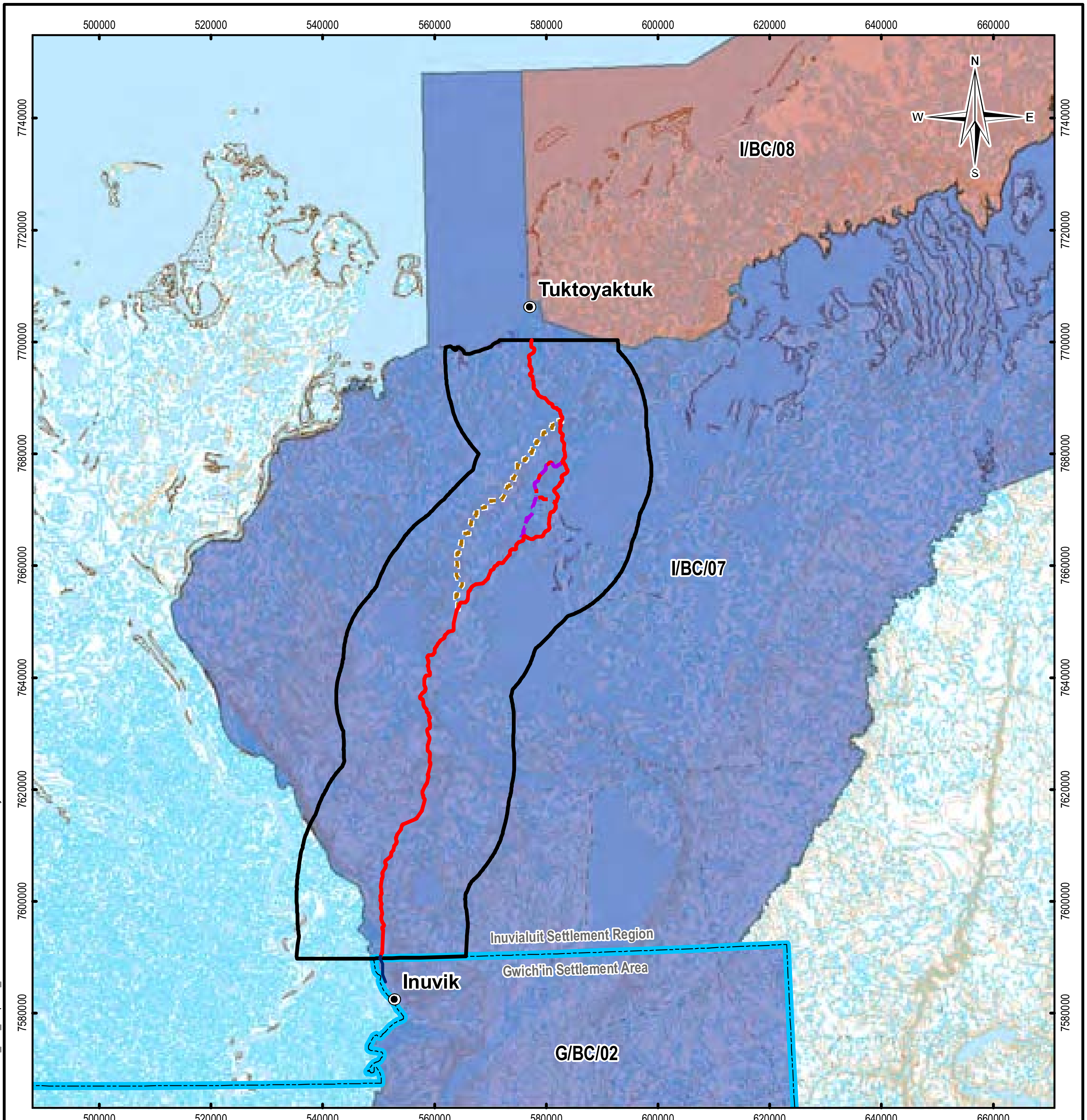
A review of past surveys by GNWT ENR indicates that the Cape Bathurst herd declined at about 4% per year from 1992 to 2000, then at a rate of 14% per year from 2000 to 2006 (Nesbit and Adamczewski 2009). In the early 2000s, late calving and low calf:cow ratios were recorded on the calving grounds (Nagy ND, as cited in Adamczewski et al. 2009). These observations indicated that the caribou were nutritionally limited and the population would likely have been declining even without hunting (Nesbit and Adamczewski 2009).

The last estimated harvest, based on modelling, for the Cape Bathurst herd was around 730 caribou (primarily cows) in 2005 (Nesbitt and Adamczewski 2009). The 2006 survey confirmed that the population was still declining. As this harvest would have accelerated the herd's downward trend (i.e. greater than the decline from natural factors), the Wildlife Management Advisory Council (NWT) and Gwich'in Renewable Resource Board made recommendations that GNWT ENR implemented in 2006 and 2007.

In 2006, all resident, non-resident, and commercial hunting was stopped. In 2007, the barren-ground caribou management area (I/BC/06) in the Inuvialuit Settlement Region (ISR) that covered the major portion of the range of these herds was divided to better reflect the current herd movements and allow management actions to be implemented by herd (Figure 3.1.9-14).

As a result, a new management area (I/BC/07) covering the core area of the Cape Bathurst range was created. Wildlife Management Areas I/BC/07 and G/BC/02 have remained closed to all hunting of barren-ground caribou hunting since September 2007. Hunting for the Tuktoyaktuk Peninsula Herd is still permitted between June 16 and March 31 in Area I/BC/08 located to the north and east of Tuktoyaktuk on the Tuktoyaktuk Peninsula. However, I/BC/08 is closed from April 1 to June 15 of each year to allow the Cape Bathurst Herd to migrate back to its calving grounds undisturbed.

Hunters require a tag to hunt in I/BC/06, the core area for the Bluenose-west herd in the ISR and 345 tags are given to the Inuvialuit Game Council and 22 to the Gwich'in Renewable Resources Board to be distributed annually. The Bluenose-West herd harvest is shared with users from the Inuvialuit, Gwich'in, and Sahtu Regions. The estimated hunter harvest for this herd was around 1,900 animals in 2003 (primarily cows) (Sahtu Harvest Study and ENR data). Currently the harvest of the Bluenose-West and East herds is restricted to subsistence harvesters for the Wildlife Management Areas I/BC/06, S/BC/01 and S/BC/03. By recommendation of the Wildlife Management Advisory Council (NWT) and the Gwich'in and Sahtu Renewable Resource Boards, GNWT ENR set a Total Allowable Harvest at 720 caribou (4% of the herd), with a target of at least 80% bulls.



LEGEND

Restricted Management Areas with Respect to Hunting

- Closed all year
- Closed April 1 to June 15

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- Gwich'in / Inuvialuit Boundary

- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Wildlife Management Area: NWT Centre for Geomatics, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Wildlife Management Areas with Hunting Restrictions for the Barren-ground Caribou

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:1,000,000
10 5 0 10 20 30
Kilometres

FILE NO.
V23201322_EIS_Map048_CaribouWMA.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.9-14

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A five year management plan, created in 1998, is currently being updated. The process is led by the Advisory Committee for Co-operation on Wildlife Management, which consists of the co-management boards established under the Inuvialuit, Gwich'in, Sahtu, Tlicho and Nunavut land claims agreements.

Health of Harvested Species and Potential Contaminants

Metals can accumulate in the livers of caribou. There is some concern that high metal levels in the organs of caribou could lead to disease (INAC 2003).

In a study conducted by Lambden et al. (2007) of Inuit, Dene/Metis and Yukon groups, between 10% and 38% of participants noticed recent changes in the quality or health of traditional food species, with physical changes and decreasing availability reported most often. However, caribou were among the foods considered particularly healthier and held special value to the population.

Contaminant levels have been measured in all major barren-ground caribou herds in the NWT and most contaminants are present at low levels that are not considered to be a health risk for human consumption or for the caribou themselves. The Bathurst herd has been monitored by the GNWT and community partners under the CircumArctic Rangifer Monitoring and Assessment Network and the Northern Contaminants Program (GNWT ENR NDa).

Mercury

The level of mercury in the kidneys of NWT caribou is very low and does not pose a health risk to either caribou or people who eat caribou. Both the meat and organs of NWT caribou are safe to eat. There are naturally occurring sources of mercury in the Arctic environment, and the levels of mercury found in caribou often reflect exposure to these background levels. The primary source of mercury exposure from human activities results from long-range atmospheric transport of mercury from other parts of the world. Mercury is a toxic element that accumulates in brain and kidney tissue, and can affect neurological functions and cause poor growth, and kidney damage (GNWT ENR NDa).

Cadmium

Cadmium is found naturally in the environment. Wildlife exposure to cadmium reflects regional and local differences the type of rocks and soil in the area. In some areas, human activity may also be a source of cadmium. Long-range atmospheric transport can distribute this cadmium to other places in the environment. Lichens absorb cadmium directly from the air and pass it on to the animals that feed on the lichen (GNWT ENR NDa). Caribou foraging on lichen, may have cadmium build up in the liver and kidneys, rather than the muscles (or "meat") itself.

The levels of cadmium in NWT caribou vary considerably with age (increasing levels in older animals), season (higher in spring than in fall), and sex (higher in female vs. male caribou) but the levels of cadmium in NWT caribou kidneys are generally low and not considered a concern for caribou health (GNWT ENR NDa).

According to INAC (2007a), caribou have less opportunity to build up elevated levels of contaminants because their diet consists of lichen and plant sources. As a result, caribou avoid building up elevated levels of contaminants. However, people in the NWT are advised to not consume more than one caribou kidney per week to reduce potential health risks from cadmium (INAC 2007a).

Further discussion on potential wildlife contamination is found in Section 3.1.9.13.

Distribution and Timing in Relation to Project Alternatives, Construction Activities and Operation

The temporal overlap of Highway construction with caribou is limited to October 1 to May 31 (Figure 3.1.9-3 to 3.1.9-10). As the majority of the Bluenose-West and Cape Bathurst herds overwinter over a wide range east and south of the Husky Lakes, only a small portion of the herd that crosses to the west of the Husky Lakes will potentially encounter the construction activities. It is also important to note that these caribou herds are not present in the RSA during the critical calving/ post-calving periods (Figure 3.1.9-5).

The location of construction activities and borrow sites will change between years. Construction activities will overlap with caribou overwintering areas during the first year only in the northern portion of the Project, near Tuktoyaktuk. As construction proceeds in subsequent years, closer to the Husky Lakes area, more of the construction will occur within caribou overwintering areas. All alignment alternatives overlap with the known caribou overwintering areas. Potentially overlapping activities include borrow site activities, temporary haul roads, Highway construction activities and Highway operations.

The Bluenose-West caribou herd marginally overlaps with the proposed Highway alignment along the northwest corner of their annual range and a few individuals can be expected to be present from October to April (Nagy et al. 2005a). As herd numbers decline, the range contracts and in recent years a lower proportion of collared animals have been migrating into the regional study area. As herd size increases there will be the potential for more effects on this herd.

The proposed Highway alignment is located south of the summer and fall caribou harvesting areas, sites 306C and 309C respectively (Community of Tuktoyaktuk et al. 2008). The northern portion of the proposed Highway corridor is located within the spring and winter caribou harvesting areas, sites 302C and 315C respectively (Figure 3.2.8-1; Community of Tuktoyaktuk et al. 2008). As well, the proposed Highway alignment occurs within the western part of Bluenose-West winter range management area, site 701E (Figure 3.2.9-5; Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

The portion of the Highway that is within the areas potentially used by caribou harvesters varies by season. For example, the spring and winter caribou harvest areas overlap with KM 40 to KM 137 of the proposed Highway. Whereas, during summer and fall, most (if not all) of the proposed Highway is not located within the summer and fall caribou harvest areas. During the construction phase, access to these areas by harvesters would only occur by traditional routes.

Infrequent disturbance will continue to occur along the Highway right-of-way during Highway operations, when caribou are in the vicinity of the Highway. The potential effects to caribou and caribou habitat from the Project are discussed further in the Wildlife and Wildlife Habitat effects section (Section 4.2.7).

3.1.9.6 Moose

Population Status and Distribution

Moose occur in the Mackenzie Delta, but their distribution is restricted to patches of suitable habitat (ICC et al. 2006), which occur along the proposed Highway corridor. On the tundra, north of the treeline, moose are typically associated with areas where forage is available.

South of the treeline (near Inuvik), moose are widely distributed and are generally found at low densities, compared to the densities found in other parts of the boreal forest (GNWT ENR 2005a). Studies suggest that population density ranges between 0.03 to 0.17 moose/km² (IOL et al. 2004) or 0.05 to 0.15 moose/km² (GNWT ENR 2011c).

The population of moose in the northern Delta area has reportedly declined since 1948 and is believed to still be in decline (Community of Inuvik et al. 2008). Table 3.1.9-5 includes population data derived from the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008).

TABLE 3.1.9-5 MOOSE POPULATION ESTIMATES IN THE INUVIK AREA

Location	Population Estimate (moose/100 km²)	Year
Arctic Red River	5.5	1999
	none surveyed	2006
Northern Richardson Mountains	4.8	2000
	3.5	2006
Fort McPherson – Peel River	3 – 13	1980
	0.84	2006
Inuvik-Tsiigehtchic	0.09	1996
	6.0	1998
	1.62	2006

Source: Community of Inuvik et al. (2008)

In September 2009, during an aerial reconnaissance along the proposed Highway alignment, a total of 16 moose were observed including seven bulls, five cows, three yearlings and one calf (Photo 3.1.9-2). In addition, two observations of moose tracks were documented. Moose or moose sign was present throughout the length of the proposed Highway alignment; however, 55% of the observations were below the treeline, near Inuvik, while 36% were near the southwest end of Husky Lakes, and finally, 9% were closer to Tuktoyaktuk, near Granular Source 177. Above the treeline, moose observations were associated with tall shrubs that typically occur along rivers or creeks.

Photo 3.1.9-2
Several moose were observed along the proposed Highway alignment, in association with lush willow growth along rivers

Important Habitat and Habitat Requirements

The best habitats for moose are characterized by semi-open forest cover, an abundance of willow and aspen stands, and are located close to lakes, river valleys, and stream banks. They prefer deciduous shrubs for fall and winter food and thick conifers for winter cover. In the summer they can be found close to river valleys and lakes where they feed on aquatic vegetation. Moose tend to favour areas previously disturbed (15-30 years prior) by forest fires, as the natural regeneration meets their habitat requirements (GNWT ENR 2011c).

According to the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008), important habitat areas include valleys and creeks with willow. In particular, moose are known to use the Husky Lakes, Sitidgi River, Miner River, Richardson Mountains, Bell River, Babbage River, Yukon North Slope and the northern Mackenzie River Delta (Community of Inuvik et al. 2008; Community of Tuktoyaktuk et al. 2008).

Seasonal Movements

Moose are in the regional study area year-round. Spring moose harvesting areas are identified as Site No. 303B in the Tuktoyaktuk Community Conservation Plan (see Figure 3.2.8-4). This harvesting area is located at the south boundary of Sitidgi Lake, north to the southern end of Husky Lakes and east to Kugaluk River, south of the treeline. The proposed Highway crosses through a portion of the western edge of the harvesting area.

Sensitive Time Periods

Breeding typically occurs in the third week of September and calving occurs in May or early June.

Harvest Pressures

Moose in the NWT are harvested by resident and non-resident hunters, with a limit of one moose per hunter (GNWT ENR 2011c). According to the Inuvialuit Harvest Study, 10 or fewer moose were harvested in Tuktoyaktuk annually between 1988 and 1997. Whereas in Inuvik, between 8 and 42 moose were harvested annually between 1988 and 1997. Section 3.2.8 provides detailed information regarding moose harvests in the ISR. Due to recent restrictions to caribou harvesting, the pressure on moose has likely increased (GNWT ENR, pers. comm., March 17, 2011).

Health of Harvested Species and Potential Contaminants

Metals can accumulate in the livers of moose. There is some concern that high metal levels in the organs of these mammals could lead to disease (INAC 2003). Further discussion on potential wildlife contamination is found in Section 3.1.9.13.

Distribution and Timing in Relation to Project Alternatives, Construction Activities and Operation

There are likely no major differences in local habitats between the Project route alternatives; however, Alternative 2 (Upland Route) likely crosses less preferential habitat as moose tend to seek riparian and willow habitat. The Primary 2009 Route, the route closest to the Husky Lakes, is located just within the Spring Moose Harvesting Area (Site No. 303B).

Minimal disturbance to moose is anticipated to occur during the construction and operations phases of the Project. The potential effects to moose and moose habitat from the Project are discussed in the Wildlife and Wildlife Habitat effects section (Section 4.2.7).

3.1.9.7 Grizzly Bear

Population Status and Distribution

Grizzly bear occur throughout the regional study area. For the Tuktoyaktuk-West Grizzly Bear Management Area, there was an estimated 214 bears over the age of two, occurring at a density of six bears per 1,000 km^2, compared to a density of seven to eight bears per 1,000 km^2 in the rest of the Inuvialuit Settlement Region (Nagy and Branigan 1998). In the Northwest Territories grizzly bear population levels are believed to have remained stable since 1991 (COSEWIC 2002). However, because of increased industrial development related to resource exploration and extraction activities and their low population densities, the northern populations of grizzly bears are considered vulnerable (COSEWIC 2002).

In the Mackenzie Delta, Edwards (2010) identified four subpopulations of grizzly bears which were identified as the Richards Island, Storm Hills, Eskimo Lakes, and the Tuktoyaktuk Peninsula subpopulations (Figure 3.1.9.-15). Edwards (2010) found that these four grizzly bear subpopulations were segregated based on seasonal geographical locations. Paetkau et al. (1998 in Edwards 2010) suggested that landscape components such as the parallel orientation of mountains and valleys, low-level wetlands, rivers, and deltas, may limit bear movements across the landscape. Within the Mackenzie Delta overall bear movement did not appear to be influenced by landscape components but landscape variability likely influenced the observed subpopulation structure (Edwards 2010). These features included the Beaufort Sea to the north and possibly the boreal forest to the south, Sitidgi and Eskimo Lakes, the Mackenzie channels, and the Delta.

Arctic grizzly bear populations are characterised by low density and large home range size, which may be an adaptation to the low primary productivity, high seasonality, and lower predictability of the ecosystem (Nagy and Haroldson 1990; Ferguson and McLoughlin 2000). Grizzly bears are highly mobile and able to move across large expanses creating a continuous distribution over broad geographic areas (Noss et al. 1996).

According to Edwards et al. (2009), the home ranges of 36 grizzly bears studied from April 1 to November 30 between 2003 and 2006 indicate that the annual home range estimate for males and females was 1,215 km^2 (range: 1,475 km^2 to 6,735 km^2) and 680 km^2 (range: 80 km^2 to 4,965 km^2), respectively. The location of the arithmetic mean centre of 54 annual home ranges for 36 bears is shown on Figure 3.1.9-16. The study identified the actual distances between mean daily locations, 12-months apart, and grouped into spring, summer, and fall seasons, but found no significant difference in fidelity among the seasons.

Edwards et al. (2009) also found that grizzly bears in the Mackenzie Delta did not exhibit fidelity to annual or seasonal home range areas although they did find that actual distances between home range centers for consecutive years were small for both male and female bears, at 7.7 km and 8.4 km, respectively. Edwards et al. (2009) calculated a 24.2% overlap for annual home ranges in consecutive years. Home range position and configuration had changed although the distance between arithmetic mean home range centers and the percent overlap between years were small (Edwards et al. 2009). Overall, the observed patterns of fidelity reflect the productivity of the habitat and the spatiotemporal variability of available resources.

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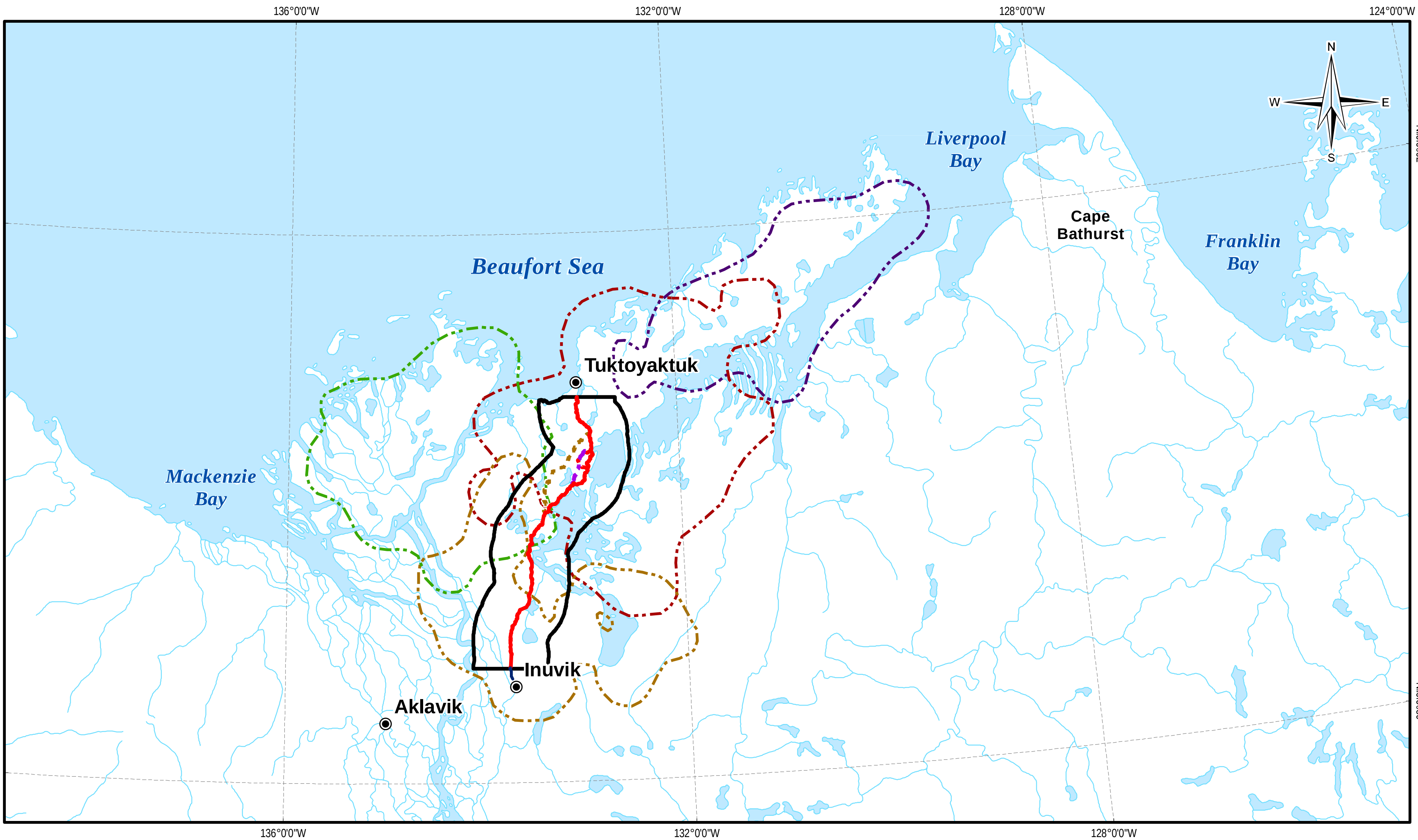


LEGEND

Grizzly Subpopulation

- Tuktoyaktuk Peninsula
- Eskimo Lakes
- Storm Hills
- Richards Islands

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road

- Watercourse
- Waterbody

NOTES

Base data source: National Atlas

Grizzly Subpopulations: Utilization distribution (95% fixed kernal contours) from Edwards, 2009

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map055_GrizzlyHabitat.mxd

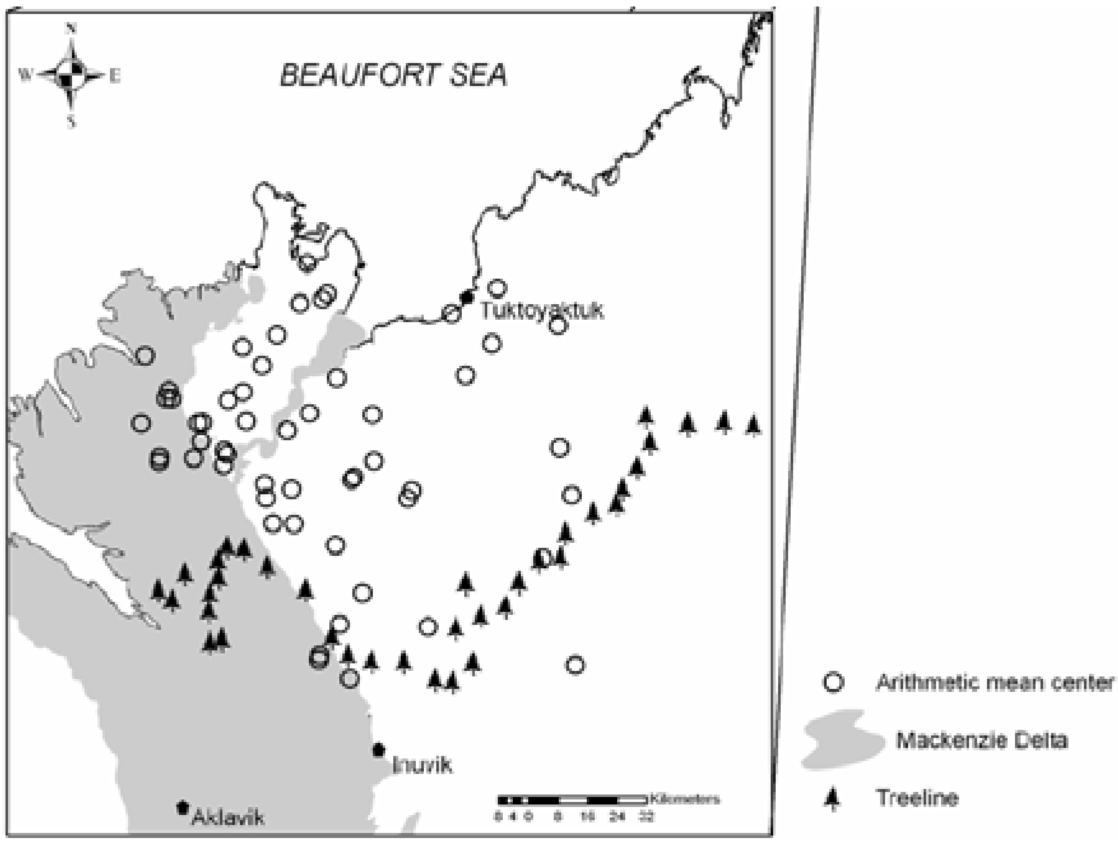
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Grizzly Bear Subpopulations
in the Mackenzie Delta

PROJECT NO.	DWN	CKD	REV
V23201322	SL	JM	0

OFFICE	DATE
EBA-VANC	May 9, 2011

Figure 3.1.9-15



Source: Edwards (2009)

Figure 3.1.9-16
Arithmetic Mean Centers for Annual Grizzly Bear Ranges in the Mackenzie Delta

The northern barren-ground grizzly bears have recruitment rates that are among the lowest known for terrestrial mammals (Edwards et al. 2009). Females do not typically reproduce until 6 to 10 years of age, litter sizes average 2 cubs/litter and the reproductive interval average is 3 years (GNWT 2011). McLoughlin and Messier (2001) found that grizzlies in the Northwest Territories and Nunavut had an average of 74% survival rate in their first year.

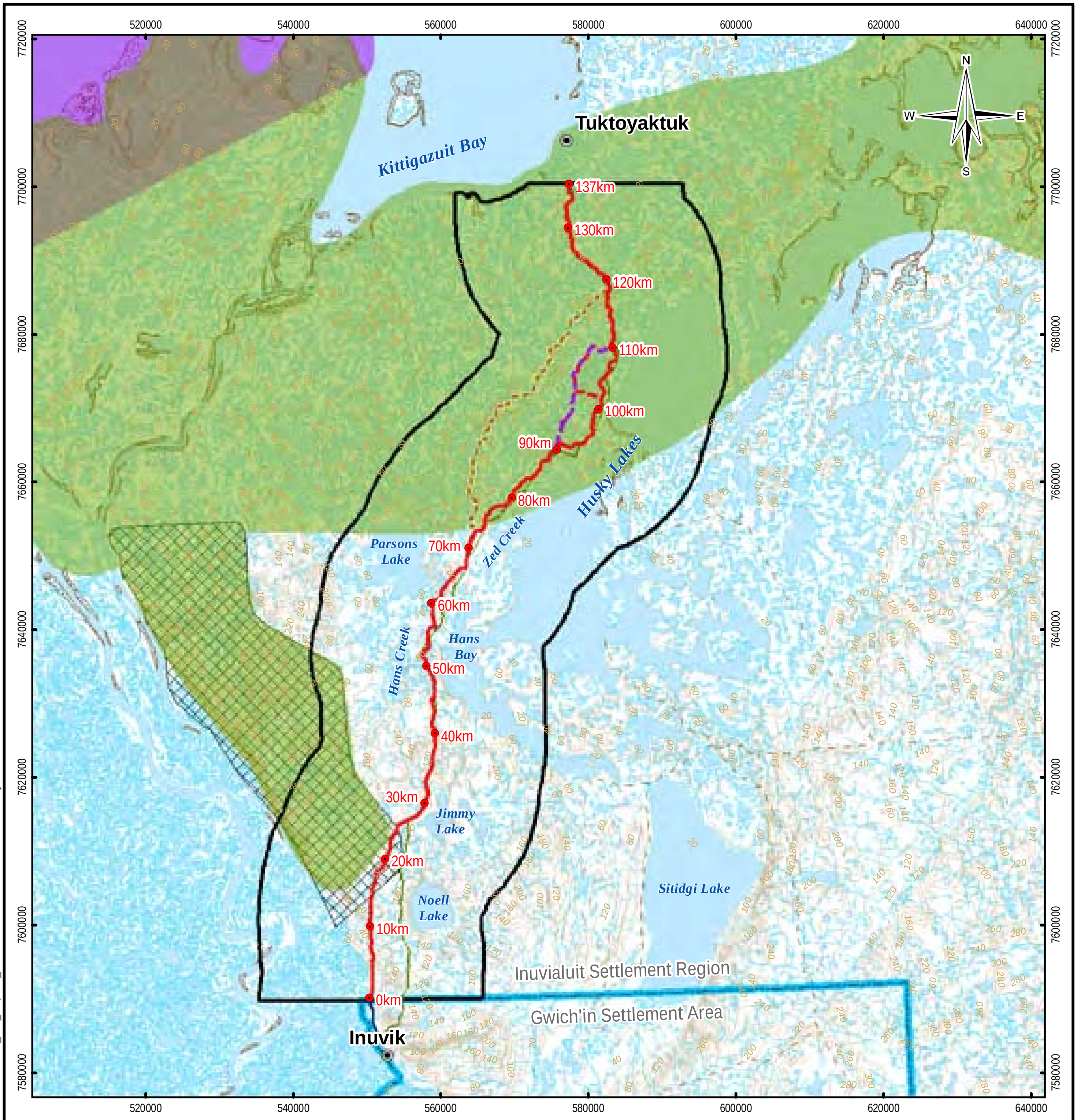
Habitat Requirements

The proposed Highway alignment occurs within the Grizzly Bear Denning Areas, site 322C (see Figure 3.1.9-17; Community of Tuktoyaktuk et al. 2008). Critical Grizzly bear denning areas are also shown on Figure 3.1.9-17. Important habitat areas for denning are major river drainages, eskers, and southerly slopes. Previous studies identified eskers as extremely important grizzly bear denning habitat in the central Arctic (Mueller 1995; Banci and Moore 1997). However, McLoughlin et al. (2002) found that of 56 grizzly den sites they surveyed in the central Arctic only seven of 56 den sites were situated in eskers. Heath tundra (23/56) and heath-boulder habitats with >30% boulder content (11/56) formed the majority (60%) of den sites. The remaining dens were in birch seep habitats (5/56), spruce forest (5/56) riparian tall shrub (3/56), and heath tundra habitat with >30% bedrock content (1/56). In addition, one den was situated in a non-vegetated sand embankment adjacent to a river.

Although McLoughlin et al. (2002) did not find eskers to be critical grizzly denning sites, this habitat type was selected more than expected by chance, given the low availability of eskers in the central Arctic. Of the dens surveyed most were on south-facing slopes and were constructed under cover of tall shrubs (McLoughlin et al. 2002). Steep slopes (>25%) with well-drained soils were favoured. Well-developed patches of dwarfbirch (*Betula nana*) and berry-producing shrubs were often observed at den sites on steep southerly-facing slopes (McLoughlin et al. 2002). McLoughlin et al. (2002) found dwarf birch and crowberry had the highest percent coverage of any plant species around den entrances. It is suspected that the roots of these shrubs may add to the structural integrity of den cavity ceilings.

During an aerial reconnaissance flight in mid-September 2009, EBA identified three freshly dug grizzly bear dens in the vicinity of KM 36 to 38 (Photo 3.1.9-3, see Map 08 of the Inuvik to Tuktoyaktuk 1:25,000 Map Book, Appendix D) and a number of old dens along the proposed Highway alignment.

Photo 3.1.9-3
Several freshly dug grizzly bear dens were documented, such as this one found on a south facing slope hidden amongst shrubs



LEGEND

- Critical Grizzly Bear Denning Areas
- Mainland Coastal Polar Bear Denning Areas
- Regional Study Area (15 km buffer)
- Gwich'in / Inuvialuit Boundary
- Caribou Hills
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Bear Denning Areas: GNWT ENR, February 2011

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Grizzly and Polar Bear Denning Areas

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map046_BearDenAreas.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Northwest Territories
Town of Inuvik
KIGGIAK - EBA

Figure 3.1.9-17

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According to the Community of Tuktoyaktuk et al. (2008) and the Community of Inuvik et al. (2008), some foods and areas may be more important than others from season to season, and from year to year. Within the Mackenzie Delta region the grizzly bear is considered a food-limited species as it occupies a region where the availability of quality protein-rich foods is low (Edwards 2010). Grizzly bears within the Delta benefit from a flexible foraging behaviour that allows them to switch to prey that provide greater energy return for search and handling efforts (Edwards et al 2010). In the central barrens, important parts of the grizzly bear diet include caribou, various berry and herbaceous plant species. Edwards et al. (2010) found that the primary diet of grizzly bears in the Mackenzie Delta consisted of horsetail (*Equisetum* spp.), grass, sedge (*Carex* spp.), sweetvetch (*Hedysarum* spp.) and all available berry species as well as caribou, moose and beaver.

Grizzly bears within the study area and in the central Arctic have also been observed hunting reindeer, muskrat, Arctic hare lemmings, voles, ground squirrels, which they excavate from burrows, and fish such as whitefish (*Coregonus* spp.) and longnose sucker (*Catostomus catostomus*) (Edwards et al. 2010 and Gau et al. 2001). Grizzlies are opportunistic predators and will kill moose or caribou if the occasion arises. Grizzlies are also carrion eaters and the carcasses of winter-killed animals may also provide a source of food in spring before vegetation is available. Mowat and Heard (2006) found that grizzly bears in Arctic regions that supported barren-ground caribou consistently showed the highest terrestrial meat consumption compared to other populations in North America. Population densities of two western Arctic grizzly bear populations with access to abundant caribou were reported to be greater than in a population with no such access (Reynolds and Garner 1987 in Mowat and Heard 2006).

At northern latitudes the grizzly bears must store enough energy reserves to last the six to seven months of winter dormancy. The long dormant period, delayed and short growing season of the region makes it difficult for grizzly bears to meet their requisite resource needs during the five to six month active period from May/June to October/November (Edwards 2006).

Seasonal Movements

Grizzly bear seasonal ranges are defined as an area utilized during spring, summer or fall but excludes the den site (Craighead 1974). Edwards (2010) identified three grizzly bear seasonal breaks based on changing habitat use within the Mackenzie Delta (Table 3.1.9-6). The following table summarizes grizzly bear seasonal EOSD habitat uses within the RSA. These habitats are based on habitats described by Edwards (2010) and were then translated to equivalent EOSD habitats.

TABLE 3.1.9-6 GRIZZLY BEAR SEASONAL EOSD HABITAT USES BY GENDER

Season	Female Habitat Use	Male Habitat Use
Season 1 (Den emergence – August 4)	• Exposed/barren land, bryoids • Shrub tall, mixedwood and broadleaf classes • Coniferous dense • Shrub low • Wetland herb	• Wetland herb, wetland shrub, wetland treed • Shrub tall, mixedwoord and broadleaf classes
Season 2 (August 5 – September 29)	• Exposed/ barren land, bryoids • Wetland herb, wetland shrub, wetland treed	• Wetland herb, wetland shrub, wetland treed • Exposed/ barren land, bryoids • Wetland herb • Coniferous dense
Season 3 (September 20 – Den entry)	• Exposed/ barren land, bryoids • Wetland herb, wetland shrub, wetland treed • Coniferous dense • Shrub tall, mixedwood and broadleaf classes	• Shrub tall, mixedwood and broadleaf classes • Wetland herb, wetland shrub, wetland treed

Source: Adapted from Edwards 2009

Based on empirical analysis of telemetry and historical data, Edwards (2010) produced a seasonal habitat selection model for both female and male grizzly bears within the Mackenzie Delta region. The model suggested that upon den emergence to August 4, preferred habitat for female grizzly bears could be found throughout the landscape including the low shrub upland habitats of the LSA while for the remaining two seasonal breaks preferred habitats for female grizzlies were more likely to occur along the Mackenzie River and Delta. The model also suggested that preferred habitats for male grizzlies were more likely to occur along the Mackenzie River and Delta during all three seasons identified.

Sensitive Time Periods

Four seasons identify the key annual life periods:

- Season 1 (den emergence – August 4);
- Season 2 (August 5 – September 29);
- Season 3 (September 20 – den entry); and
- Season 4 (denning).

These seasons are based on the phenology of food plants and the foraging and movement behaviour of grizzly bears within the Mackenzie Delta (Edwards 2010).

Den digging happens over an extended time period, when the land and lakes are not generally frozen. The actual time it takes for a bear to dig a den is not known but is likely relatively short in duration. Grizzly bears in the ISR typically den from October to May (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). In the Central Arctic, den entrance occurs primarily in the last two weeks of October with the majority of bears emerging from dens in the 1st week of May (McLoughlin et al. 2002). Dens generally collapse in the summer and are not reused.

Grizzly bears breed in June-July (Bamfield 1974). Due to delayed implantation, grizzly bear cubs are typically born between mid-January and early March while the female is still in her den (Bamfield 1974).

Harvest Pressures

The Mackenzie Delta is located within the Inuvialuit Settlement Region (ISR) and the Gwich'in Settlement Area (GSA). The ISR and GSA are divided into Grizzly Bear Management Areas where an allowable harvest is set for each area.

The grizzly bear hunt is controlled by a tag-issuing system where a target of 33% of the harvested bears should be female (GNWT ENR 2010h). After recent quota increases, the Inuvialuit Settlement Region has a quota of 56 bears per year that is distributed to local Hunter and Trapper Committees. The quota is implemented by the requirement for a tag to hunt grizzly bears. There is a total allowable harvest of 13 bears per year in the Tuktoyaktuk-West hunting area (I/GB/04) and nine bears per year in the Inuvik hunting area (I/GB/03). ENR annually provides a report on species under quota, including grizzly bears (GNWT ENR 2010h). Harvesting occurs within the RSA, mainly subsistence harvesting, but sport hunting is conducted out of Tuktoyaktuk. Harvest totals reported in 2005-2010 are 1 and 37 bears for Inuvik and Tuktoyaktuk-West (I/GB/04) respectively (GNWT ENR 2010h). Access to hunting areas is currently by snowmachine only.

Figure 3.1.9-18 shows the number of bears harvested by Tuktoyaktuk hunters between 2003 and 2008 based on the type of harvest and the sex of the bear and Figure 3.1.9-19 shows the grizzly bear harvest locations in the Tuktoyaktuk-West are (I/GB/04) for the same period.

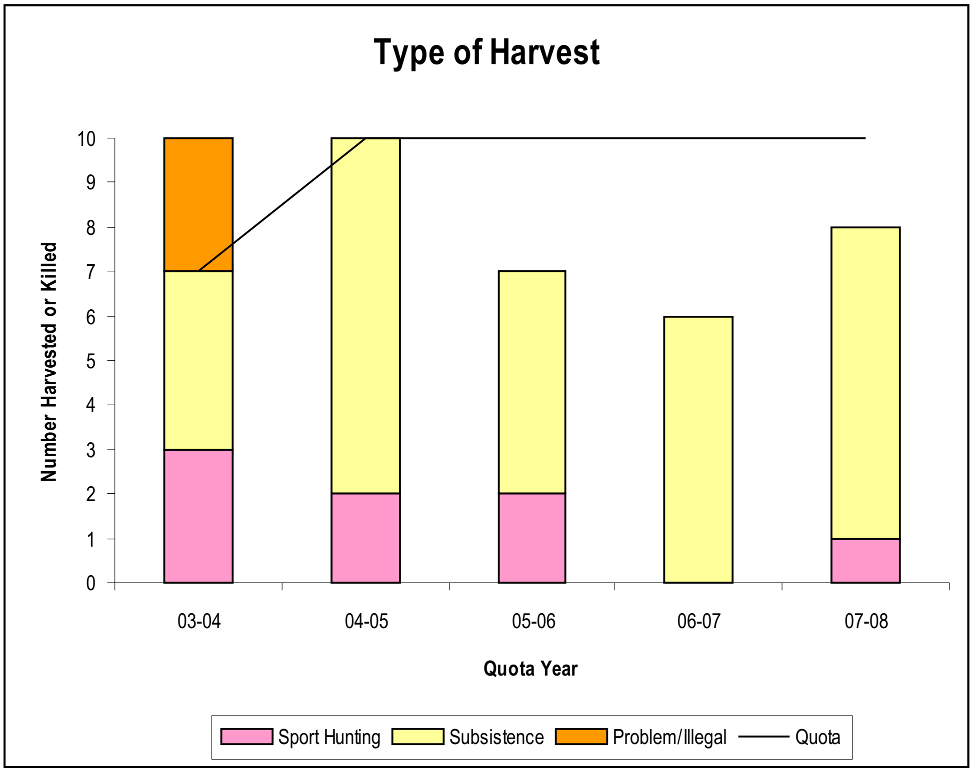
The Hunters and Trappers Committee by-laws that are written into the NWT *Wildlife Act* regulations provide a mechanism for ensuring industry-induced bear mortalities come off the quota. It is illegal for anyone to kill denning bears or bears with cubs.

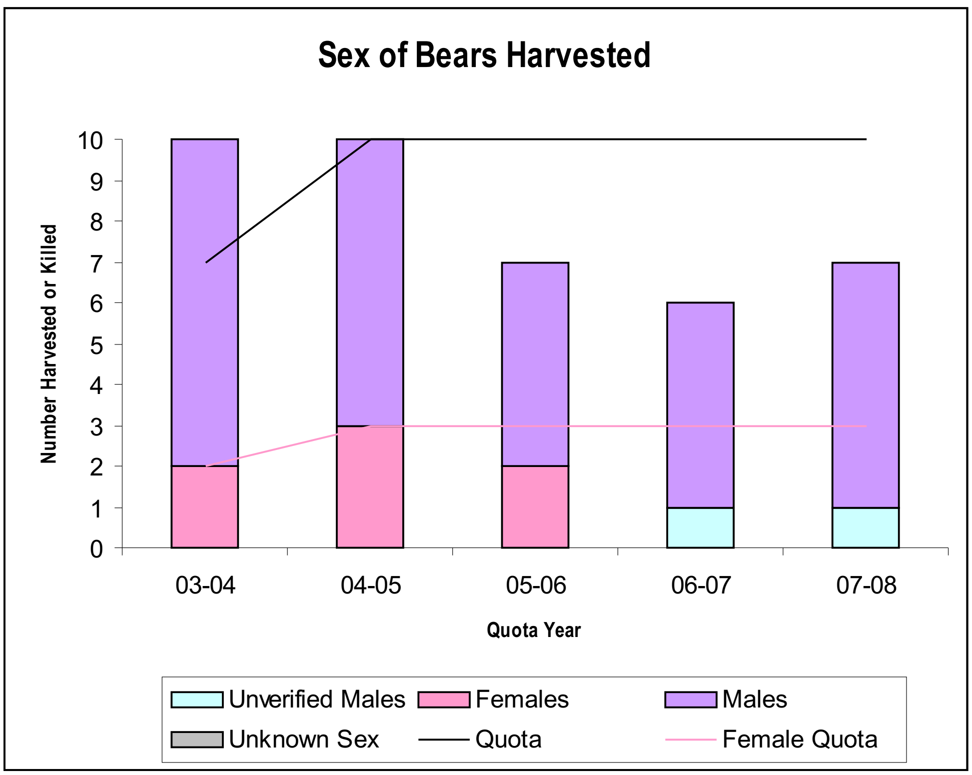
Grizzly bears in the ISR are co-managed under the *Inuvialuit Final Agreement* (IFA) by the following agencies and land claim organizations:

- Wildlife Management Advisory Council (NWT) (WMAC (NWT));
- Wildlife Management Advisory Council (North Slope) (WMAC (North Slope));
- Inuvialuit Game Council (IGC);
- Aklavik, Inuvik, Paulatuk, and Tuktoyaktuk Hunters and Trappers Committees (HTCs);
- GNWT, Department of Environment and Natural Resources (GNWT ENR);
- Government of the Yukon, Department of Environment (YTG DOE); and,
- Parks Canada.

Health of Harvested Species and Potential Contaminants

Further discussion on potential wildlife contamination is found in Section 5.1.9.11.





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NOTES
Source: GNWT ENR

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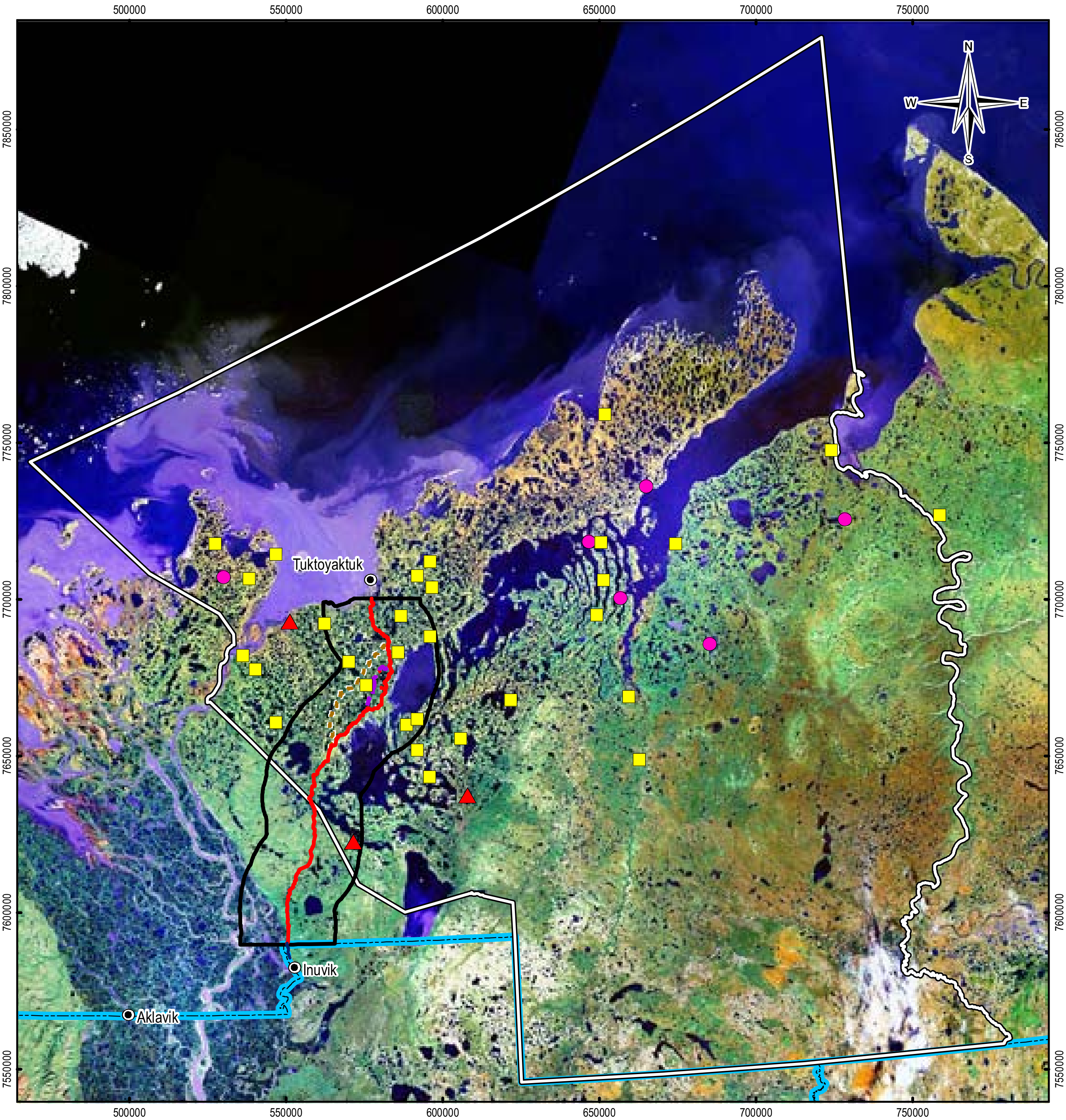
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENFVIRONMENTAL IMPACT STATEMENT

Grizzly Bear Harvest by Type and Sex July 2003 to June 2008

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.1.9-18



LEGEND

- Community
- Tuktoyaktuk West (I/GB/04)

Harvest Locations (approximate)

- Problem
- Sport
- Subsistence
- Gwich'in / Inuvialuit Boundary
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road

NOTES

Base data source: EarthSat Imagery
I/GB/04: NWT Centre for Geomatics, February 2011

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Tuktoyaktuk West (I/GB/04) Grizzly Bear Harvest Locations July 2003 to June 2008

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:1,800,000

20 10 0 20 40

Kilometres

FILE NO.
V23201322_EIS_Map047_GrizzlyHarvest.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.1.9-19

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Distribution and Timing in Relation to Project Alternatives, Construction Activities and Operation

According to Figure 3.1.9-15, the majority of grizzly bears occur west of the proposed Highway, within the Mackenzie Delta area; however, there is potential denning habitat throughout the length of the proposed Highway. Winter denning season is the time of greatest sensitivity of grizzly bears to disturbance, particularly for females with cubs. In winter, construction activities could disturb denning bears. Since bears do not use dens in the summer, summer construction activities will not affect denning.

Following the four winter seasons of construction, disturbance may occur at borrow sources that remain open for Highway maintenance work. Otherwise, den disturbance is not expected to occur during Highway operations.

The potential effects to grizzly bears and grizzly bear habitat from the Project are discussed in the Wildlife and Wildlife Habitat effects section (Section 4.2.7).

3.1.9.8 Wolverine

Population Status and Distribution

According to Community of Tuktoyaktuk et al. (2008), relatively few wolverine are present in the Mackenzie Delta region. The population estimate for wolverines in the Northwest Territories is unknown; however, GNWT ENR estimates that there are 1.6 to 3.7 per 1,000 km^2 for males and lower for females (GNWT ENR 2011c). Estimates suggest there is a stable but sparsely distributed population numbering in the thousands.

Home range sizes in the central Arctic vary between 126 km^2 (females) and 404 km^2 (males). Dispersal distances by females average 133 km (range 69-255 km) and males 231 km (range 73-326 km) (Community of Tuktoyaktuk et al. 2008). They live at low densities even under optimal conditions (Banci 1994). Reproductive rates are low and sexual maturity is delayed, in comparison with some (or most) other carnivores.

The proposed Highway is located within the Winter Wolverine Harvesting Area, Site 314C (Figure 3.2.8-11; Community of Tuktoyaktuk et al. 2008).

Important Habitat and Habitat Requirements

Wolverines are scavengers and predators of birds and small mammals, relying on a diversity of foods to offset the uncertainty of availability in the harsh northern environment. There appears to be a correlation between wolverine numbers, ungulate populations, and the presence of more (successful) efficient predators such as wolves (Van Zyll de Jong 1975).

Wolverine feed on dead animals, eggs, small and large mammals (lemmings, caribou and sheep). Most large mammal food sources are obtained as carrion from wolf or bear kill. Wolverines feed mainly on large game animals like caribou. However, the wolverine is more a scavenger than a hunter and will travel long distances in search of carrion or food caches. They also feed on small animals, ptarmigan, fish, roots and berries (GNWT ENR 2011a). The population is sensitive to fluctuations in large game populations.

Wolverines do not hibernate but they do construct dens. Dens are used to escape predators and for raising kits (GNWT ENR 2011a). Reportedly wolverine dens can vary from simple rest beds to complex natal dens with extensive tunnel networks (Pullianinen 1986 and Magoun 1985, as cited in Mulders 2000) and are frequently associated with rock scree slopes and large snowdrifts (Magoun 1985 and Bevanger 1992, as cited in Mulders 2000). Caves, rock crevices, fallen logs and holes in the snow and burrows are often used for shelter (Community of Inuvik et al. 2008).

According to Community of Tuktoyaktuk et al. (2008), the Husky Lakes and Finger Lakes areas are considered important habitat for wolverine.

Seasonal Movements

Wolverines are non-migratory (Government of Canada 2010).

Sensitive Time Periods

Wolverine breed in March to May and young emerge from June to July (Community of Tuktoyaktuk et al. 2008).

Harvest Pressures

Harvest pressures on wolverines have been increasing and are influenced by factors such as increased pelt prices and easier access into areas where hunting and trapping can occur (GNWT ENR 2011a). The Inuvialuit have exclusive rights to harvest wolverine and in recent years have allowed guided sport hunts of wolverines. Hunters have been providing carcasses from harvested animals for a number of years. Information and samples are being analyzed.

Health of Harvested Species and Potential Contaminants

Wolverines are important to northern communities, even though they are not consumed for food. In a study of contaminants in the Canadian Arctic, persistent organic pollutants were not of concern for wolverine from Kugluktuk, Nunavut. The PCB levels documented in wolverines were also documented as low (INAC 2003).

Further discussion on potential wildlife contamination is found in Section 5.1.9.11.

Distribution and Timing in Relation to Project Alternatives, Construction Activities and Operation

Home-range sizes are extensive, and vary between males and females. The proposed Highway is within the wolverine winter harvesting area (Figure 3.2.8-11). Construction and operation of the Highway itself is not expected to affect wolverine populations directly; however, improving access for hunting and trapping may have an indirect effect on wolverine populations. As well, there is potential that wolverines may also be attracted to the camps or scavenging along the Highway.

The potential effects to furbearers, including wolverine, from the Project are discussed in the Wildlife and Wildlife Habitat effects section (Section 4.2.7).

3.1.9.9 Red and Arctic Fox

Population Status and Distribution

Foxes are important furbearers in the region. The population status of Arctic and Red foxes can be highly variable from year to year (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Red fox habitat is typically considered widespread below the treeline (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008) with higher densities located there. Red foxes also occur sparsely on the southern tundra (GNWT ENR 2011b). Four red foxes and one old den site were observed during the aerial reconnaissance in mid-September 2009 (Photo 3.1.9-4).

Normal home ranges of Red fox vary between 5 and 35 km². Foxes may undertake long migrations in search of food, especially in years of low prey density and high fox numbers. The wide distribution of red foxes indicates that it is able to survive in a variety of habitats. Red foxes are most often found in semi-open country, such as natural clearings, river valleys, tundra and agricultural areas (GNWT ENR 2011b).

Arctic fox habitat is typically considered widespread above the treeline and throughout the arctic tundra; they inhabit both inland and coastal terrain (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008; GNWT ENR 2011b). The natural southern limit of its distribution is the treeline, but some Arctic foxes venture into the boreal forest, especially when their food decreases on the tundra. They also move extensively over the polar ice cap (GNWT ENR 2011b).

Each Arctic fox has its own home range, which varies in size from 3 to 25 km². However, Arctic foxes are very mobile and can travel great distances over land or sea ice. Movement by individuals of over 2,000 km has been recorded (GNWT ENR 2011b).

Photo 3.1.9-4
Red foxes commonly occur along the proposed Highway alignment

Important Habitat and Habitat Requirements

Foxes have a range of habitats including natural clearings, river valleys, tundra and agricultural areas (GNWT ENR 2011b). Habitat requirements are linked to food sources, such as carrion, birds and small mammals.

Denning habitat consist of well-drained, stable soils (Martell et al. 1984). Arctic fox den sites include areas that are gently sloping with sandy soil near rivers or lakes or on elevated areas free from permafrost. They typically are complex with multiple tunnels and entrances and are occupied in successive years (GNWT ENR 2011b).

Red fox prefer den sites in sandy soil along riverbanks and can use the same den more than once. The dens used by Red fox are not as complex as those used by Arctic fox.

Arctic fox feed on lemmings and voles which they find in tunnels or while travelling across the tundra. Arctic fox population is closely tied to the availability and population fluctuations of lemming. Other food sources include arctic hares, ptarmigan and carrion (i.e. scavenge for remains of wolf or polar bear kills). In summer Arctic fox add ground squirrels, hares, eggs and fish to their diet. Limited food resources can have a profound effect on Arctic fox numbers (GNWT ENR 2011b).

Red foxes are omnivorous, feeding on whatever is available, but chiefly mice. In the winter, their diet also includes muskrats, squirrels, hares and grouse. During the summer, they expand this diet to include birds' eggs, beetles and vegetable matter, such as grass and berries. Red foxes are also scavengers, eating garbage and carrion. Such versatility in switching to different food items is another factor which has enabled red foxes to be so widely distributed (GNWT ENR 2011b).

Seasonal Movements

Foxes typically have normal home ranges between 3 km² and 35 km²; however, as stated previously, both the arctic and the red foxes may undertake long migrations in search of food.

Sensitive Time Periods

Arctic fox breed in March, den in April and pups are active in May. Pups tend to stay near their den until October (Community of Tuktoyaktuk et al. 2008).

Red fox breed from February to April (Community of Inuvik et al. 2008), and pups are born between March and May (GNWT ENR 2011b). During mating, a den is dug or an existing burrow is found and prepared for habitation. Red fox families stay together until fall (Community of Tuktoyaktuk et al. 2008).

Harvest Pressures

Fox in NWT are harvested for their pelts and harvest records given are based on fur auction records. For Arctic fox, average harvest data from 1991 to 2009 was 706 foxes per year (with a low value of 37 animals harvested in 1994/1995 to a high value of 2,291 animals harvested in 1991/1992) (GNWT ENR NDb). For Red fox, average harvest data from 1991 to 2009 was 706 foxes per year (with a low value of 139 animals harvested in 2003/2004 to a high value of 1,171 animals harvested in 1997/1998) (GNWT ENR NDc).

Health of Harvested Species and Potential Contaminants

According to Community of Tuktoyaktuk et al. (2008), the population can be highly variable from year to year. There are potential concerns related to rabies. Rabies is the most common disease that affects foxes. Encephalitis and distemper are also fatal diseases, which are more prevalent during years with high numbers of foxes. Most foxes are infected with a variety of internal and external parasites (GNWT ENR 2011b).

Further discussion on potential wildlife contamination is found in Section 3.1.9.13.

Distribution and Timing in Relation to Project Alternatives, Construction Activities and Operation

According to Community of Tuktoyaktuk et al. (2008), Arctic fox are known to move great distances (e.g., Alaska to Banks Island). Both the Arctic fox and Red fox have widespread habitats, are very mobile, and have home ranges between 3-25 km² (Arctic fox) or 5-35 km² (Red fox). Given the adaptability of Red and Arctic fox and the range of habitats used by each, the conflicts anticipated from construction and operation are expected to be limited.

The potential effects to furbearers, including red and Arctic fox, from the Project are discussed in the Wildlife and Wildlife Habitat effects section (Section 4.2.7).

3.1.9.10 Other Mammals

The following section includes mammals that were not identified as VCs in this study but that are considered important wildlife species in NWT. As such, a brief discussion of each mammal has been included here.

Boreal Woodland Caribou

Boreal woodland caribou are listed by COSEWIC and SARA as Threatened, and by the NWT General Status Rank as Sensitive.

Boreal woodland caribou are dispersed over a large area throughout the boreal forest (GNWT ENR 2011), occurring along the Mackenzie Valley from the Northwest Territories/Alberta border north to the Mackenzie Delta (Olsen et al. 2001). Based on traditional knowledge and scientific studies, there are an estimated 6,000 to 7,000 boreal caribou in the NWT, which still occupy much of their historic range (GNWT ENR NDe). They occur throughout their range in low numbers. In the Inuvialuit region, GNWT ENR reported an estimated density of about 1 per 100 km^2 based on radio-collared caribou data during the period of 2005 and 2006 (GNWT ENR NDf).

The Town of Inuvik and the Husky Lakes are located on the northern edge of their distribution. Boreal woodland caribou typically prefer mature or old growth coniferous forests associated with bogs, lakes and rivers. GNWT ENR has collared boreal woodland caribou that have shown annual movements from south of the Highway to Husky Lakes verifying that some Boreal woodland caribou do live in the area, though this would not be considered year-round habitat.

Boreal caribou have been shown to be affected by linear development (GNWT ENR NDg); however, the density of linear development in the RSA is less than the threshold predicted to impact populations (Canadian Boreal Initiative 2007).

Black Bear

Black bears occupy much of the NWT, predominantly in forested habitats, including the forested area around Inuvik. The size of the NWT black bear population is unknown, but is estimated conservatively to be 10,000 (GNWT ENR 2011a). Black bear distribution is generally linked to treed environments, which provide security from predators such as grizzly bears, wolves, and other black bears as trees provide security, as visual cover for hiding, and escape for climbing (Herrero 1978). Dense shrub communities are also important for security, and are also used for bedding (Jonkel 1978).

Black bear habitat quality is also primarily related to the abundance and availability of seasonally important food items. Their diet consists mainly of vegetation; however, meat (particularly winter-killed ungulates), insects and possibly fish during the summer, may also be important.

After den emergence, bears favour areas with early-emerging vegetation such as wetlands dominated by sedges and cotton-grass. Grasses and horsetails are also important, and black bears may be found on sites such as meadows. Black bears typically dig dens in till material available on eskers, stream banks, or in natural cavities such as an upturned tree roots, crevices or caves.

Black bear denning habitat is limited to the forested area that occurs along the southernmost portion of the proposed Highway near Inuvik. Therefore, there may be some temporal overlap during the first season of construction and during the long-term operation of the Highway.

Wolf

Wolves are found in the vicinity of the proposed Highway. They are ecologically important predators and economically important furbearers. Wolf habitat and density is closely related to that of their prey, such as caribou and reindeer. They are often observed in association with barren-ground caribou, especially in the winter (Carruthers et al. 1986; McLean 1992; McLean and Jackson 1992). The wolf population appeared to decline in the 1950s, but recovered in the mid 1970s (Community of Tuktoyaktuk et al. 2008).

Habitat requirements include den sites, typically on steep slopes with stable soils, and as such, are susceptible to habitat displacement. In contrast to grizzly bears, roads may not cause wolves to avoid the area. Winter travel routes include game trails, ridges, seismic lines and frozen waterways. In deep fluffy snow, wolves find traveling difficult and any easier route, including roads or snowmachine trails are preferred (GNWT ENR NDd).

Wolves may occur in the area of the proposed Project however, it is not expected that the construction will affect wolves during the winter construction periods.

3.1.9.11 Species and Areas Subject to Exclusive or Preferential Rights Granted by Land Claims

The *Inuvialuit Final Agreement* (IFA) provides the Inuvialuit with certain harvesting rights to wildlife in the Western Arctic Region. The exercise of the Inuvialuit rights to harvest is subject to laws of general application respecting public safety and conservation. The IFA defines exclusive right to harvest as "the sole right to harvest the wildlife referred to in paragraphs Yukon - 12(24)(b) and (c) and Western Arctic Region - 14(6)(b) to (d), to be allocated the total allowable harvest and to permit non-Inuvialuit to harvest any such wildlife."

Section 14(6)(b), subject to the qualifications set out in subsections (15) to (18) of the Agreement, sets out the harvesting rights as:

(a) the preferential right to harvest all species of wildlife, except migratory non-game birds and migratory insectivorous birds, for subsistence usage throughout the Western Arctic Region;

(b) the exclusive right to harvest furbearers, including black and grizzly bears, throughout the Western Arctic Region;

(c) the exclusive right to harvest polar bear and muskox throughout the Western Arctic Region; and

(d) the exclusive right to harvest game on Inuvialuit lands and, if agreed on, other areas.

Under Section 14.(7), where harvesting rights are extended to other native peoples pursuant to subsections (15) to (18), their requirements as to subsistence usage shall be taken into account when setting subsistence quotas and the subsistence quotas and subsistence requirements of all the native peoples shall be accommodated within conservation limits. Where, in the exercise of their exclusive right to harvest referred to in paragraphs (6)(b), (c) and (d), the Inuvialuit permit persons other than natives to harvest, harvesting by those persons shall be subject to the laws of general application.

As well, the *Gwich'in Comprehensive Land Claim Agreement* (1992) provides the Gwich'in with certain harvesting rights to wildlife in the Western Arctic Region. In particular, according to Sections:

27.2.3 The Gwich'in have the right to harvest those species of wildlife which they have traditionally harvested within those areas of the Western Arctic Region which have been traditionally used by the Gwich'in to harvest wildlife.

27.2.4 The rights of the Gwich'in to harvest wildlife pursuant to 27.2.3 are subject to legislation applicable to Inuvialuit harvesters pursuant to the *Inuvialuit Final Agreement*.

3.1.9.12 Habitat Fragmentation

The total length of semi-permanent or permanent linear features within an area provides information on the extent of fragmentation or disturbance to a landscape. Some wildlife species may alter their behavior based on openings in forest canopy or ground cover and linear features on the landscape may affect wildlife movements. Some animals use linear features as transportation corridors. Other species avoid the openings. Once an area is opened, there is increased chance that people will use the linear feature as a new access point into previously inaccessible areas, increasing human presence for hunting and recreation (GNWT and NWT Biodiversity Team 2010).

The proposed Highway is primarily located in the tundra, and does not involve the creation of openings in forest canopy. The extent of linear disturbance in the NWT (less than 1 km/100 km^2) is much less than in other areas in Canada. For example, road density in the British Columbia portion of the Taiga Plains is 52 km/100 km^2. The average road density in Alaska is 1.5 km/100 km^2.

Fragmentation density levels are measured in km^2 by km^2. Human features included are communities, mines, oil-gas wells, pipelines (all below ground), seismic lines, all-weather roads, winter roads, power stations, power lines, and the Canol Trail. A level of 0.6 km^2/km^2 means that in an Ecoregion, an animal, such as a caribou, has a 60% chance of being within a buffer zone near a human feature.

Historic human-caused disturbances to vegetation in the Regional Study Area were limited to small sites or resulted in minimal impacts. The level of fragmentation and connectivity are considered to be insignificant. Human-caused disturbances in the RSA include:

Ikhil Gas Development and Pipeline – The gas production facility is located 50 km north of Inuvik in the Caribou Hills. The pipeline is a 6 inch buried pipeline. The buried pipeline approaches the proposed Highway alignment at KM 5 and parallels the alignment to the ISR boundary.

Tuktoyaktuk Source 177 Access Road – is a 19 gravel road from Tuktoyaktuk to a community borrow source. The road was completed in the summer of 2010.

Winter Access Trails – Several routes are established every winter from Tuktoyaktuk to the Husky Lakes area and from Inuvik to the Husky Lakes area. These trails do not result in vegetation changes and are partially over frozen water.

Former Northern Canada Power Commission Power Line – a 144 km wooden pole power line ran from Inuvik to Tuktoyaktuk from 1972 until the late 1980s. The power line was salvaged and little evidence of the line remains.

Oil and Gas Exploration Drilling – Gulf Oil drilled several exploratory wells in the early 1970s.

Oil and Gas Geophysical Activities – Seismic exploration has occurred since the 1960s across the ISR. In the Parsons Lake area about 1.5% of the 41,105 ha was subjected to seismic lines and associated activities. As these activities were conducted in the winter on frozen ground and water, limited change to vegetation occurred. The vegetation along seismic lines appears to have a different colour from the air but little physical evidence remains on the ground.

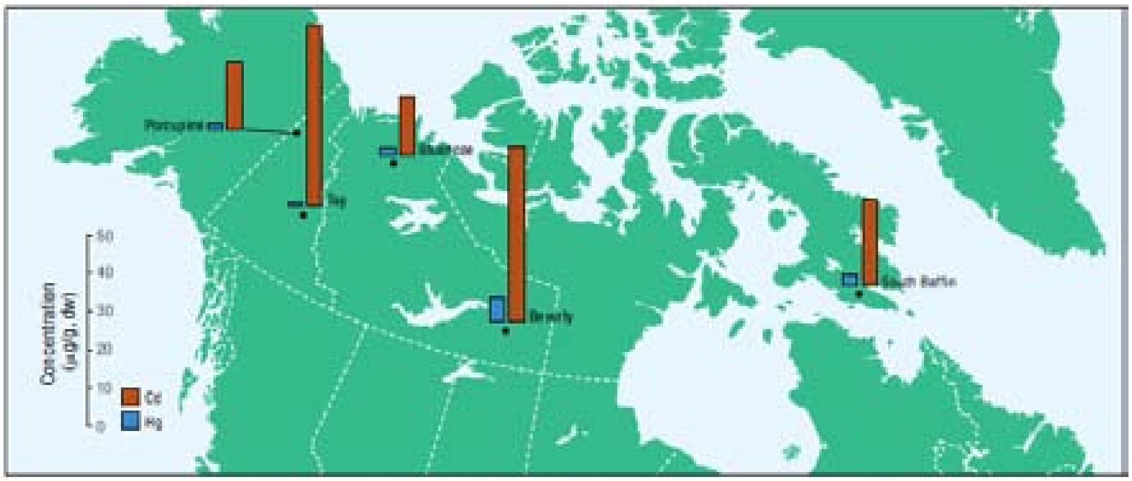
3.1.9.13 Contaminants and Wildlife

The Northern Contaminants Program is a national monitoring program that tracks contaminants in the air, water, wildlife and environment. The program was established in 1991 in response to concerns about potential elevated levels of contaminants in fish and wildlife species that are important to the traditional diets of northern Aboriginal peoples, and their possible exposure (INAC 2003). Modern day contaminant products and by-products are detected in the Arctic, often far from the source of the pollution. Once in the Arctic, contaminants accumulate in the plants and animals of the region, which are used by Aboriginal peoples for nourishment (Lambden et al. 2007).

Levels of organochlorines (OCs), metals and radionuclides are described in the Canadian Arctic Contaminants and Health Assessment Report (INAC 2003). Since that report, there has been very little data generated for terrestrial mammals as the levels of contaminants were considered very low (INAC 2003).

During the 1990s metal data samples were taken from the kidneys and livers of caribou from a total of 15 herds across the Canadian Arctic. A multi-element analysis was conducted, the concentration of Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cobalt (Co), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silicon (Si), Strontium (Sr), Tellurium (Te), Thorium (Th), Tin (Sn), Thallium (TI), Uranium (U) and Vanadium (V) were all below detection limits. Of the major elements Aluminum (Al), Cadmium (Cd), Copper (Cu), Chromium (Cr), Iron (Fe), Lead (Pb), Manganese (Mn), total Mercury (Hg) and Zinc (Zn), only cadmium, total mercury and zinc increase significantly with age (INAC 2003). The cadmium and mercury concentrations can be observed in Figure 3.1.9-20. From

Figure 3.1.9-20 it can be observed that the Bluenose caribou herd, located closest to the proposed Highway, has lower levels of mercury and cadmium compared to other Canadian Arctic locations.



Source: INAC (2003)

Figure 3.1.9-20
Concentration of Mercury and Cadmium in the Liver of Caribou from the Canadian Arctic

Specific levels of contaminants for other mammals occupying the region surrounding the proposed Highway were not available. In general, terrestrial mammals in the NWT are generally found to have lower concentrations of pollutants than animals from more southern species or marine species (GNWT ENR NDa).

3.1.10 Birds and Habitat

This section of the document focuses on avian (bird) species likely to be found within the Local and Regional Study Area and is based on a review of background information and traditional knowledge, and the results of field studies.

There are potentially 108 species of birds occurring within the Regional Study Area (Table 3.1.10-1). The local and regional abundance and distribution of these species varies considerably depending on habitat availability. Some may only rarely occur and do not routinely breed in the area. The majority of these species migrate to southern wintering areas.

TABLE 3.1.10-1 BIRD SPECIES POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA[1]			
Common Name[2]	**Scientific Name**	**COSEWIC Status**	**NWT General Status Rank[3]**
Red-throated Loon	*Gavia stellata*	Not Listed	Secure
Common Loon	*Gavia immer*	Not at Risk	Secure
Yellow-billed Loon	*Gavia adamsii*	Not at Risk	Undetermined
Pacific Loon	*Gavia pacifica*	Not Listed	Secure
Horned Grebe	*Podiceps auritus*	Special Concern	Sensitive
Red-necked Grebe	*Podiceps grisegena*	Not at Risk	Secure
Tundra Swan	*Cygnus columbianus*	Not Listed	Secure
Greater White-fronted Goose	*Anser albifrons*	Not Listed	Secure
Snow Goose	*Chen caerulescens*	Not Listed	Secure
Canada Goose	*Branta canadensis*	Not Listed	Secure
Brant	*Branta bernicla*	Not Listed	Sensitive
Mallard	*Anas platyrhynchos*	Not Listed	Secure
Northern Pintail	*Anas acuta*	Not Listed	Sensitive
Gadwall	*Anas strepera*	Not Listed	Undetermined
American Wigeon	*Anas americana*	Not Listed	Secure
Northern Shoveler	*Anas clypeata*	Not Listed	Secure
Green-winged Teal	*Anas crecca*	Not Listed	Secure
Lesser Scaup	*Aythya affinis*	Not Listed	Sensitive
Greater Scaup	*Aythya marila*	Not Listed	Secure
Canvasback	*Aythya valisineria*	Not Listed	Secure
Long-tailed Duck	*Clangula hyemalis*	Not Listed	Sensitive
King Eider	*Somateria spectabilis*	Not Listed	Sensitive
Common Eider	*Somateria mollissima*	Not Listed	Sensitive
Surf Scoter	*Melanitta perspicillata*	Not Listed	Sensitive
White-winged Scoter	*Melanitta fusca*	Not Listed	Sensitive
Common Goldeneye	*Bucephala clangula*	Not Listed	Secure
Red-breasted Merganser	*Mergus serrator*	Not Listed	Secure
Northern Harrier	*Circus cyaneus*	Not at Risk	Secure
Northern Goshawk	*Accipiter gentilis*	Not Listed	Secure
Rough-legged Hawk	*Buteo lagopus*	Not at Risk	Secure

TABLE 3.1.10-1 BIRD SPECIES POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA[1]			
Common Name[2]	**Scientific Name**	**COSEWIC Status**	**NWT General Status Rank[3]**
Golden Eagle	*Aquila chrysaetos*	Not at Risk	Secure
Bald Eagle	*Haliaeetus leucocephalus*	Not at Risk	Secure
Merlin	*Falco columbarius*	Not at Risk	Secure
Tundra/ Anatum Peregrine Falcon	*Falco peregrinus anatum/ tundrius complex*	Special Concern	Sensitive
Gyrfalcon	*Falco rusticolus*	Not at Risk	Secure
Sharp-tailed Grouse	*Tympanuchus phasianellus*	Not Listed	Secure
Spruce Grouse	*Falcipennis canadensis*	Not Listed	Secure
Rock Ptarmigan	*Lagopus muta*	Not Listed	Secure
Willow Ptarmigan	*Lagopus lagopus*	Not Listed	Secure
Sandhill Crane	*Grus canadensis*	Not at Risk	Secure
Black-bellied Plover	*Pluvialis squatarola*	Not Listed	Sensitive
American Golden-Plover	*Pluvialis dominica*	Not Listed	Sensitive
Semipalmated Plover	*Charadrius semipalmatus*	Not Listed	Secure
Lesser Yellowlegs	*Tringa flavipes*	Not Listed	Sensitive
Spotted Sandpiper	*Actitis macularius*	Not Listed	Secure
Whimbrel	*Numenius phaeopus*	Not Listed	Sensitive
Hudsonian Godwit	*Limosa haemastica*	Not Listed	Sensitive
Ruddy Turnstone	*Arenaria interpres*	Not Listed	Sensitive
Sanderling	*Calidris alba*	Not Listed	Sensitive
Dunlin	*Calidris alpina*	Not Listed	Sensitive
White-rumped Sandpiper	*Calidris fuscicollis*	Not Listed	Secure
Baird's Sandpiper	*Calidris bairdii*	Not Listed	Secure
Semipalmated Sandpiper	*Calidris pusilla*	Not Listed	Sensitive
Least Sandpiper	*Calidris minutilla*	Not Listed	Sensitive
Pectoral Sandpiper	*Calidris melanotos*	Not Listed	Secure
Long-billed Dowitcher	*Limnodromus scolopaceus*	Not Listed	Sensitive
Short-billed Dowitcher	*Limnodromus griseus*	Not Listed	Undetermined
Wilson's Snipe	*Gallinago delicata*	Not Listed	Undetermined
Red-necked Phalarope	*Phalaropus lobatus*	Not Listed	Sensitive
Red Phalarope	*Phalaropus fulicaria*	Not Listed	Sensitive

TABLE 3.1.10-1 BIRD SPECIES POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA[1]			
Common Name[2]	**Scientific Name**	**COSEWIC Status**	**NWT General Status Rank[3]**
Pomarine Jaeger	*Stercorarius pomarinus*	Not Listed	Undetermined
Parasitic Jaeger	*Stercorarius parasiticus*	Not Listed	Undetermined
Long-tailed Jaeger	*Stercorarius longicaudus*	Not Listed	Undetermined
Sabine's Gull	*Xema sabini*	Not Listed	Secure
Bonaparte's Gull	*Larus philadelphia*	Not Listed	Secure
Mew Gull	*Larus canus*	Not Listed	Secure
Herring Gull	*Larus argentatus*	Not Listed	Secure
Thayer's Gull	*Larus thayeri*	Not Listed	Secure
Glaucous Gull	*Larus hyperboreus*	Not Listed	Secure
Arctic Tern	*Sterna paradisaea*	Not Listed	Secure
Short-eared Owl	*Asio flammeus*	Special Concern	Sensitive
Northern Hawk Owl	*Surnia ulula*	Not at Risk	Secure
Great Horned Owl	*Bubo virginianus*	Not Listed	Secure
Snowy Owl	*Bubo scandiacus*	Not at Risk	Secure
Northern Flicker	*Colaptes auratus*	Not Listed	Secure
Alder Flycatcher	*Empidonax alnorum*	Not Listed	Secure
Northern Shrike	*Lanius excubitor*	Not Listed	Secure
Gray Jay	*Perisoreus canadensis*	Not Listed	Secure
Common Raven	*Corvus corax*	Not Listed	Secure
Tree Swallow	*Tachycineta bicolor*	Not Listed	Secure
Bank Swallow	*Riparia riparia*	Not Listed	Secure
Cliff Swallow	*Petrochelidon (Hirundo) phyrrhonota*	Not Listed	Secure
Black-capped Chickadee	*Poecile atricapillus*	Not Listed	Secure
Boreal Chickadee	*Poecile hudsonica*	Not Listed	Sensitive
Gray-headed Chickadee	*Poecile cincta*	Not Listed	May Be At Risk
American Robin	*Turdus migratorius*	Not Listed	Secure
Gray-cheeked Thrush	*Catharus minimus*	Not Listed	Secure
American Pipit (Water Pipit)	*Anthus rubescens*	Not Listed	Sensitive
Bohemian Waxwing	*Bombycilla garrulus*	Not Listed	Secure
Orange-crowned Warbler	*Vermivora celata*	Not Listed	Secure

TABLE 3.1.10-1 BIRD SPECIES POTENTIALLY OCCURRING WITHIN THE REGIONAL STUDY AREA[1]			
Common Name[2]	**Scientific Name**	**COSEWIC Status**	**NWT General Status Rank[3]**
Yellow Warbler	*Dendroica petechia*	Not Listed	Secure
Yellow-rumped Warbler	*Dendroica coronata*	Not Listed	Secure
Blackpoll Warbler	*Dendroica striata*	Not Listed	Sensitive
Northern Waterthrush	*Seiurus noveboracensis*	Not Listed	Secure
Wilson's Warbler	*Wilsonia pusilla*	Not Listed	Secure
American Tree Sparrow	*Spizella arborea*	Not Listed	Sensitive
Chipping Sparrow	*Spizella passerina*	Not Listed	Secure
Savannah Sparrow	*Passerculus sandwichensis*	Not Listed	Secure
Fox Sparrow	*Passerella iliaca*	Not Listed	Secure
White-crowned Sparrow	*Zonotrichia leucophrys*	Not Listed	Secure
Dark-eyed Junco	*Junco hyemalis*	Not Listed	Secure
Lapland Longspur	*Calcarius lapponicus*	Not Listed	Secure
Smith's Longspur	*Calcarius pictus*	Not Listed	Undetermined
Snow Bunting	*Plectrophenax nivalis*	Not Listed	Secure
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Sensitive
White-winged Crossbill	*Loxia leucoptera*	Not Listed	Secure
Common Redpoll	*Carduelis flammea*	Not Listed	Secure
Hoary Redpoll	*Carduelis hornemanni*	Not Listed	Undetermined

[1] This species list is based on range maps from Birds of North America (Cornell Lab of Ornithology 2011) and Sibley Guild to Birds (Sibley 2003).

[2] Species are listed in phylogenetic order (Sibley 2003).

[3] GNWT ENR's General Status Ranks (Working Group on General Status of NWT Species 2011).

3.1.10.1 Species at Risk

The federal *Species at Risk Act* (SARA) was adopted in 2002 and the territorial *Species at Risk (NWT) Act* came into effect in 2010. The purpose of these Acts is to: prevent wildlife species from being extirpated or becoming extinct; to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity; and, to manage species of special concern to prevent them from being endangered or threatened.

Schedule 1 of the federal SARA provides lists of wildlife species at risk that include mammals, birds, reptiles, amphibians, fish, lepidopterans, plants, lichens, mosses and molluscs. Species listed as Threatened under Schedule 1 must have recovery strategies prepared for the conservation of the species and its habitat within three years of listing while species of Special Concern must have management plans prepared.

Species whose known ranges overlap the Project corridor that are protected by SARA include the Eskimo curlew (Schedule 1 Endangered), the anatum subspecies of Peregrine Falcon (Schedule 1 Threatened) and the Rusty Blackbird (Schedule 1 Special Concern)(Government of Canada 2011). In 2007, COSEWIC re-assessed the Peregrine Falcon and recommended that *Falco pereginus anatum* and *Falco pereginus tundrius* subspecies be listed as Special Concern on SARA. An extended public consultation is underway but no formal decision has been made. The short eared owl and horned grebe have been assessed by COSEWIC and Special Concern.

3.1.10.2 Valued Components

Valued Components (VCs) are typically selected to represent the range of important biological conservation values existing within the RSA. This process requires selecting indicator species to serve as VCs.

Selection of avian VC species in this EIS is based on species, or species groups, that are considered important to stakeholders and researchers. VCs were selected from Table 3.1.10-1 using the following categories:

- Species listed on Schedule 1 of SARA;
- Species assessed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC), other than those assessed as not at risk;
- Species assessed with an NWT General Status Rank other than Secure; and
- Species that are likely of high importance for subsistence/country foods.

The VCs that will form the list for the baseline are summarized below in Table 3.1.10-2.

TABLE 3.1.10-2: BIRD SPECIES CATEGORIZED AS VALUED COMPONENTS

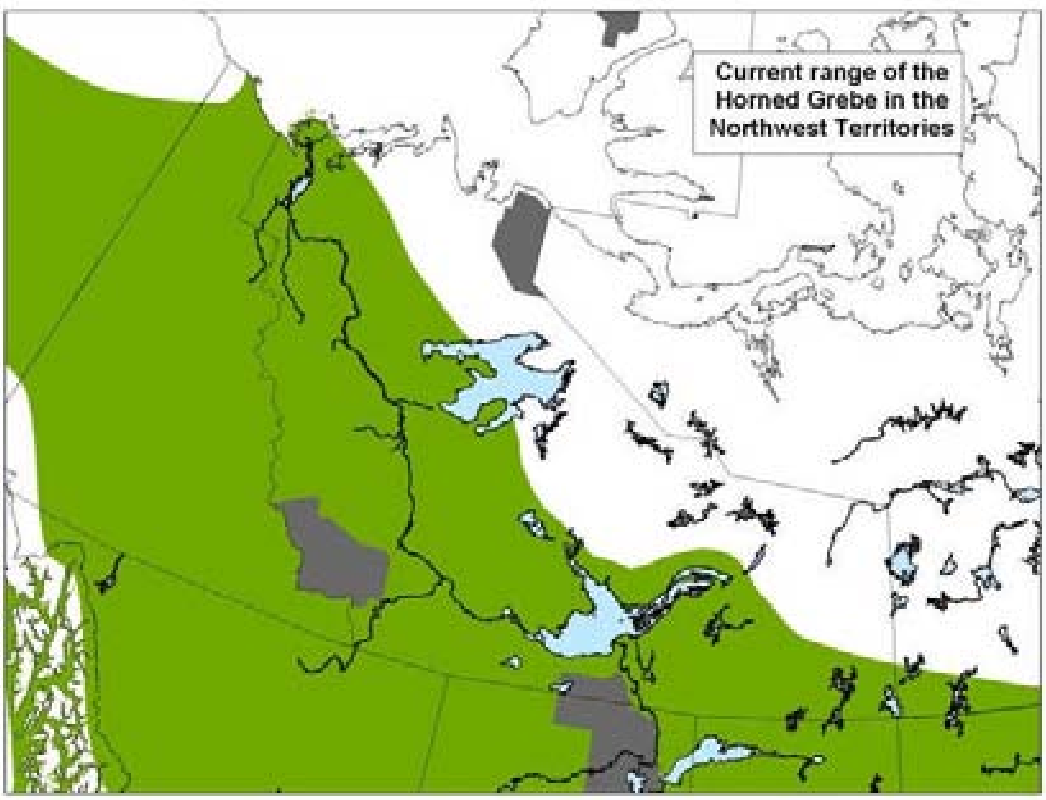
Common Name	Scientific Name	SARA (Schedule 1)	COSEWIC Status	NWT General Status Rank
Horned Grebe	*Podiceps auritus*	--	Special Concern	Sensitive
Tundra Swan	*Cygnus columbianus*	--	Not Listed	Secure
Greater White-fronted Goose	*Anser albifrons*	--	Not Listed	Secure
Snow Goose	*Chen caerulescens*	--	Not Listed	Secure
Canada Goose	*Branta canadensis*	--	Not Listed	Secure
Mallard	*Anas platyrhynchos*	--	Not Listed	Secure
Northern Pintail	*Anas acuta*	--	Not Listed	Sensitive
Peregrine Falcon	*Falco peregrinus tundrius/anatum*	Threatened	Special Concern	Sensitive
Rock Ptarmigan	*Lagopus muta*	--	Not Listed	Secure
Willow Ptarmigan	*Lagopus lagopus*	--	Not Listed	Secure
Short-eared Owl	*Asio flammeus*	--	Special Concern	Sensitive
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern	Sensitive

3.1.10.3 Horned Grebe

Population Status and Trends, Distribution, Abundance,

Horned grebe primarily breeds in the Prairie region, but is also known to breed in British Columbia, Yukon, the Mackenzie River Valley in the NWT, southern Nunavut, northwestern Ontario, and the Magdalen Islands (Government of Canada 2009). According to a 2009 COSEWIC report for trends from 1966 and 2005 (GNWT ENR 2009a), horned grebe populations have declined by 66%.

Main threats to the population are uncertain; however, wetland loss is suspected to be a threat. Climate change may be linked to wetland loss through drought or changes in water quality. Other potential threats include increases in nest predation by crows, ravens, magpies, gulls, mink and foxes; as well as chick predation by northern pike and gulls (GNWT ENR 2011a). Horned grebe populations have decreased in their wintering areas but similar decreases are not evident in the NWT. The current range of horned grebe in the NWT is shown in Figure 3.1.10-1.



Source: GNWT ENR (2011a)

Figure 3.1.10-1
Current Range of the Horned Grebe in the NWT

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Horned grebes are associated with aquatic habitat during all of their life stages and are therefore thought to be a good indicator of wetland ecosystem health (GNWT ENR 2011a). Horned grebes migrate to the NWT in May; their eggs hatch in mid-June and July. Adults leave NWT by mid-August and their young leave by early September and winter along the Pacific and Atlantic Coasts of North America (GNWT ENR 2011a). Horned grebes eat aquatic insects, small fish and crustaceans.

Known Issues with Respect to Health of Harvested Species (e.g. parasites, diseases, condition)

As horned grebes are not a species that is typically harvested for subsistence, information related to the health of harvested species could not be found.

Harvest Pressures

Horned grebes are not described as a species that is harvested for country food or subsistence (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

3.1.10.4 Tundra Swan

Population Status and Trends, Distribution, Abundance

The timing of Tundra Swan migration to and from the NWT is related to the availability of open water and freeze up (Community of Inuvik et al. 2008). Swans winter along the east coast of the United States and arrive in the NWT in May. Swans lay their eggs in June but remain on the nest until mid-August. Swans will stay near nesting areas until migration in fall (September).

The Tundra Swan is the most common swan in Canada and the size of the population is estimated at 140,000 individuals (Environment Canada 1998). Mean annual density of swans on the Mackenzie Delta between 1989 and 1996 was 0.83/km², with a range of 0.57 to 1.13 swans/km² (IOL et al. 2004). The tundra swan population has reportedly been increasing or stable in recent years (IOL et al. 2004; Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Breeding habitat consists of tundra lakes, ponds and pools in coastal deltas (IOL et al. 2004). Swans occur less frequently inland and rarely breed in forested areas in the Mackenzie Delta (Martell et al. 1984, as cited in IOL et al. 2004). Swans prefer marshy areas with a supply of aquatic plants. Tundra Swan are solitary nesters and defend a large territory that can be greater than 2 km². Suitable nesting habitat is often located close to a tundra pond or lake large enough to provide a food source for young swans but not too large to defend against other breeding pairs (Environment Canada 1998). Adults start to moult in late summer after the eggs hatch and leave moulting areas in late September to early October to begin migration (IOL et al. 2004).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

There are records of tundra swan deaths in Ontario related to an infection with a trematode parasite, *Sphaeridiotrema globulus* (Canadian Cooperative Wildlife Health Centre 1996). Information on the potential presence of this infection in NWT swan populations was not available.

No health issues were identified by Community of Tuktoyaktuk et al. (2008) and Community of Inuvik et al. (2008).

Harvest Pressures

Swans are harvested as an important food source in spring and the down is used for pillows and blankets. In the 1980s, tundra swan hunting was banned or restricted to protect the species for conservation purposes (Environment Canada 1998; ICC et al. 2006).

According to Inuvik Community Corporation et al. (2006), residents reportedly prefer to harvest ducks or geese instead of swans. Swans are harvested when there are no ducks available or when geese change their migration routes away from the area.

Detailed information regarding harvest levels is found in Section 3.2.8.

3.1.10.5 Greater White-fronted Goose ("Yellow legs")

Population Status and Trends, Distribution, Abundance,

White-fronted geese overwinter in coastal Texas and Mexico. They occur along the Mackenzie Valley during spring and fall migration (IOL et al. 2004). They leave their wintering grounds in early February to March and arrive in the Mackenzie Delta between May and June (Community of Inuvik et al. 2008).

The mid-continent population size of greater white-fronted geese is 700,000 or more and the most populated area is the Beaufort Sea area between the Mackenzie River and Anderson River deltas. The mid-continent population appears to be either stable or increasing and density estimates for the Mackenzie Delta between 1989 and 1993 average 1.54 geese/km² and 0.28 breeding pairs/km².

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

White-fronted geese nest in coastal and upland areas and feed on seeds and grass (Community of Inuvik et al. 2008). The main habitats of geese are the Kendall Island Bird Sanctuary, the Mackenzie River, and anywhere along the coast or Mackenzie River Delta – from the Yukon in the west to past Paulatuk in the east (ICC et al. 2006).

Flocks arrive on the Mackenzie Delta in mid to late May and birds disperse along the coast. Greater white-fronted geese begin laying their eggs in June and eggs hatch 30 days after clutch initiation (IOL et al. 2004). The young fledge five to six weeks after hatching. Adult moulting occurs in late August to early September, and likely in late June for non-breeding adults (IOL et al. 2004). Migration occurs from late August until early October with the majority of birds migrating in early to mid-September.

The greater white-fronted goose feeds on grasses, berries, bulbils, tubers and rhizomes of grasses and sedges. They forage on the mudflats and hummocks within nesting rounds before snowmelt occurs and after snowmelt they forage along the margins of ponds in water up to 1 m deep (IOL et al. 2004).

White-fronted geese use a variety of habitats such as stream deltas, sedge-cotton-grass moss meadows, tussock lowlands, tundra ponds, areas with emergent vegetation, taiga forest and bogs, hummocky ground, inland tributary stream edges, dwarf and tall shrub tundra of birch and willow, heath tundra, rock fields, eskers and hill slopes with grasses and lichens (IOL et al. 2004).

Nesting areas typically are on the ground near streams, small ponds, shallow lakes and tidal pools (Martell et al. 1984; Ely and Dzubin 1994, as cited in IOL et al. 2004). Geese nest on tidal flats and near lakes or rivers (Koski and Tull 1981, as cited in IOL et al. 2004) as well as dry hummocks in lowlands or tundra beside wetlands (Sirois and Dickson 1989, as cited in IOL et al. 2004).

Brood rearing has been documented in wetland complexes where goslings can seek cover in sedges. Grazing areas can include meadows, tidal marshes, sheltered bays, lagoons and beaches (Sirois and Dickson 1989; Ely and Dzubin 1994, as cited in IOL et al. 2004). Moulting often occurs in coastal locations and inland lakes. The Mackenzie Delta is an important staging area for fall migration (IOL et al. 2004).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

Predation by eagles, foxes and wolves are potential causes of mortality for both adults and juveniles. Egg and gosling predation by gulls, jaegers, arctic foxes and grizzly bears are also a threat (IOL et al. 2004). Some participants in a traditional knowledge study prepared by the Inuvik Community Corporation et al. (2006) reported that spring geese were “fat and appear in good health as they first come from the south”.

Harvest Pressures

Geese are hunted in spring and fall although there were periods when spring hunting was prohibited. Detailed information regarding harvest levels is found in Section 3.2.8.

3.1.10.6 Snow Goose

Population Status and Trends, Distribution, Abundance

Snow geese overwinter in California and Mexico and arrive in the NWT in mid-May. Egg laying occurs typically in the first week of June and incubation occurs until the first week in July. Snow geese feed on terrestrial and aquatic vegetation and migration occurs in early September with staging occurring in both the outer Mackenzie Delta and the north

Yukon coast (Community of Inuvik et al. 2008). There are sites along the Mackenzie River where snow geese gather during spring migration (IOL et al. 2004).

Snow geese populations are considered secure in the NWT. The number of snow geese in North America in 1997 was estimated to be 6.7 million, including 5 million breeding birds (Mowbray et. al. 2000, as cited in IOL et al. 2004). In the ISR, the Lesser Snow Goose is estimated at 486,000 in 1995, compared to 169,600 in 1976 (Community of Tuktoyaktuk et al. 2008). The North American population is reportedly increasing and growing at a rate of 5% per year (IOL et al. 2004).

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Important regional habitat includes Kendall Island, Anderson River Delta, Egg River and Thomsen River (Community of Inuvik et al. 2008). Adult snow geese arrive at Kendall Island at the end of May or shortly thereafter and clutch initiation occurs in the first or second week of June. Eggs hatch in late June/ early July and movement to brooding areas occurs within a few days. Most young leave brooding areas by mid to late August. Adults moult in mid-July, two weeks after eggs hatch. Staging occurs from mid-August to early September with migration occurring in mid to late September (IOL et al. 2004).

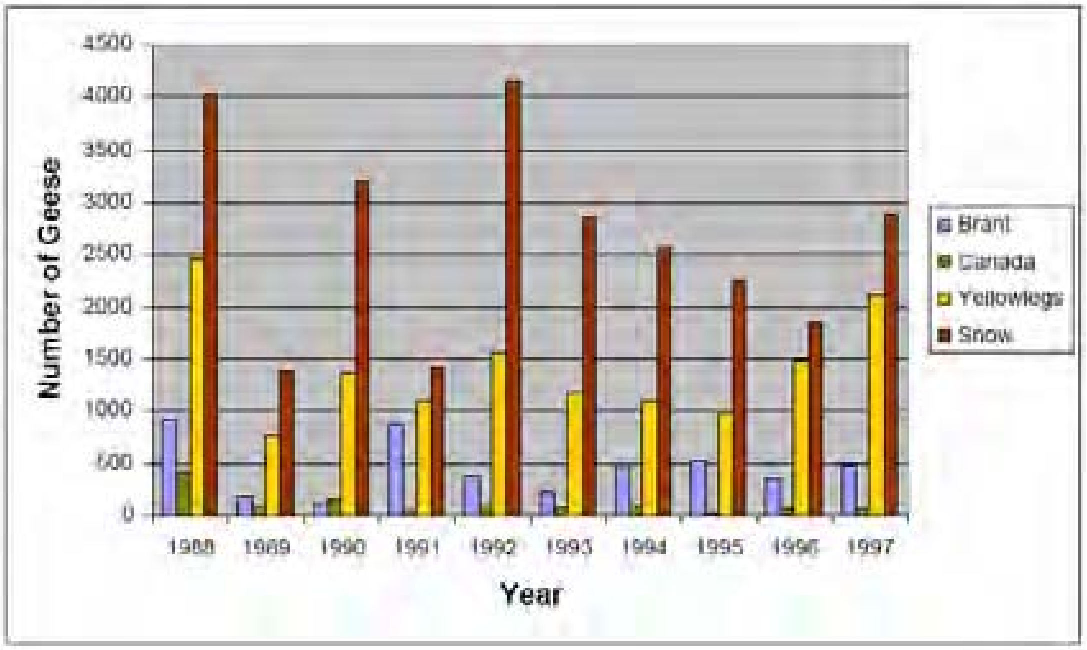
Breeding occurs near ponds, shallow lakes, streams or braided streams. Nesting occurs inland near coastal salt marshes and vegetation that is typically associated with nest sites includes dwarf willow and sea-lyme grass (IOL et al. 2004). Rearing and moulting habitat includes inland meadows, edges of shallow ponds and lakes and upland tundra where forage is abundant. Staging areas vary and can include low lying areas, wet meadows, and tundra with drainage tracks (IOL et al. 2004).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

No health issues were identified by Community of Tuktoyaktuk et al. (2008), Community of Inuvik et al. (2008), or Inuvik Community Corporation et al. (2006).

Harvest Pressures

As indicted in Figure 3.1.10-2, snow geese make up the majority of harvested geese species in the NWT. Further information regarding harvest levels is found in Section 3.2.8.



Source: ICC et al. (2006)

Figure 3.1.10-2
Total Estimated Annual Goose Harvests for Aklavik, Inuvik and Tuktoyaktuk, 1988-1997

3.1.10.7 Canada Goose

Population Status and Trends, Distribution, Abundance

Canada geese winter in the central United States, between Colorado and Texas. Reportedly Canada geese arrive in the arctic in May and leave in early September (Community of Inuvik et al. 2008).

There are believed to be 11 "races" of Canada geese in Canada (Environment Canada 2003). Canada geese populations are stable or increasing and the species as a whole has "flourished" in the last 50 years (Environment Canada 2003). Management programs, including refuge creation and regulation of hunting, as well as agricultural practices have contributed to the success of Canada Geese populations.

According to Community of Tuktoyaktuk et al. (2008) and Community of Inuvik et al. (2008), approximately 500,000[3] Canada geese are in North America., with an increasing population trend.

[3] No date is associated with this population estimate.

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Canada geese use a wide variety of nest sites and reportedly feed on grasses, sedges, berries, seeds and cereal grains (Community of Inuvik et al. 2008). Feeding areas are mainly associated with aquatic environments (Environment Canada 2003). Breeding areas can include wet grassy meadows associated with ponds and lakes that serve as a refuge from Predators. In the NWT, Canada geese breed on the tundra above the treeline. Below the treeline, Canada geese nest in open boreal forest (Environment Canada 2003).

Canada geese breed throughout North America except in the high arctic and in the extreme southern parts of the United States and Mexico. Breeding typically occurs in April or early May. Some species winter in Southern Canada from British Columbia to Ontario.

Spring migration for northern breeding geese occurs in late winter and can take several weeks. Fall migration begins when freezing occurs on breeding grounds. Canada geese sometimes travel to moult or complete a moult following migration. This moulting typically occurs in open water where birds can seek refuge from predators while growing feathers and where food is present. Non breeding geese usually initiate a migration moult between late May and early June while breeding geese moult later in the season (Environment Canada 2003).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

Avian malaria is a potential health concern in Canada geese and other waterfowl species although mortality from this disease is reportedly low in waterfowl (Wildlife Information Network 2011). No health issues were identified by Community of Tuktoyaktuk et al. (2008), Community of Inuvik et al. (2008), or Inuvik Community Corporation et al. (2006).

Harvest Pressures

Please refer to Figure 3.1.10-2 under the Harvest Pressures heading for information on Canada geese harvest levels in the NWT between 1988 and 1997. Canada geese populations have thrived in many parts of Canada and hunters are encouraged to harvest Canada Geese. Further information regarding harvest levels is found in Section 3.2.8.

3.1.10.8 Mallard

Population Status and Trends, Distribution, Abundance

Mallards are found throughout North America, Europe and Asia and have been introduced into other parts of the world. Mallards are hardy and some regularly overwinter in southern Ontario and British Columbia although the majority migrate to the central and southern United States (Environment Canada 1996). The population trend for mallards is reportedly decreasing (Community of Inuvik et al. 2008).

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Mallards leave wintering areas in early February through to early April. They arrive on breeding grounds in early to mid-May. They usually nest within 100 m of open water but may nest up to 500 m or more away. Mallards may re-nest up to three or four times if nests are destroyed (Environment Canada 1996). Mallards prefer aquatic and shoreline plants as food although they will eat some invertebrates (Community of Inuvik et al. 2008).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

A study completed in 1977 stated that 67% of mallards in the Mackenzie Delta were infected with blood parasites (Williams et al. 1977).

Harvest Pressures

Ducks are a traditional food consumed in many Inuvialuit households. In particular, mallards are among the ducks most often discussed for harvesting. Ducks are harvested in spring and fall. Further information regarding harvest levels is found in Section 3.2.8.

3.1.10.9 Northern Pintail

Population Status and Trends, Distribution, Abundance

The largest number of breeding pintails in the Arctic is in the Mackenzie Delta (Community of Inuvik et al. 2008). Northern Pintail range over more of the earth than any other waterfowl. Northern pintail populations are estimated at 2.9 million in North America (Community of Tuktoyaktuk et al. 2008, Community of Inuvik et al. 2008); the population has decreased from its peak population of greater than 9 million in 1955 and 1956. Biologists believe reduced and degraded habitat is the cause of the decline of the population (Ducks Unlimited 2011).

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Northern pintail winter in Texas, California, the Mississippi Delta, and Mexico. They leave wintering grounds beginning in early January through to March and arrive in the Mackenzie Delta by mid-May. Fall migration begins in mid-August (Community of Inuvik et al. 2008).

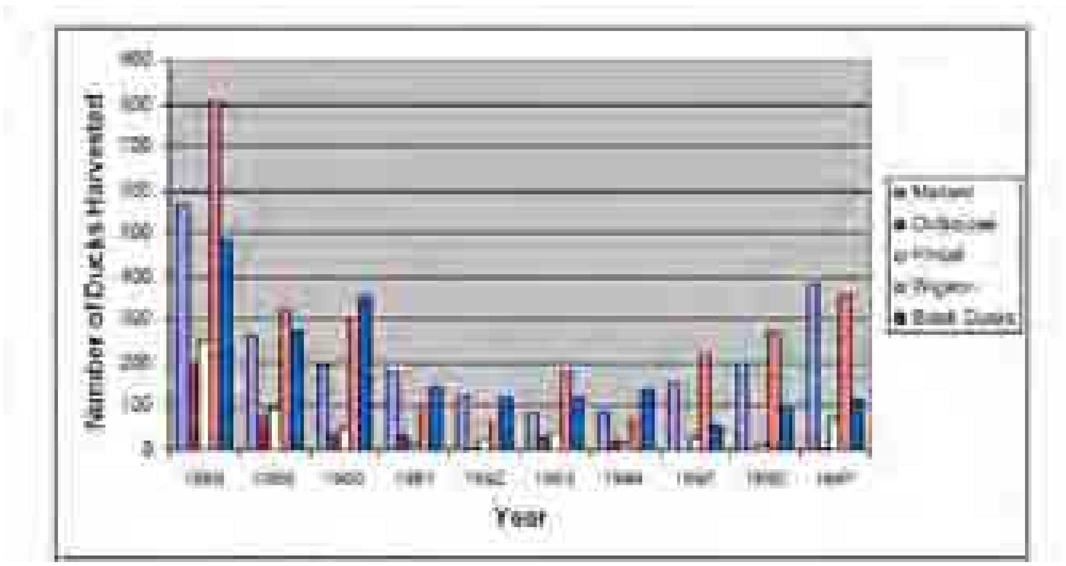
Suitable habitat includes fast-warming seasonal or permanent wetlands and prairie (Ducks Unlimited 2011). Northern pintail are common in freshwater ponds and marshes. They nest on the ground in sparse grassy vegetation and feed on seeds found in the water (Sibley 2003).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

A study completed in 1977 stated that 27% of Northern pintails were infected with a blood parasite (Williams et al. 1977).

Harvest Pressures

Northern pintail are one of the most common types of ducks harvested in the Inuvialuit Settlement Region. Figure 3.1.10-3 shows the mean pintail harvest for Aklavik, Inuvik and Tuktoyaktuk between 1988 and 1997 (ICC et al. 2006).



Source: ICC et al. (2006)

Figure 3.1.10-3
Total Estimated Annual Duck Harvests for Aklavik, Inuvik and Tuktoyaktuk, 1988-1997

3.1.10.10 Peregrine Falcon

Population Status and Trends, Distribution, Abundance

In 2007, COSEWIC re-assessed Peregrine Falcon and recommended the species to be downlisted from Threatened to Special Concern under SARA. An extended public consultation is underway but no formal decision has been made. Two subspecies of Peregrine falcons nest in the NWT. The anatum subspecies (*Falco peregrinus anatum*) nests in forested regions and the tundrius subspecies (*Falco peregrinus tundrius*) nests in tundra regions. Both subspecies could be affected by the proposed Highway and borrow source activities. The NWT Peregrine Falcons winter from Mexico south to southern South America.

The GNWT ENR is responsible for managing bird of prey species and their habitat. ENR participates in the development of species Recovery Plans, sits as a member of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and conducts monitoring programs. As part of the Peregrine Falcon recovery planning, ENR works cooperatively with the Canadian Wildlife Service to conduct Peregrine Falcon population monitoring.

Population surveys have been completed for the Peregrine falcon in the Mackenzie Valley since the 1960s. Peregrine numbers have been increasing since the mid-1970s due to the North American ban on organochloride pesticides. A survey in 2010 from Tulita to Inuvik re-surveyed all known nest sites. Preliminary data shows that of 191 sites surveyed (S. Carriere and S. Matthews, GNWT ENR, pers. comm. 2010), 106 were occupied and productivity was average. Parks Canada has collected similar survey data in tundra areas such as the Tuktut Nogait National Park (Parks Canada 2009a). In the NWT, there are more than 1,000 known breeders (COSEWIC 2007).

GNWT ENR reviewed raptor maps for the different proposed Highway alignments and searched the NWT/Nunavut Raptor database for known nesting sites. This review indicated there are no known Peregrine falcon nest sites within 1.5 km of these routes (S. Matthews, GNWT ENR, pers. comm., 2010).

Peregrine falcons prey on other birds. Other food sources include mammals and insects (IOL et al. 2004). Food availability affects the annual reproductive success of this species and fluctuates between years (Matthews et al. 2006).

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

The habitat requirements of the Peregrine Falcon can be divided into three components:

1) The nest site: nests are usually scrapes made on cliff ledges on steep cliffs, usually near wetlands -- including artificial cliffs such as quarries and buildings;
2) The nesting territory: the area defended around the nest prevents other pairs from nesting within 1 km or more, ensuring adequate food for all nesting pairs and their young; the density of nests tends to be related to food availability;
3) The home range: the extended, non-defended area in which the peregrines hunt for additional food and which can extend to 27 km from the nest; peregrines prefer open habitats such as wetlands, tundra, savanna, sea coasts and mountain meadows, but will also hunt over open forest (GNWT ENR 2006d).

Peregrine falcons arrive in the NWT in mid-April. They start defending territories in mid-May and lay their egg the first week of June, every year like clockwork. The eggs hatch the second week of July and young birds can fly around 21 August, again like clockwork. All Peregrines fly back south by the end of September.

The age at which reproduction starts depends on the availability of a nesting territory as nesting territories can be very limited. Peregrine falcons use the same territory each year, with some minor changes in the actual location of the nest. This behaviour is key to monitoring population levels and productivity since known and historic nesting sites can be monitored. Peregrine falcons have very specific nesting requirements. Nesting pairs are susceptible to disturbance.

The most consistent nesting habitat sites are "waterfront properties". The nests themselves are simple. They are a scrape or space on a ledge. The nesting habitat is usually high cliffs within hunting distance of wetlands or ponds or lakes, as the Peregrine's food are mostly waterbirds. The area defended around the nest prevents other pairs from nesting within 1 km or more, ensuring adequate food for all nesting pairs and their young; the density of nests tends to be related to food availability.

Peregrine falcon pairs may use other "less standard" nesting sites where optimal habitat is rare or taken. Such sites used along the Mackenzie Valley include mud banks, rock outcrops or stick nests built by other raptors. Elsewhere some pairs use human-made structures.

The home range for Peregrine falcons can be >15 km from the nest as Peregrines use a large non-defended area foraging area to hunt for additional food beyond the defended nest territory. Peregrines prefer open habitats for hunting.

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition) and Harvest Pressures

Peregrine falcons are not harvested in the Inuvialuit Settlement Region (Joint Secretariat 2003). According to Inuvik Community Corporation et al. (2006), Peregrine falcons have been used as spirit animals in the past by shamans.

3.1.10.11 Rock Ptarmigan and Willow Ptarmigan

Population Status and Trends, Distribution, Abundance

Ptarmigan populations are cyclical and based on a 2006 traditional use study, may have been at the low end of the population cycle in 2006 (ICC et al. 2006). Study participants, when interviewed, suggested that there was a lack of ptarmigan in the Inuvialuit Settlement Region but that the population would likely rebound, as is typical. Some hunters believe the population is declining.

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Ptarmigan are found throughout the Inuvialuit Settlement Region, with Willow Ptarmigan occurring throughout and Rock Ptarmigan occurring primarily along the coastline. Ptarmigan stay in the north all year and live in the tundra, foothills, and the Mackenzie River Delta, among the willows. Ptarmigan feed in the willow and nest in the foothills of the mountains (ICC et al. 2006). They eat willow buds, pebbles and berries.

Ptarmigan migrate from the west around the end of April and moult when they have their young. Their feathers are often used for nests. They mate in May and nest in June. Eggs hatch in June. Their predators include eagles, crows, hawks, falcons, lynx and fox (ICC et al. 2006).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition)

Ptarmigan and grouse are low on the food chain and eat plants and insects. Contaminants become more concentrated when animals (predators) eat other animals (prey). This process is called biomagnification. Since ptarmigan and grouse do not eat other animals, this helps them avoid building up elevated levels of contaminants. As a result Ptarmigan and grouse have extremely low levels of most contaminants (INAC 2004d).

Harvest Pressures

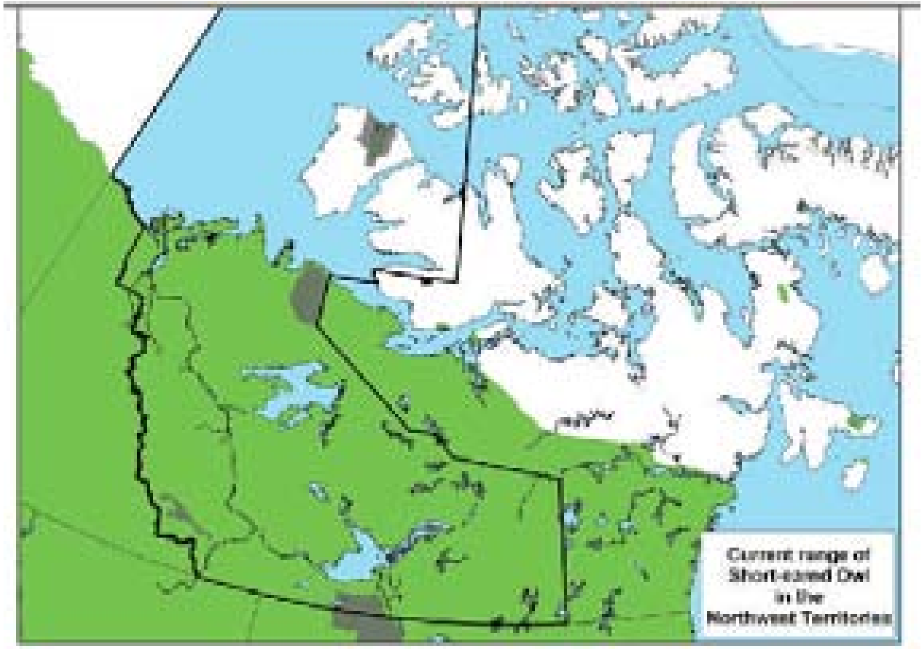
Ptarmigan are widely recognized as an important food source. Harvesting often occurs in winter when Ptarmigan have more fat, but they are also hunted in spring (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008). Further information regarding harvest levels is found in Section 3.2.8.

3.1.10.12 Short-eared Owl

Population Status and Trends, Distribution, Abundance

The short-eared owl has been assessed as Special Concern by COSEWIC and ranked as Sensitive by GNWT ENR. The size of the Canadian short-eared owl population is unknown but changes in local populations suggest that overall population is decreasing at a rate of 1.8% per year (GNWT ENR 2011a). The Canadian short-eared owl population reportedly declined by 43% between 1966 and 1989. The size of the NWT population is unknown but is assumed to be decreasing in number similar to the Canadian population overall (GNWT ENR 2011a).

Short-eared owls were historically found in all of Canada's unforested areas with the exception of the High Arctic Islands (Figure 3.1.10-4; GNWT ENR 2011a). In summer, short-eared owls are present on the Arctic and alpine tundra from Alaska to Hudson Bay, along the northern coast from Manitoba to Labrador and down the coastline of the Maritimes. They reportedly breed in some areas of the taiga and boreal forest as well as the tundra and migrate to the southern portion of their range in winter (GNWT ENR 2011a).



Source: GNWT ENR (2011a)

Figure 3.1.10-4
Current Range of the Short-eared Owl in the NWT

Habitat Requirements (Breeding, Moulting, Staging, Feeding) and Sensitive Periods

Short-eared owls hunt in open areas and require large ranges. They prey on small rodents and small birds. They are found in summer in open grasslands, prairies and tundra. They typically roost in grassy areas and roost and hunt in abandoned pastures, fields, airports, hay meadows and marshes during winter. They nest on the ground. Breeding occurs anytime from April to August (GNWT ENR 2011a). Loss of coastal marshes and grasslands on wintering grounds is most likely a threat; the loss of habitat has reduced the short-eared owl's food supply and is a key factor in their decline. Human activities such as hunting can also cause mortality in ground-dwelling chicks (GNWT ENR 2011a).

Known Issues with Respect to Health of Harvested Species (e.g. Parasites, Diseases, Condition) and Harvest Pressures

Some owls are used for food and their claws are used for fishing hooks as fishing (ICC et al. 2006).

3.1.10.13 Rusty Blackbird

Population Status and Trends, Distribution, Abundance

The northern limit of the Rusty Blackbird's breeding range in Canada is delineated by the Old Crow region in northern Yukon; the Mackenzie River delta, Great Bear Lake and Great Slave Lake in the NWT; the Thelon and Arviat rivers in Nunavut (COSEWIC 2006). The breeding range of the Rusty Blackbird corresponds closely to the boreal forest and taiga terrestrial ecozones. The Rusty Blackbird is generally absent from wetlands in regions about the treeline, such as the alpine tundra and Arctic tundra, and it is not abundant in high mountain wetlands (COSEWIC 2006).

Rusty blackbirds are listed as a species of Special Concern under SARA by COSEWIC. There has been a 90% reduction in their population size in the last 30 years; however, their numbers do not appear to have declined in the NWT. Figure 3.1.10-5 shows the range of the rusty blackbird in the NWT.

Source: COSEWIC (2006)

Figure 3.1.10-5
Current Range of Rusty Blackbirds in the NWT

Habitat Requirements (breeding, moulting, staging, feeding) and Sensitive Periods

The breeding range of the Rusty Blackbird is closely linked to the both the boreal forest and taiga terrestrial ecozones. In Canada, the northern limit to their breeding range is defined by the Old Crow region in northern Yukon; the Mackenzie River delta, Great Bear Lake and Great Slave Lake in the Northwest Territories; and the Thelon and Arviat rivers in Nunavut. The Rusty Blackbird is typically absent from wetland regions above the treeline including the alpine tundra and Arctic tundra, in high mountain wetlands the Rusty Blackbird is not abundant (COSEWIC 2006).They nest in trees near bogs within boreal forests and forage for insects and seeds on the ground in wooded swamps (Sibley 2003). Threats to the rusty blackbird include changes to wetland or prey (i.e., changes to wetland chemistry and water levels resulting from climate change (GNWT ENR 2011a).

Known Issues with Respect to Health of Harvested Species (e.g. parasites, diseases, condition) and Harvest Pressures and Harvest Pressures

No evidence could be found suggesting that rusty blackbirds are harvested for subsistence.

3.1.10.14 Species or Areas Subject to Preferential Rights Granted by Land Claims

The *Inuvialuit Final Agreement* (IFA) provides the Inuvialuit with certain harvesting rights to wildlife in the Western Arctic Region. The exercise of the Inuvialuit rights to harvest is subject to laws of general application respecting public safety and conservation. The IFA defines exclusive right to harvest as "the sole right to harvest the wildlife referred to in paragraphs Yukon - 12(24)(b) and (c) and Western Arctic Region - 14(6)(b) to (d), to be allocated the total allowable harvest and to permit non-Inuvialuit to harvest any such wildlife."

Only those sections that specifically apply to birds will be noted here.

Section 14(6)(b), subject to the qualifications set out in subsections (15) to (18) of the Agreement, sets out the harvesting rights as:

(a) the preferential right to harvest all species of wildlife, except migratory non-game birds and migratory insectivorous birds, for subsistence usage throughout the Western Arctic Region;

(d) the exclusive right to harvest game on Inuvialuit lands and, if agreed on, other areas.

Under Section 14.(7), where harvesting rights are extended to other native peoples pursuant to subsections (15) to (18), their requirements as to subsistence usage shall be taken into account when setting subsistence quotas and the subsistence quotas and subsistence requirements of all the native peoples shall be accommodated within conservation limits. Where, in the exercise of their exclusive right to harvest referred to in paragraphs (6)(b), (c) and (d), the Inuvialuit permit persons other than natives to harvest, harvesting by those persons shall be subject to the laws of general application.

3.1.10.15 Baseline Contaminant Concentrations In Harvested Species

The following excerpt is from a fact sheet produced by INAC (2004b):

Contaminant levels have been measured in waterfowl because they are an important traditional food. Studies have found that most contaminants are present at such low levels that they are not considered health risks to waterfowl or to the people who eat them. The only contaminants found in slightly higher levels were certain heavy metals which can concentrate in the organs of some ducks. There have never been any health advisories issued in the Northwest Territories due to contaminants in birds. Contaminant levels in ducks and geese are so low that they pose no health risks, as long as they are cleaned very carefully if killed using lead shot.

Spatial trends of contaminants in waterfowl and game birds were documented in Arctic communities; however, none of these communities were near the region of the proposed Highway. Populations of certain bird species are declining (specifically eider ducks) and it is suspected that contaminants are one of several risk factors (INAC 2003).

3.2 HUMAN ENVIRONMENT

The following sections describe the conditions and resources of the human environment as it exists in the Inuvik to Tuktoyaktuk area. This background information is subsequently considered in Section 4.0 of this Environmental Impact Statement to identify potential human environmental effects and proposed mitigation measures to avoid or minimize potential negative effects.

3.2.1 Background

3.2.1.1 Tuktoyaktuk

The Hamlet of Tuktoyaktuk is located on the Tuktoyaktuk Peninsula at 69°27'N and 133°02'W, and the peninsula is located on the shores of Kugmallit Bay (part of the Beaufort Sea). The community is located approximately 126 km northeast of Inuvik and 1,130 km northwest of Yellowknife. Tuktoyaktuk is accessible by air, winter ice road, and water during the ice-free summer months.

3.2.1.2 Inuvik

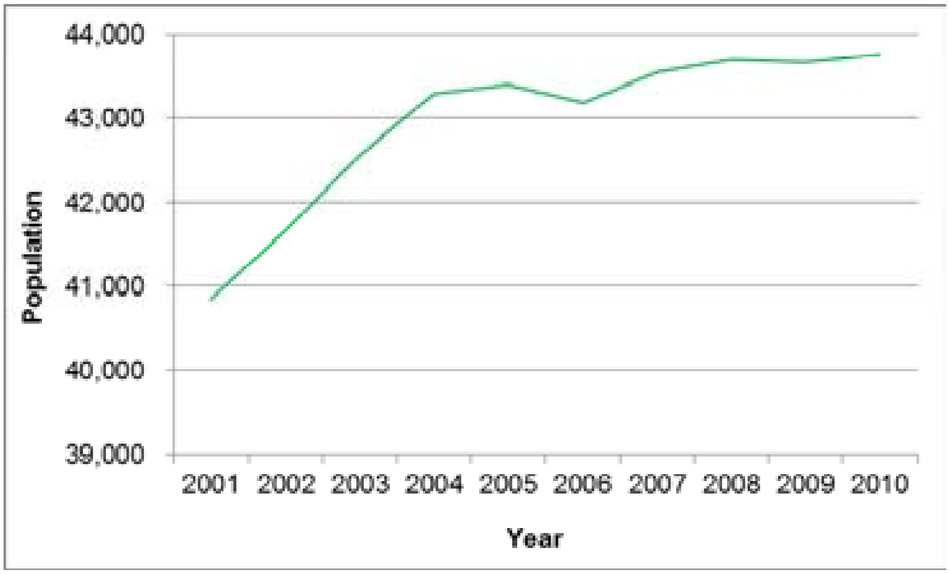
The Town of Inuvik is located on the Mackenzie River Delta at 68°21'N and 133°43'W. The community is located approximately 1,086 km northwest of Yellowknife. Inuvik is accessible year-round by air, all-weather road (Dempster Highway), and water (Mackenzie River) during the ice-free summer months.

Inuvik is the regional government centre, and transportation and recreation hub for the Canadian Western Arctic. Due to its strategic location, Inuvik is also a center for the oil and gas industry operating in the Beaufort Sea/Mackenzie Delta (Town of Inuvik 2009). The airport, government services, recreational programs, retail outlets and the hospitality industry attract residents from neighbouring communities and tourists to the region.

3.2.2 Demographics

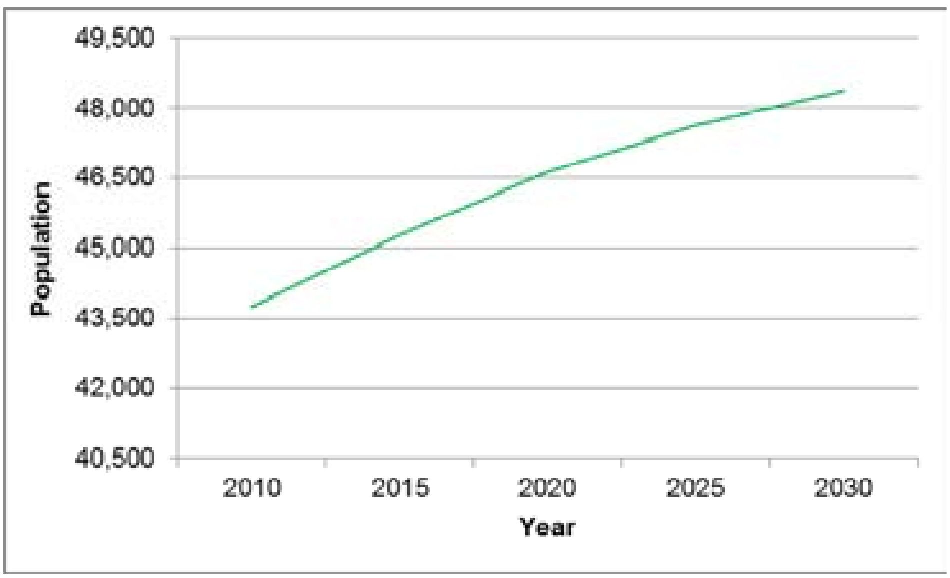
3.2.2.1 Population and Population Trends

The total population for the Northwest Territories has increased from 40,844 in 2001 to 43,759 in 2010 (Figure 3.2.2-1). The GNWT Bureau of Statistics expects the population to continue to increase, reaching a projected 46,616 in 2020 and 48,365 in 2030 (Figure 3.2.2-2) (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k)

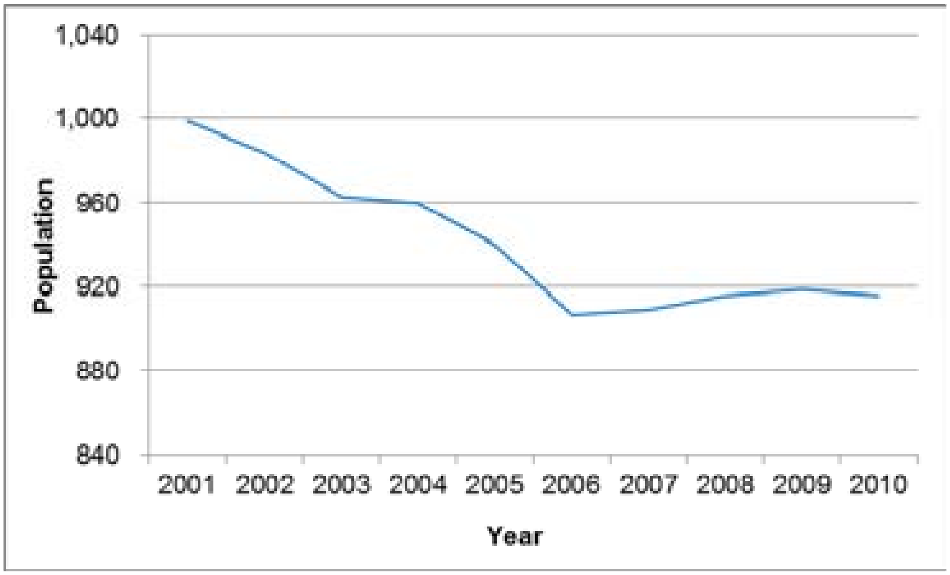
Figure 3.2.2-1
Northwest Territories Estimated Population, 2001-2010



Source: GNWT Bureau of Statistics (2010l)

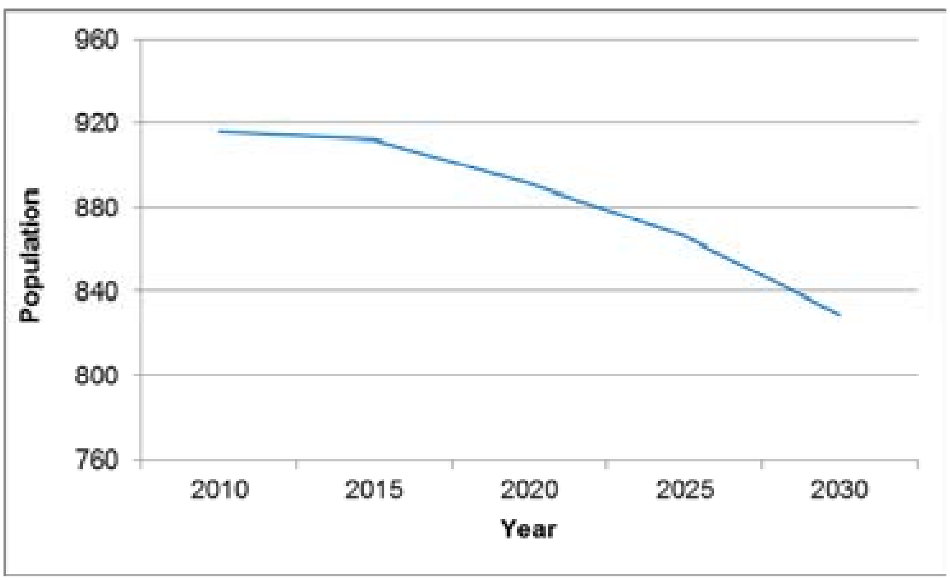
Figure 3.2.2-2
Northwest Territories Projected Population, 2010-2030

The population of Tuktoyaktuk has decreased from 999 in 2001 to 916 in 2010 (Figure 3.2.2-3). The GNWT Bureau of Statistics anticipates that the population of Tuktoyaktuk will continue to decrease in the future with a projected population of 891 in 2020 and 829 in 2030 (Figure 3.2.2-4) (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k)

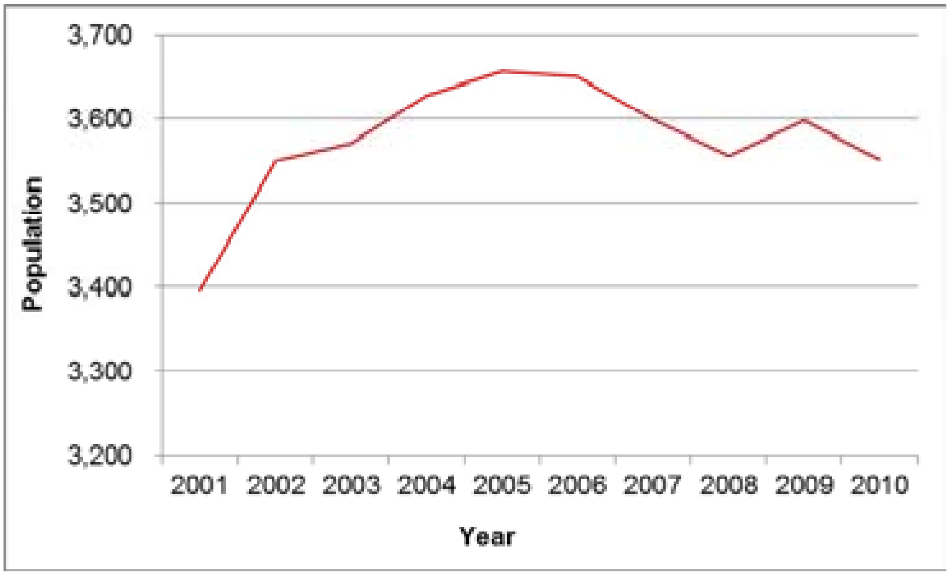
Figure 3.2.2-3
Tuktoyaktuk Estimated Population, 2001 – 2010



Source: GNWT Bureau of Statistics (2010l)

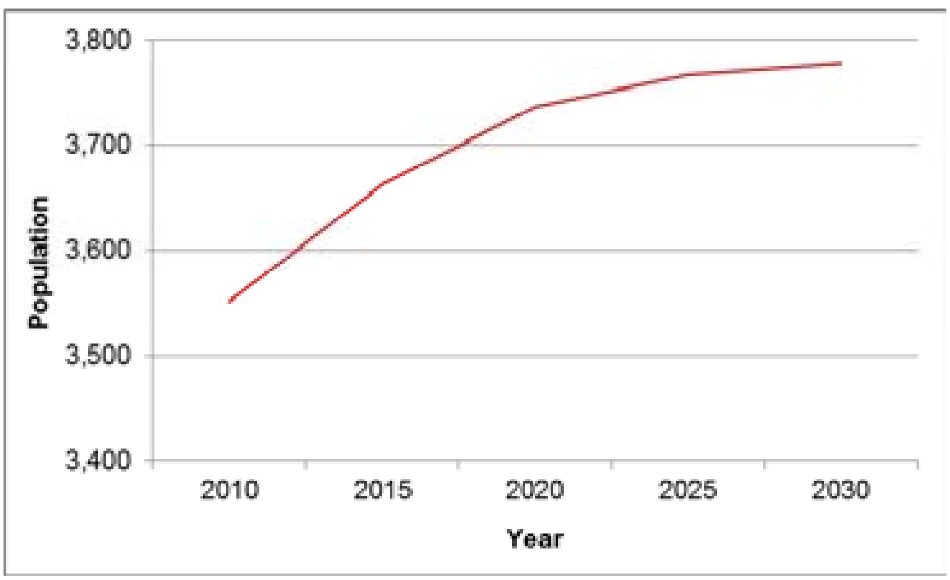
Figure 3.2.2-4
Tuktoyaktuk Projected Population, 2010 – 2030

Similar to the NWT population, the Inuvik population is increasing. The Inuvik population rose from 3,395 in 2001 to 3,552 in 2010 (Figure 3.2.2-5). The GNWT Bureau of Statistics anticipates that the population of Inuvik will continue to increase in the future with a projected population of 3,737 in 2020 and 3,777 in 2030 (Figure 3.2.2-6) (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.2-5
Inuvik Estimated Population, 2001 – 2010

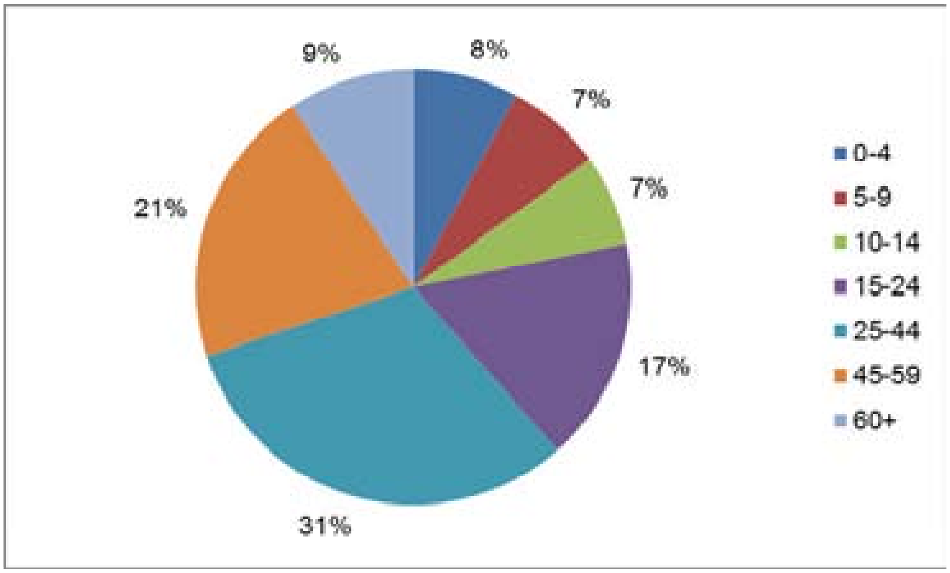


Source: GNWT Bureau of Statistics (2010l)

Figure 3.2.2-6
Inuvik Estimated Population, 2010 – 2030

3.2.2.2 Trends for Age, Gender and Ethnicity

In the NWT, 70% of the population are aged 44 or younger. The distribution between males and females and Aboriginal and non-Aboriginal people is almost equal. Figure 3.2.2-7 and Table 3.2.2-1 present the NWT population by age gender and ethnicity.



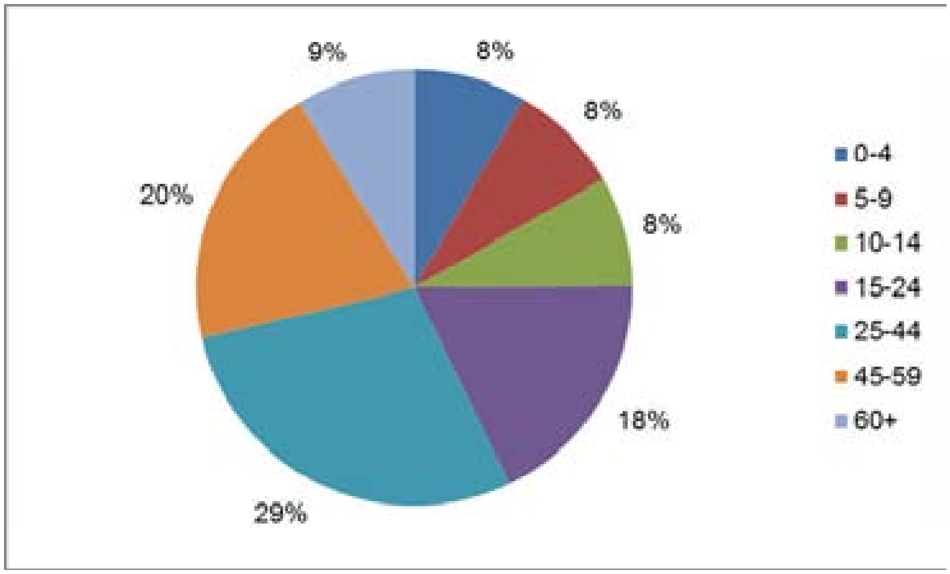
Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.2-7
Northwest Territories Population by Age, 2009

TABLE 3.2.2-1: NORTHWEST TERRITORIES POPULATION BY GENDER AND ETHNICITY, 2009

Gender	Population	Percent
Male	22,627	52%
Female	21,132	48%
Aboriginal	22,123	51%
Non-Aboriginal	21,636	49%

Data collected by the GNWT Bureau of Statistics for Tuktoyaktuk indicates that 71% of the population is aged 44 or younger. There are more males than females in the community and the Aboriginal population makes up 84% of the total population (GNWT Bureau of Statistics 2010k). Tuktoyaktuk population by age, gender and ethnicity is described in Figure 3.2.2-8 and Table 3.2.2-2, respectively.



Source: GNWT Bureau of Statistics (2010k)

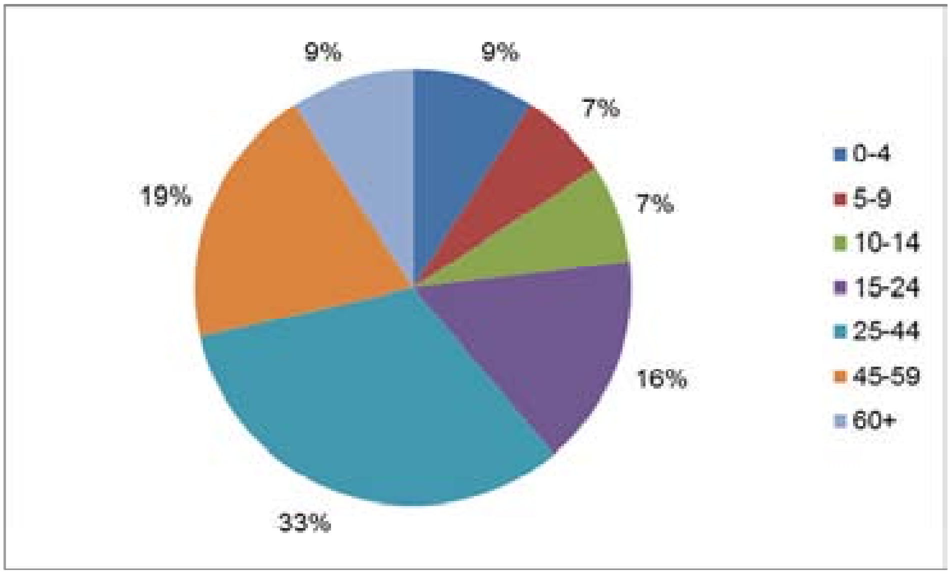
Figure 3.2.2-8
Tuktoyaktuk Population by Age Group, 2009

TABLE 3.2.2-2: TUKTOYAKTUK POPULATION BY GENDER AND ETHNICITY, 2009

Gender	Population	Percent
Male	497	54%
Female	419	46%
Aboriginal	765	84%
Non-Aboriginal	151	16%

Source: GNWT Bureau of Statistics (2010k)

Data collected by the GNWT Bureau of Statistics for Inuvik indicates that 72% of the population is aged 44 or younger. There are slightly more males than females in the community and the Aboriginal population makes up 64% of the total population (GNWT Bureau of Statistics 2010l). The population by age, gender and ethnicity is described in Figure 3.2.2-9 and Table 3.2.2-3, respectively.



Source: GNWT Bureau of Statistics (2010l)

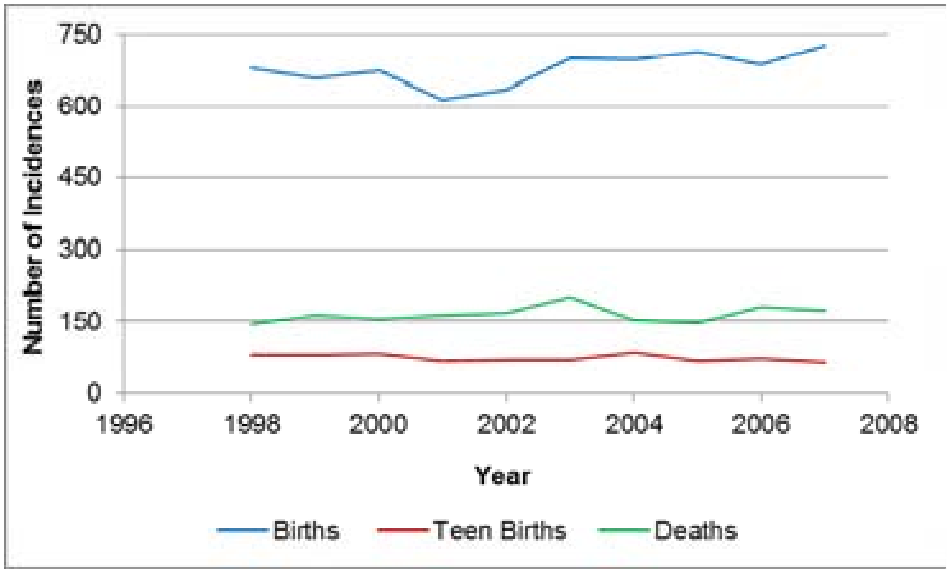
Figure 3.2.2-9
Inuvik Population by Age Group, 2010

TABLE 3.2.2-3: INUVIK POPULATION BY GENDER AND ETHNICITY, 2009		
Gender	**Population**	**Percent**
Male	1,806	51%
Female	1,746	49%
Aboriginal	2,271	64%
Non-Aboriginal	1,281	36%

Source: GNWT Bureau of Statistics (2010l)

3.2.2.3 Incidences of Births and Deaths

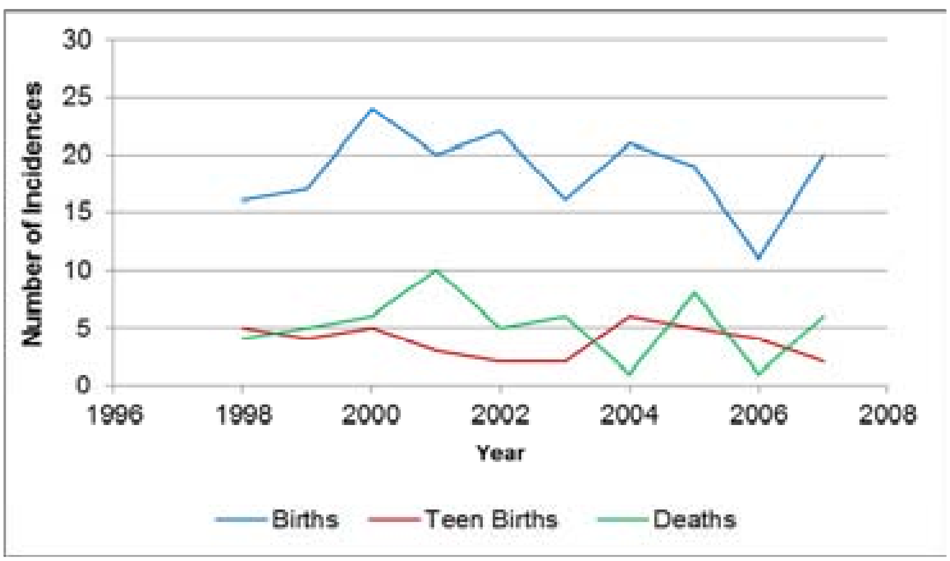
In the NWT, the number of births per year increased from 678 in 1998 to 725 in 2007. The number of teen births decreased during this period and the number of deaths increased (GNWT Bureau of Statistics 2010k). The number of births, teen births and deaths in the NWT are presented in Figure 3.2.2-10.



Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.2-10
Incidences of Births, Teen Births and Deaths in the Northwest Territories, 1998-2007

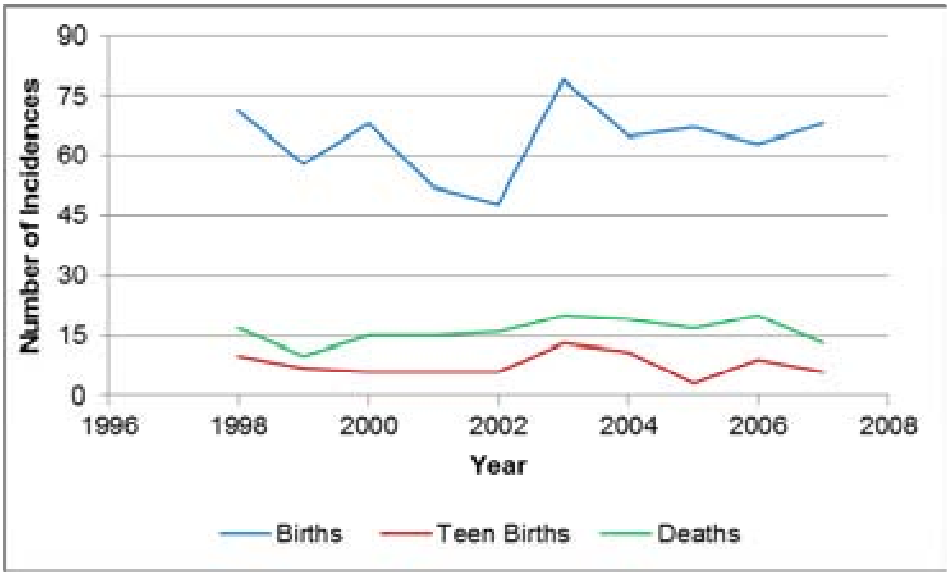
In Tuktoyaktuk, the number of births per year increased from 16 in 1998 to 20 in 2007. The number of teen births decreased during this period and the number of deaths increased. The trends for Tuktoyaktuk are presented in Figure 3.2.2-11(GNWT Bureau of Statistics 2010k).



Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.2-11
Incidences of Births, Teen Births and Deaths in Tuktoyaktuk, 1998 - 2007

In Inuvik, the number of births per year decreased from 71 in 1998 to 68 in 2007. The number of teen births and deaths also decreased during this time period. The number of births, teen births and deaths in Inuvik are presented in Figure 3.2.2-12 (GNWT Bureau of Statistics 2010l).

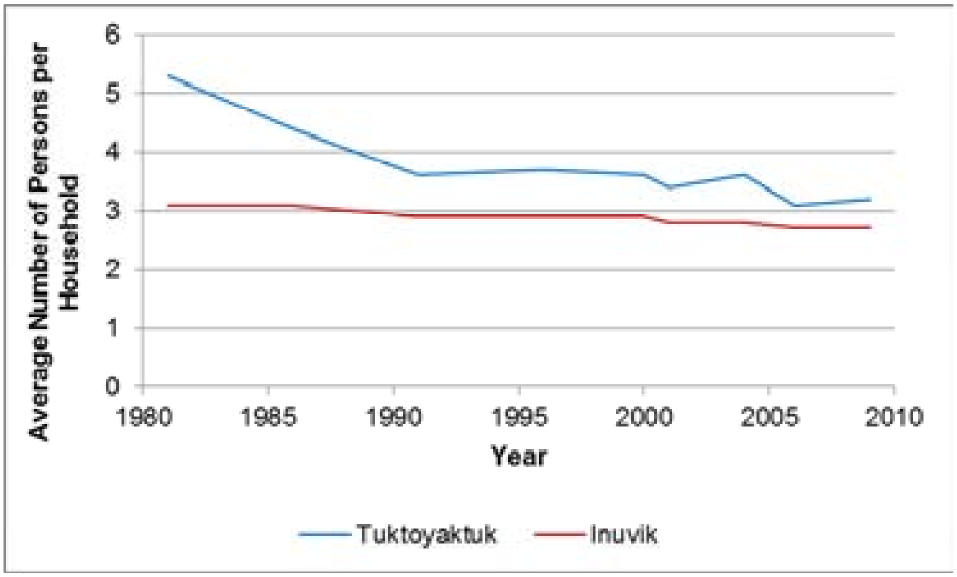


Source: GNWT Bureau of Statistics (2010l)

Figure 3.2.2-12
Inuvik Gross Births, Teen Births and Deaths, 1998 – 2007

3.2.2.4 Households

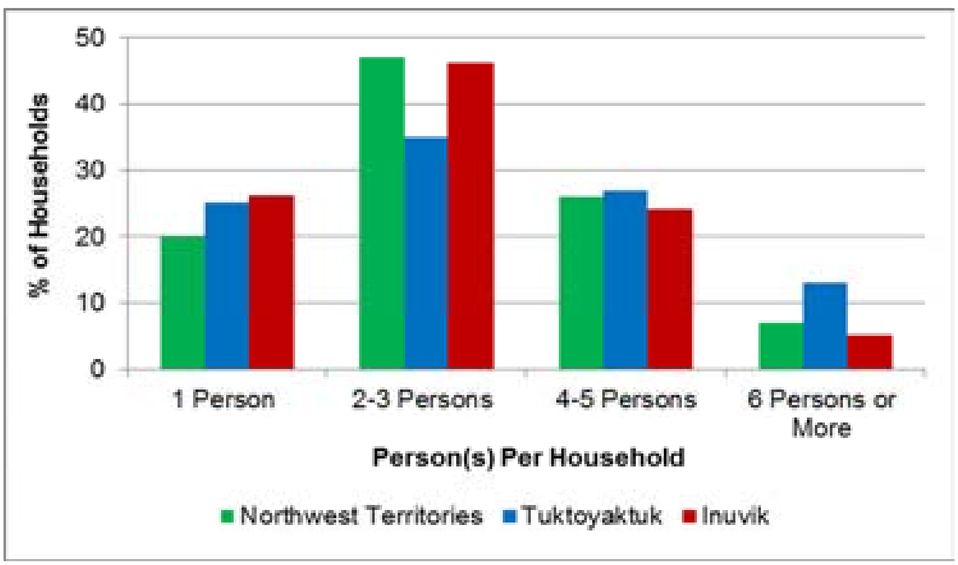
The average number of persons per household has varied in both Tuktoyaktuk and Inuvik from 1981 to 2009. In Tuktoyaktuk, the average number of persons per household has decreased from 5.3 in 1981 to 3.2 in 2009. The average number of persons per household in Inuvik has remained relatively stable, decreasing from 3.1 in 1981 to 2.7 in 2009. This can be observed in Figure 3.2.2-13 (GNWT Bureau of Statistics 2010e).



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.2-13
Average Number of Persons per Household in Tuktoyaktuk and Inuvik, 1981-2009

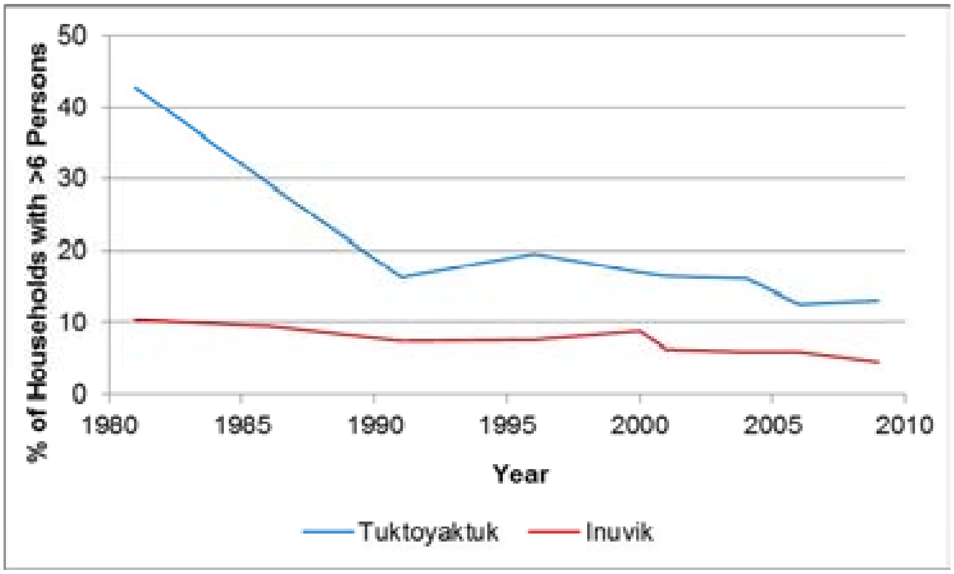
The majority of households in the region have three or fewer people, with the highest percentage being households with 2-3 people. Tuktoyaktuk had the highest percentage of households with 4-5 persons and 6 persons or more (GNWT Bureau of Statistics 2010e). Figure 3.2.2-14 shows the average number of people per household in the NWT, Tuktoyaktuk and Inuvik.



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.2-14
Households by Number of Residents, NWT, Tuktoyaktuk and Inuvik, 2009

In Tuktoyaktuk and Inuvik, the percentage of households with more than six people has decreased from 1981 to 2009, as shown in Figure 3.2.2-15. In Tuktoyaktuk, 42.9% of households had more than six people in 1981. By 2009, this percentage had decreased to 13.0%. Similarly, in Inuvik, 10.3% of households had more than six people in 1981; by 2009, this percentage had declined to 4.5% (GNWT Bureau of Statistics 2010e).

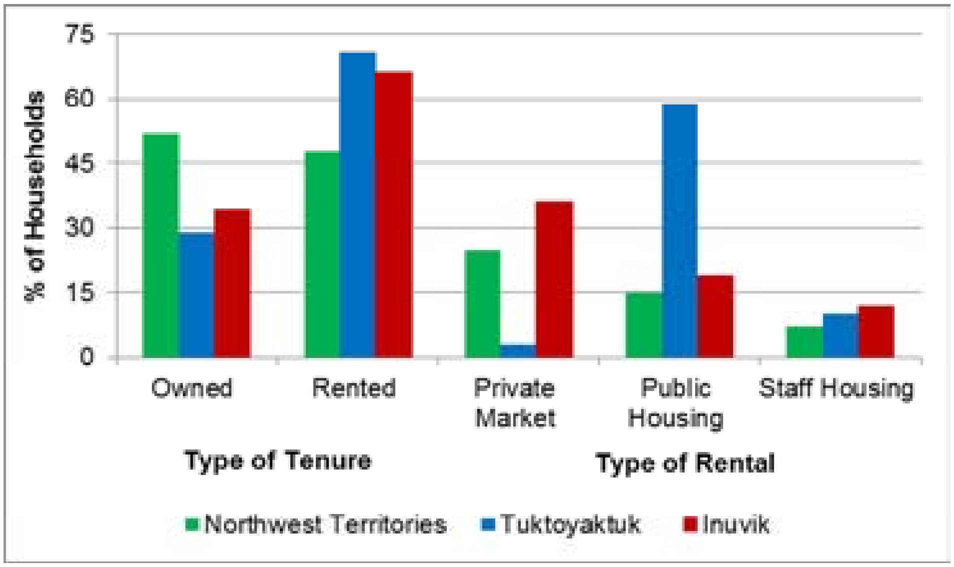


Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.2-15
Percent of Households with 6 Persons or More in Tuktoyaktuk and Inuvik, 1981-2009

In 2009, there were 14,522 households in the NWT, 283 in Tuktoyaktuk and 1,280 in Inuvik. Of the total in the NWT, 7,623 (52%) are owned and 6,899 (48%) are rented. In Tuktoyaktuk, 81 (29%) are owned and 202 (71%) are rented, and in Inuvik, 432 (34%) are owned and 848 (66%) are rented. Figure 3.2.2-16 shows the percentage of households by tenure for the NWT, Tuktoyaktuk and Inuvik (GNWT Bureau of Statistics 2010e).

According to the GNWT Bureau of Statistics (2010e), there are three types of rental housing: private market, public housing, and staff housing. Private market housing includes housing that is owned privately and rented out. Public housing includes government subsidized housing geared towards low-income households. Staff housing includes facilities such as nurses' residences, RCMP residences or residences for those involved in various industrial activities in the region. There is a greater percentage of private market rental housing available in Inuvik, compared to Tuktoyaktuk, but there is a greater percentage of public housing in Tuktoyaktuk compared to Inuvik. Figure 3.2.2-16 identifies the percentage of rental housing by type in the NWT, Tuktoyaktuk and Inuvik (K. Odziemkowska, Labour Market Statistician, GNWT Bureau of Statistics, pers. comm., January 28, 2011).



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.2-16
NWT, Tuktoyaktuk and Inuvik Households by Tenure, 2009

3.2.2.5 Migration and Migration Patterns

In and out net migration data per community are not collected by the GNWT Bureau of Statistics or Statistics Canada. Rather, migration patterns are tracked based on individual project monitoring (C. Schalkwyk, Northern Workforce Residency Analyst, GNWT ITI, pers. comm., October 21, 2010).

The majority of in-migrants to the NWT are the result of interprovincial migration; for example, relocation from one province or territory in Canada to another, changing the usual place of residence (Statistics Canada 2009b). Neither interprovincial migration nor emigration numbers are recorded by Statistics Canada, so they are estimated using data from the Canada Child Tax Benefit collected by Canada Revenue Agency (Statistics Canada 2009b). The highest number of in-migrants to the NWT come from Alberta (32%), followed by British Columbia (18%), Ontario (15%), and Nunavut (8%).. Immigrants from outside of Canada make up a much smaller percentage (GNWT ENR 2010a).

In- and out-migration for the NWT, as reported by Statistics Canada, can be observed in Table 3.2.2-4. The net migration for each quarter in the NWT is calculated by subtracting the out-migration from the in-migration plus or minus the net change in non-permanent residents. A positive net migration value indicates there are more people entering than leaving the NWT, and a negative value indicates the opposite. Data from 2007 to 2010 indicate that there was a net out-migration of people from the NWT, except during Quarters 2 and 4 in 2007 and Quarter 1 in 2010 when there was an in-migration of people into the NWT (GNWT Bureau of Statistics 2010i). Annual totals for net migration during the years 1999 to 2009 show a net out-migration for 2001, 2002 and 2003 (GNWT Bureau of Statistics 2010i). This affects the NWT economy as it results in a loss of transfer payments, skills, investment capital, economies of scale and business markets (GNWT ENR 2010a).

TABLE 3.2.2-4: MIGRATION ACTIVITY, NWT, 1999-2010

		Net Migration (TS951)	In-Migration		Out-Migration		Net change in Non-Permanent Residents (TS1073)
			Inter-Provincial (TS952)	Immigration (TS953)	Inter-Provincial (TS954)	Emigration (TS955)	
2010	Q2	-114	615	37	744	18	-4
	Q1	98	800	36	723	17	2
2009	Q4	-77	354	30	422	19	-20
	Q3	-374	572	22	929	31	-8
	Q2	-49	474	40	556	18	11
	Q1	-91	484	15	545	17	-28
2008	Q4	-258	352	16	632	19	25
	Q3	-181	553	38	707	30	-35
	Q2	-97	493	45	693	18	76
	Q1	-85	499	28	591	17	-4
2007	Q4	42	486	30	387	19	-68
	Q3	-260	606	29	833	31	-31
	Q2	172	667	13	573	14	79
Annual Totals							
2009		-591	1884	107	2452	85	-45
2008		-621	1897	127	2623	84	62
2007		-122	2230	68	2339	75	-26
2006		-718	2202	98	2954	53	-11
2005		-857	2068	84	2955	46	-8
2004		-434	2271	89	2766	42	14
2003		502	2538	94	2181	43	94
2002		178	2759	60	2577	45	-19
2001		6	2273	95	2361	39	38
2000		-415	2324	82	2838	36	53
1999		-410	2329	57	2784	35	23

Source: GNWT Bureau of Statistics (2010i)

The major factor influencing in- and out-migration of people in the NWT is the rise and fall of the NWT economy. Intra-territorial migration also occurs between regions of the NWT. For example, from 1996 to 2006, the population of the North Slave region (which includes Yellowknife) increased, while the population of the Beaufort-Delta region decreased, which may indicate an intra-territorial migration of people from more remote areas of the NWT to the Yellowknife area (GNWT ITI 2008).

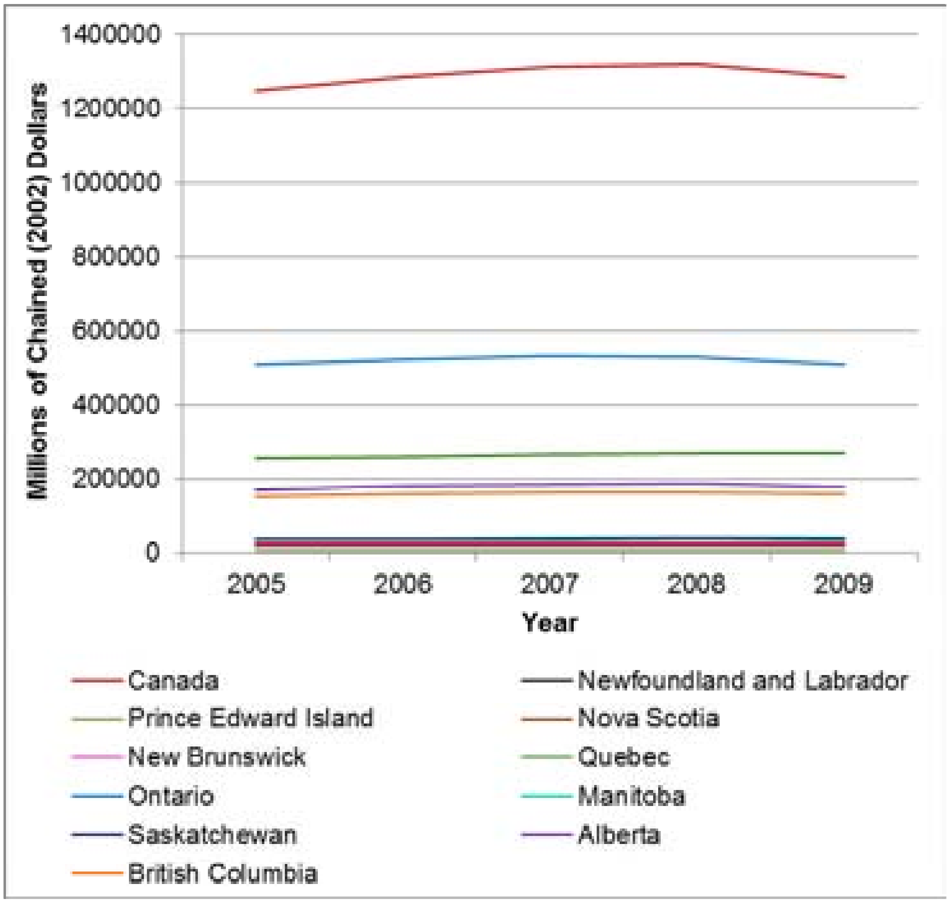
3.2.3 Regional and Local Economies

3.2.3.1 Gross Domestic Product

Gross Domestic Product (GDP) is defined by Statistics Canada as the complete unduplicated value of the goods and services produced in an economic territory of a country or region during a specific period of time (Statistics Canada 2009a). The GNWT Bureau of Statistics expresses their GDP in terms of Chained 2002 dollars. Chained (2002) GDP is a nominal GDP which does not take inflation into account, and expresses GDP over a period of time using the 2002 dollar (Investopedia 2010).

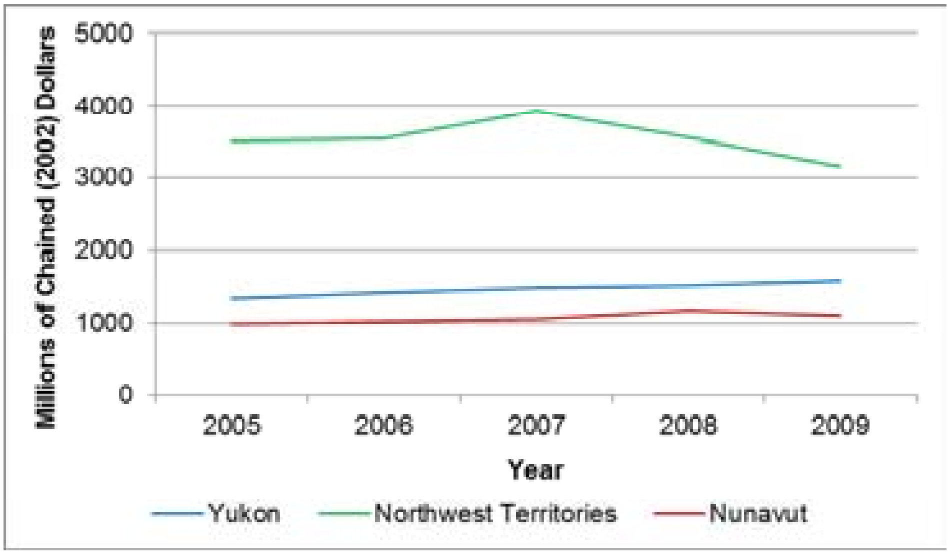
The Chained (2002) GDP for Canada peaked in 2008 then decreased significantly in 2009, demonstrating the effects of the global recession on the Canadian economy. The majority of the provinces showed a slight increase in Chained GDP from 2005 to 2009, with the exception of Ontario whose GDP increased from 2005 to 2007 then decreased from 2008 to 2009, as shown in Figure 3.2.3-1. GDP for Nunavut and the NWT follow a trend similar to the Canadian (2002) GDP; however, the NWT GDP peaked in 2007 compared to the Canadian GDP, which peaked in 2008 (Figure 3.2.3-2). The Chained GDP for the Yukon is steadily increasing (GNWT Bureau of Statistics 2010f).

The figures for the Federal, Provincial and Territorial GDPs are shown separately due to the differences in scale, as noted in Figures 3.2.3-1 and 3.2.3-2.



Source: GNWT Bureau of Statistics (2010f)

Figure 3.2.3-1
Chained (2002) GDP for Canada and Provinces, 2005 – 2009



Source: GNWT Bureau of Statistics (2010f)

Figure 3.2.3-2
Chained (2002) GDP for Territories, 2005 – 2009

3.2.3.2 Local and Regional Economic Development Goals and Objectives

The *Inuvialuit Final Agreement* (IFA) is a comprehensive land claim agreement providing the Inuvialuit people with guaranteed rights relating to land ownership and management, wildlife management and money from the Government of Canada. Sustainable development is the basis for the IFA. The IFA has set a series of basic goals which are as follows:

- Preserve the identity and values of the Inuvialuit culture within a changing northern society.
- Enable the Inuvialuit to be equal and meaningful participants in the northern and national economy and society.
- Preserve and protect the Arctic wildlife, environment and biological productivity (IRC 2007i).

Both Tuktoyaktuk and Inuvik have Community Conservation Plans (CCPs) established to protect the environment in the Beaufort-Delta region onshore and offshore, thereby ensuring the cultural survival of the Inuvialuit community. This will be done in accordance with the *Western Arctic (Inuvialuit) Claims Settlement Act* and the Inuvialuit Renewable Resource Conservation and Management Plan (Community of Tuktoyaktuk et al. 2008, Community of Inuvik et al. 2008).

Both Tuktoyaktuk and Inuvik have identified an overall strategy for conservation and resource management. This strategy is based on the following five goals:

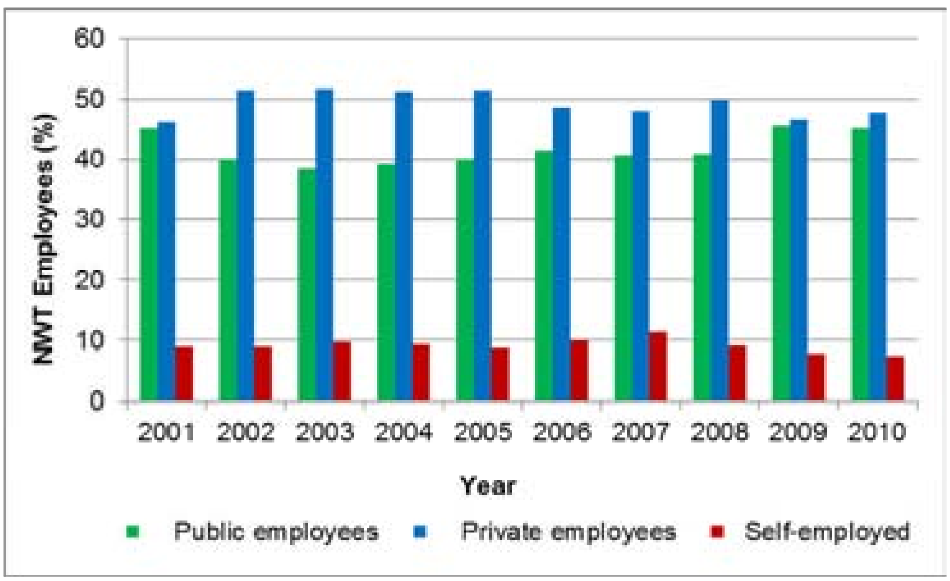
- Identify and protect important habitats and harvesting areas;
- Make land use decisions and managing cumulative impacts in order to help protect community values and conserve resources on which many lifestyles depend;

- Identify educational initiatives for the Inuvialuit of Tuktoyaktuk, Inuvik and others aimed at promoting conservation, understanding and appreciation;
- Define a system for wildlife management and conservation, and to identify population goals and conservation measures appropriate for each species of concern within a planning area; and
- Enhance the local economy by adopting a cooperative and consistent approach to community decision making and resource management (Community of Tuktoyaktuk et al. 2008, Community of Inuvik et al. 2008).

3.2.4 Employment

3.2.4.1 Employment Rate

Data for the number of public, private and self-employed employees are available annually at the territorial (NWT) level, but not at the regional (Beaufort–Delta) level. In the NWT, employment was relatively consistent from 2001 to 2009, with a slight increase overall (Figure 3.2.4-1). During this period, there were consistently more private employees than public employees, with the fewest number of people being self-employed (GNWT Bureau of Statistics 2010n).

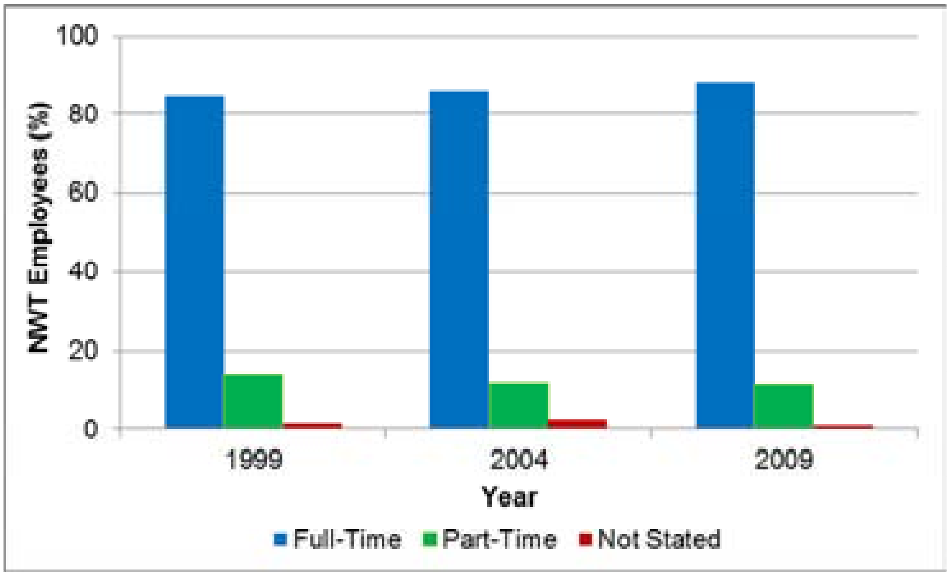


Source: GNWT Bureau of Statistics (2010n)

Figure 3.2.4-1
NWT Employment by Class of Worker, 2001 – 2009

According to GNWT Bureau of Statistics, full-time employment is defined as 30 or more paid hours worked per week. Part-time employment is defined as less than 30 paid hours worked per week (K. Odziemkowska, Labour Market Statistician, GNWT Bureau of Statistics, pers. comm., May 11, 2011).

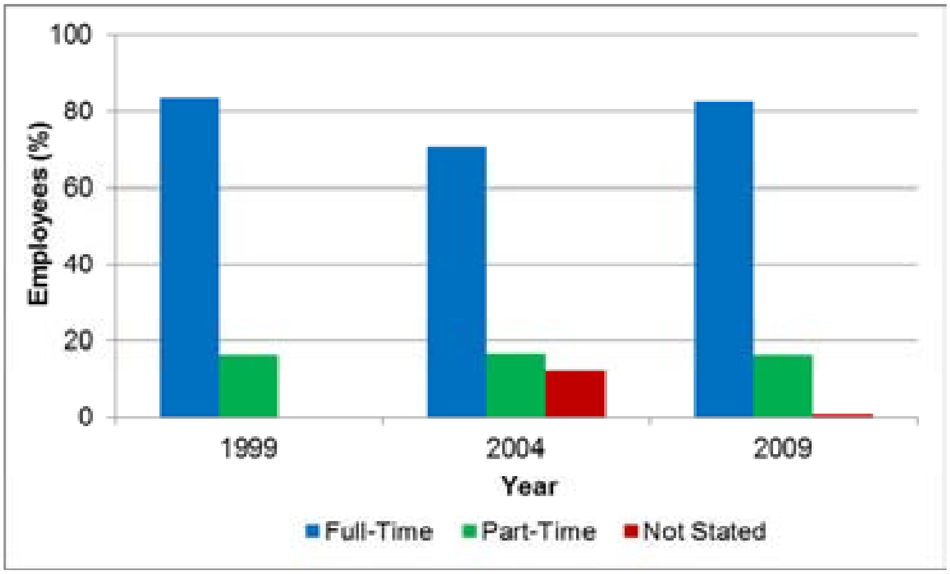
In the NWT, the majority of the population is employed full-time. Figure 3.2.4-2 presents the percent of NWT residents employed full-time, part-time and not stated.



Source: GNWT Bureau of Statistics (1999, 2004b, 2009c)

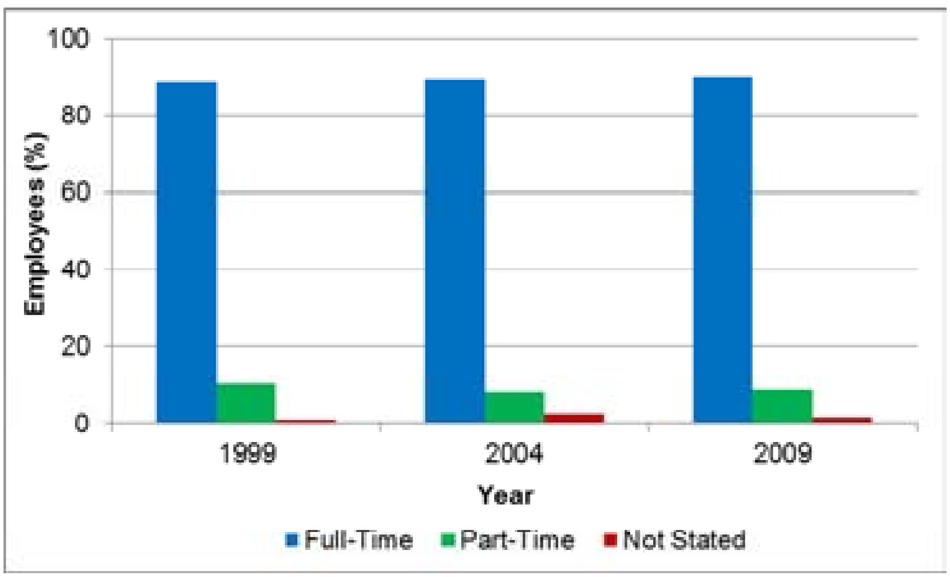
Figure 3.2.4-2
Percent of NWT Employees Working Full-Time and Part-Time, 1999-2009

The majority of the employees working in Tuktoyaktuk and Inuvik are employed full-time. However, there are a larger percentage of people working part-time in Tuktoyaktuk than in Inuvik (GNWT Bureau of Statistics 1999, 2004b, 2009c). These trends can be observed in Figure 3.2.4-3 and 3.2.4-4.



Source: GNWT Bureau of Statistics (1999, 2004b, 2009c)

Figure 3.2.4-3
Percent of Tuktoyaktuk Employees Working Full-Time and Part-Time, 1999-2009



Source: GNWT Bureau of Statistics (1999, 2004b, 2009c)

Figure 3.2.4-4
Percent of Inuvik Employees Working Full-Time and Part-Time, 1999-2009

Data from the GNWT Bureau of Statistics Data Portal were used to determine seasonal employment in the NWT. The GNWT Bureau of Statistics provided monthly employment rates at the territorial level, which were then categorized into seasonal employment rates as per the EIRB's Terms of Reference. The months were categorized into the following seasons:

- Winter season included December, January and February;
- Spring season included March, April and May;
- Summer season included June, July and August; and
- Fall season included September, October and November.

The employment rate is expressed as a percent and includes all persons aged 15 and over who were employed during the specific reporting period (years 2001 to 2010). The average employment rate for the months within each season was calculated and used to express seasonal employment rates on an annual basis, this can be observed in Figures 3.2.4-5 and 3.2.4-6.

Figure 3.2.4-5 shows the seasonal employment from 2001 to 2010. Summer and fall have the highest employment rates; however, all seasons follow a similar trend over time. The employment rates peaked in 2006 and 2007, and decreased in 2008 and 2009. This trend likely demonstrates the effects of the economic recession.

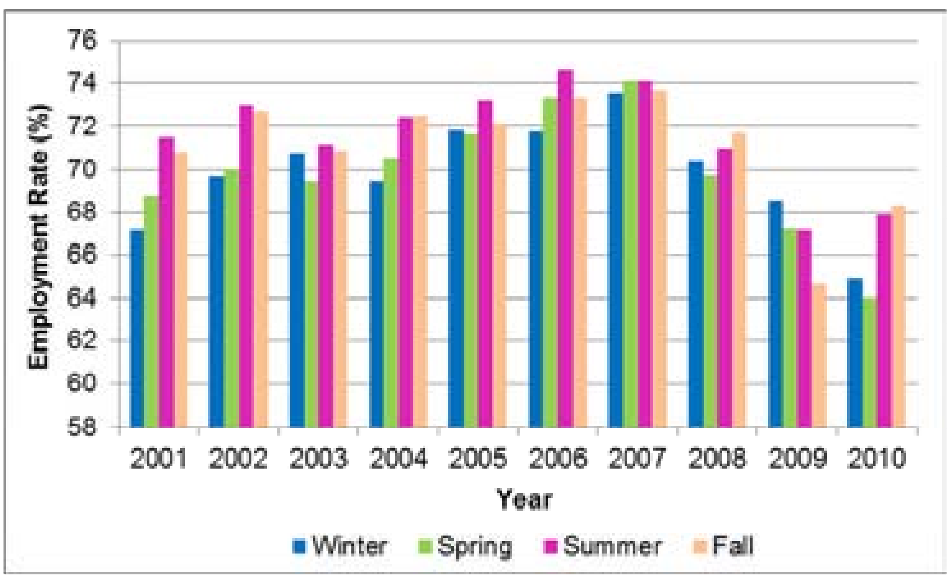


Figure 3.2.4-5
NWT Seasonal Employment Rates, 2001 - 2010

In comparison, Figure 3.2.4-6 shows the average employment rate between all the years (2000 to 2010) per season. This helped to further identify trends in employment rates among seasons. The employment rate for all seasons is relatively consistent ranging from 70-72%. Employment rates are generally higher in the summer and fall compared to winter and spring.

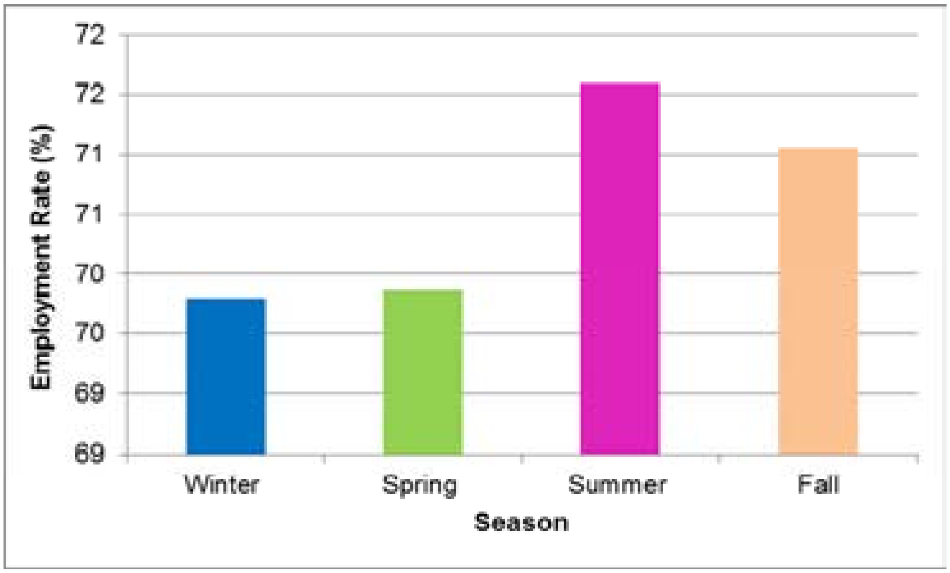


Figure 3.2.4-6
NWT Average Seasonal Employment Rates 2001 - 2010

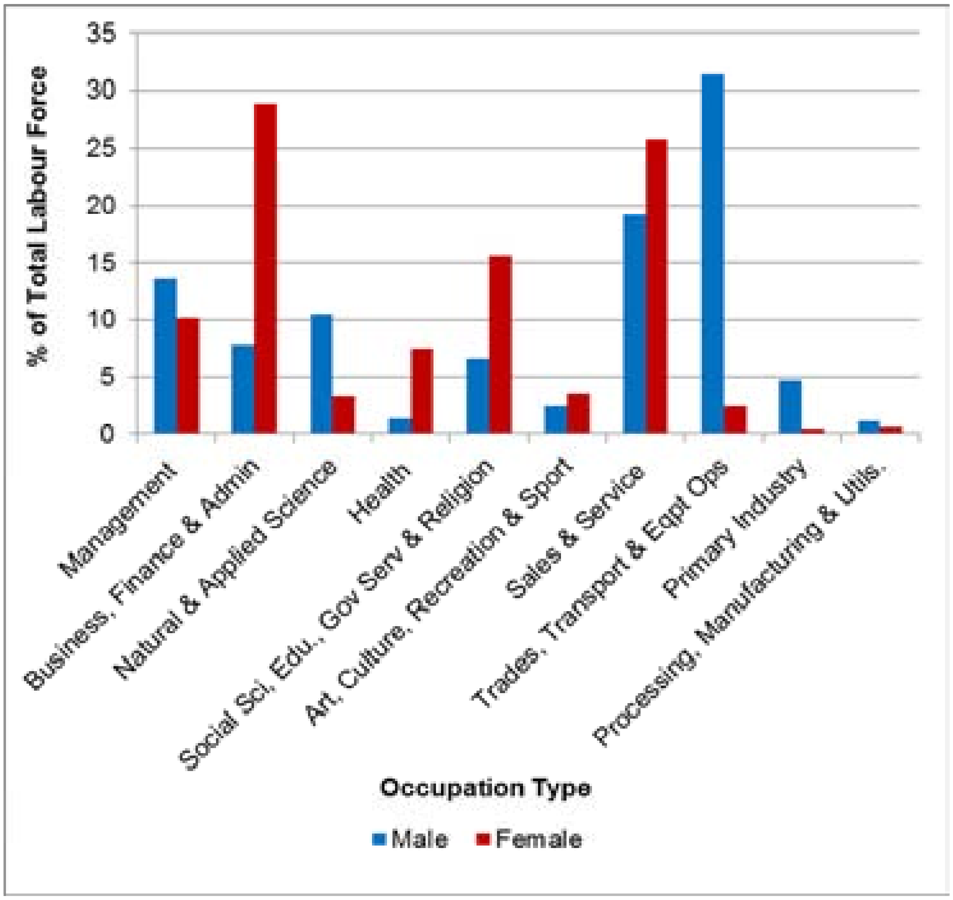
Employment by Occupation and Industry

The 2006 census conducted by Statistics Canada categorizes employment in the NWT by different parameters, including occupation and industry types.

The term "occupation" refers to the type of work that persons were doing during the census reference week, determined by both their job title and responsibilities (Statistics Canada 2006c).

Figure 3.2.4-7 shows the 2006 NWT total labour force categorized by occupation type and gender. Of the total female labour force, business, finance and administrative (28.9%); sales and services (25.8%); and social sciences, education, government services and religion (15.6%) were the three most commonly held occupation types. Of the total male labour force, trades, transport and equipment operators (31.3%), sales and services (19.2%), and management occupations[4] (13.6%) were the three most commonly held occupation types (Statistics Canada 2006a).

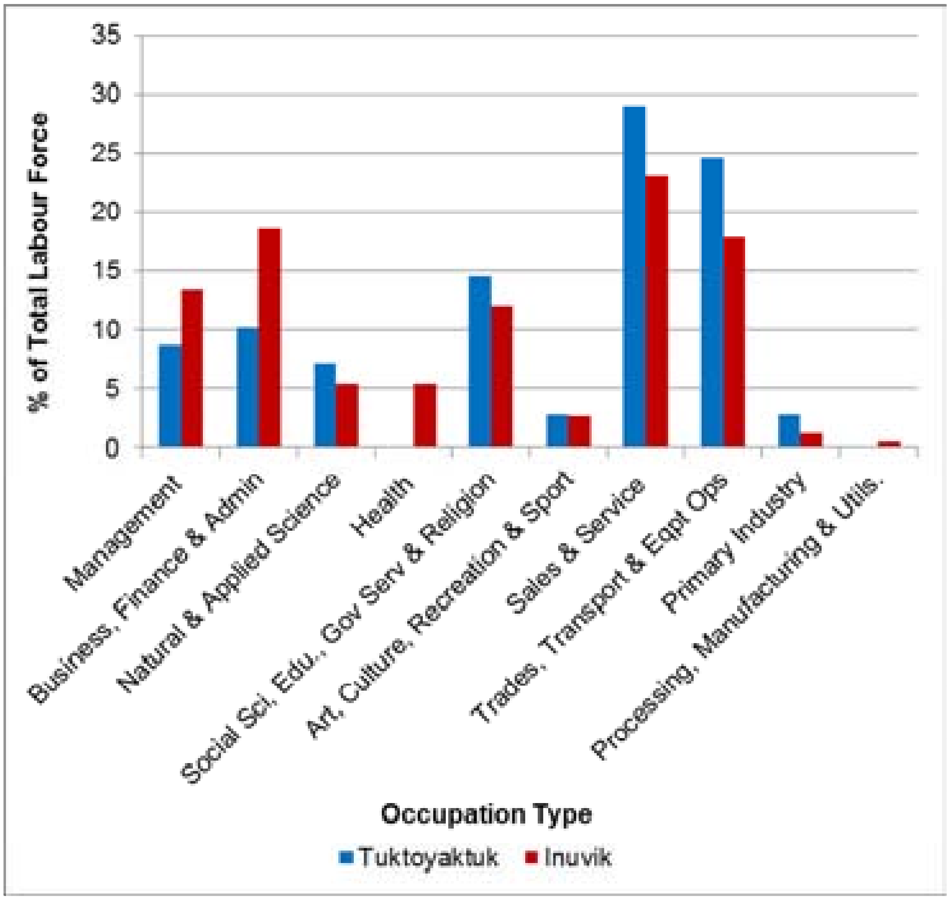
[4] Note: the category "management occupations" is broad and should be used with caution as there were coding errors that occurred when conducting the census. The appropriate level and area of specialization of management was not documented (Statistics Canada 2006d). Further, the census data have been rounded to the nearest tenth so statistics expressed for both occupation and industry are not exact (K. Odziemkowska, pers. comm., January 11, 2011).



Source: Statistics Canada 2006a

Figure 3.2.4-7
Occupation Participation by Gender, NWT, 2006

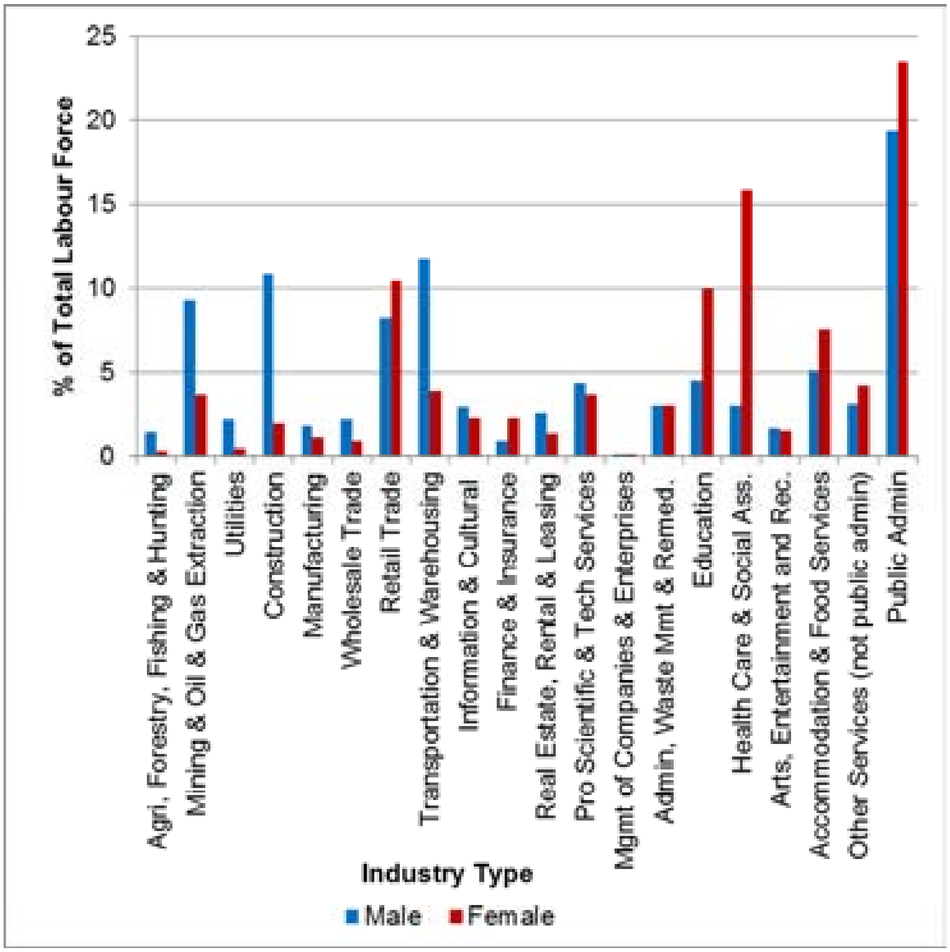
The total labour force in the Hamlet of Tuktoyaktuk is 345 persons, and the total labour force in the Town of Inuvik is 2,020 persons (Statistics Canada 2006a, 2006b). Figure 3.2.4-8 shows the 2006 NWT total labour force categorized by occupation type and community. Of the total Tuktoyaktuk labour force, sales and services (29.0%), trades transport and equipment operators (24.6%), and social science, education, government service and religion (14.5%) were the three most commonly held occupation types. Of the total Inuvik labour force, sales and services (23.0%), business finance and administration (18.6%), and trades transport and equipment operators (17.8%) were the three most commonly held occupation types (Statistics Canada 2006a, 2006b).



Source: Statistics Canada (2006a, 2006b)

Figure 3.2.4-8
Occupation Participation for Tuktoyaktuk and Inuvik, 2006

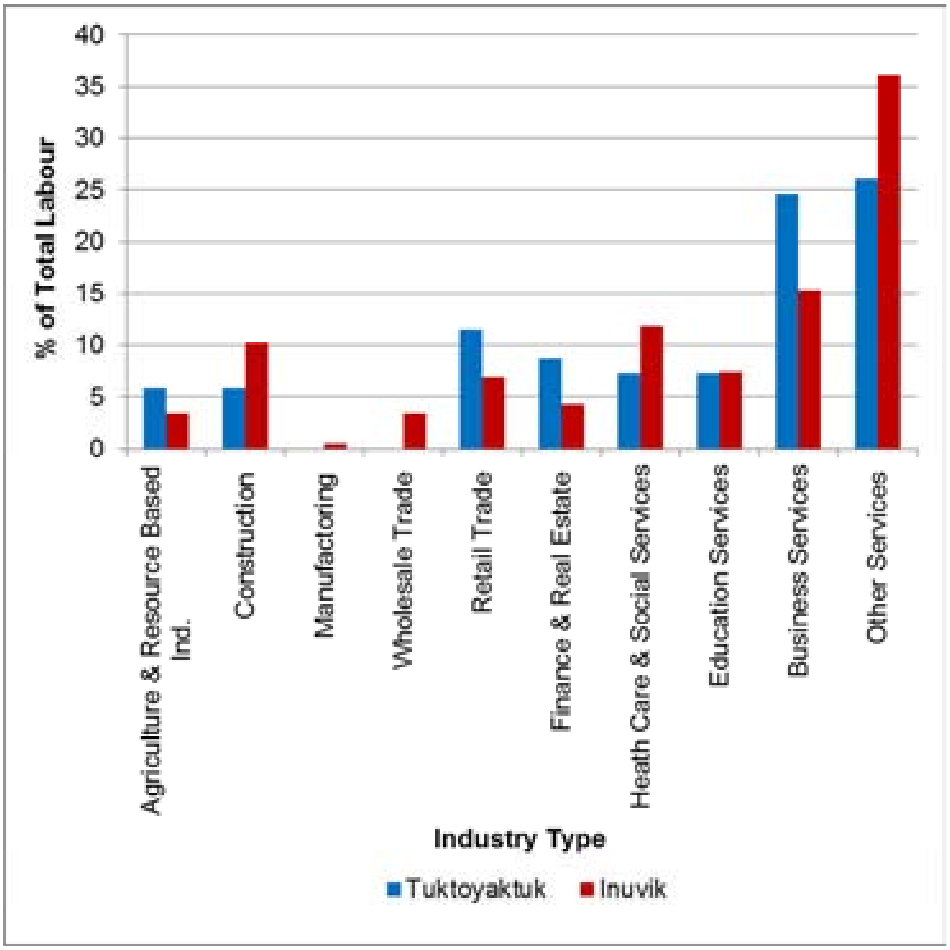
The term "industry" refers to the nature of the business being carried out at the establishment where the census participants worked (Statistics Canada 2006e). Figure 3.2.4-9 presents the 2006 NWT total labour force categorized by industry type and gender. Of the total female labour force, public administration (23.4%), health care and social assistance (15.9%), and retail trade (10.5%) were the industry types most commonly worked in. Of the total male labour force, public administration (19.4%), transportation and warehousing (11.8%), and construction (10.9%) were the industry types most commonly worked in (Statistics Canada 2006a).



Source: Statistics Canada (2006a)

Figure 3.2.4-9
NWT Industry Participation by Gender, 2006

Figure 3.2.4-10 shows the 2006 NWT labour force categorized by industry type and community. Of the total Tuktoyaktuk labour force, other services (26.1%), business services (24.6%), and retail trade (11.6%) were the three industry types most commonly worked in. Of the total Inuvik labour force, other services (36.1%), business services (15.3%), and health care and social services (11.9%) were the three industry types most commonly worked in (Statistics Canada 2006a, 2006b).



Source: Statistics Canada (2006a, 2006b)

Figure 3.2.4-10
Industry Participation for Tuktoyaktuk and Inuvik, 2006

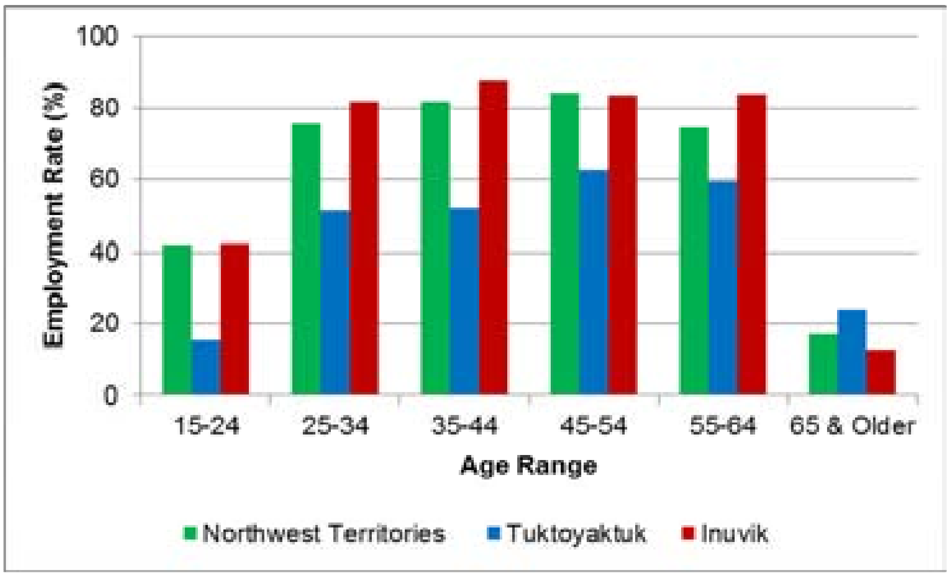
Employment Demographics

In 2009, the employment rates for the male and female residents of the NWT were 68.1% and 66.4%, respectively. The Aboriginal population had an employment rate of 49.8% and the non-Aboriginal population had an employment rate of 83.1% (GNWT Bureau of Statistics 2010k).

In 2009, the employment rates for the male and female residents of Tuktoyaktuk were 44.5% and 44.2%, respectively. The Aboriginal population had an employment rate of 31.5% and the non-Aboriginal population had an employment rate of 86.0% (GNWT Bureau of Statistics 2010k). Both genders and the Aboriginal population in Tuktoyaktuk have lower employment rates compared to the employment rates for the NWT.

In 2009, the employment rates for the male and female residents of Inuvik were 74.8% and 67.3%, respectively. The Aboriginal population had an employment rate of 57.3% and the non-Aboriginal population had an employment rate of 90.8% (GNWT Bureau of Statistics 2010l). Inuvik in general has higher employment rates than both Tuktoyaktuk and the NWT.

Figure 3.2.4-11 shows 2009 employment rates by age category for the NWT, Tuktoyaktuk and Inuvik. In both the NWT and Inuvik, the age group with the highest employment rate was 35-44. However, in Tuktoyaktuk, the age group with the highest employment rate was 45-54 (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics 2010k and 2010l)

Figure 3.2.4-11
NWT, Tuktoyaktuk and Inuvik Age Based Employment Rates, 2009

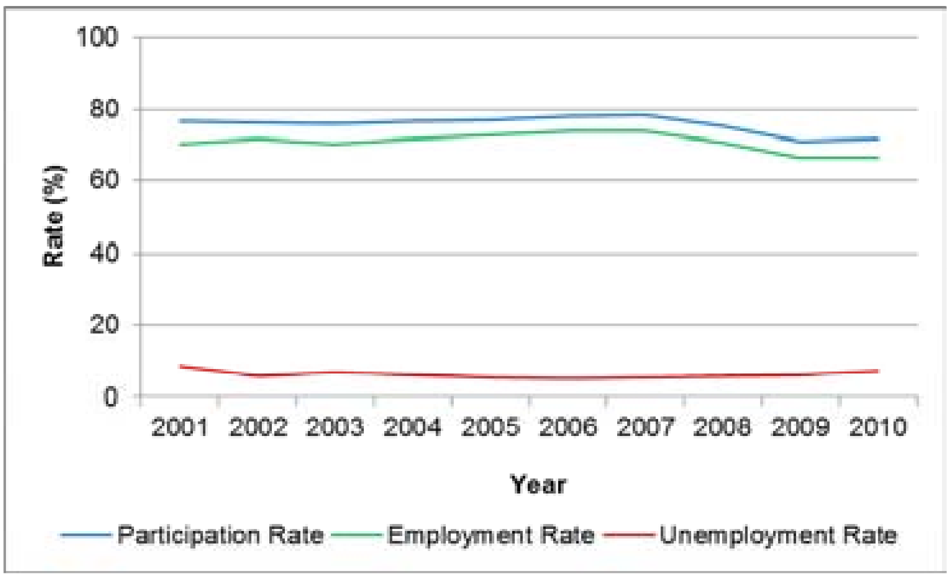
Unfilled Employment Positions

According to Jobs North, in December 2010 there were 112 job vacancies in the NWT in several employment sectors including the service industry, engineering, sciences, trades, administration, health care, and education. Of these 112 jobs, three were located in Inuvik and none were located in Tuktoyaktuk (GNWT ECE 2010a). There are likely other unfilled positions that are posted informally around the community.

Labour Force Participation & Growth

The labour force is defined by the GNWT Bureau of Statistics as persons who were either employed or unemployed during the week prior to the survey. Within the labour force, employed persons are persons who, during the week prior to the survey: (i) did any work at all, excluding housework, maintenance around the home and volunteer work; or (ii) were absent from their job or business because of vacation, illness, on strike or locked out, etc. Unemployed persons are those who, during the week prior to the survey: (i) were without work, had actively looked for work in the previous four weeks and were available for work; or (ii) had been on temporary lay-off and expected to return to their job; or (iii) had definite arrangements to start a new job within the next four weeks. Persons who do not participate in the labour force are neither employed nor unemployed (GNWT Bureau of Statistics 2010k).

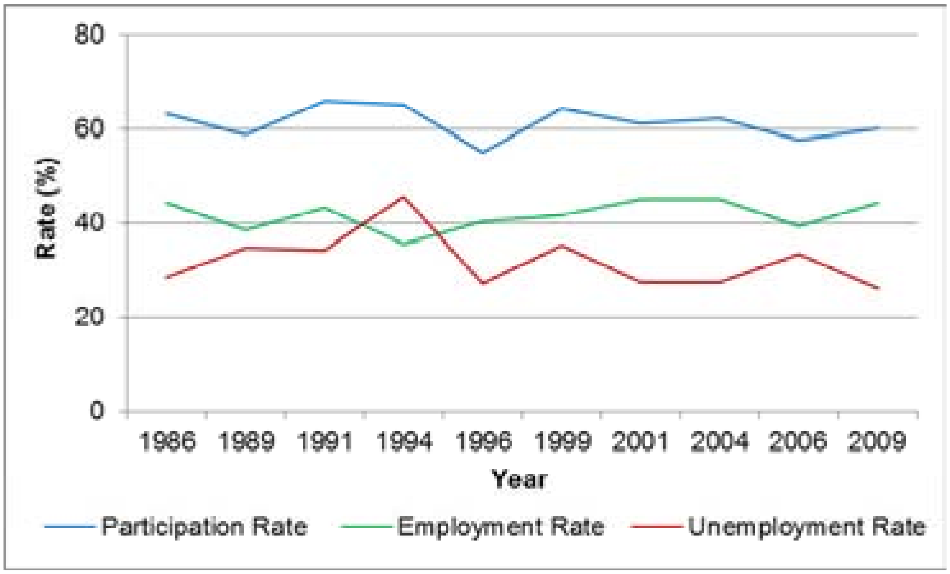
Labour force participation rate in the NWT increased from 2001 to 2007, and then decreased from 2008 to 2009, indicating that the NWT experienced labour force growth prior to the global economic recession in 2008. The employment rate followed a similar trend the participation rate and the unemployment rate remained relatively constant. The lower employment rate in 2009 is attributable to the number of persons not in the labour force, which increased by 1,300 persons (GNWT Bureau of Statistics 2010h, 2010o). The overall labour force activity in the NWT can be observed in Figure 3.2.4-12.



Source: GNWT Bureau of Statistics (2010o)

Figure 3.2.4-12
NWT Population (Aged 15 & Older) by Labour Force Activity, 2001-2009

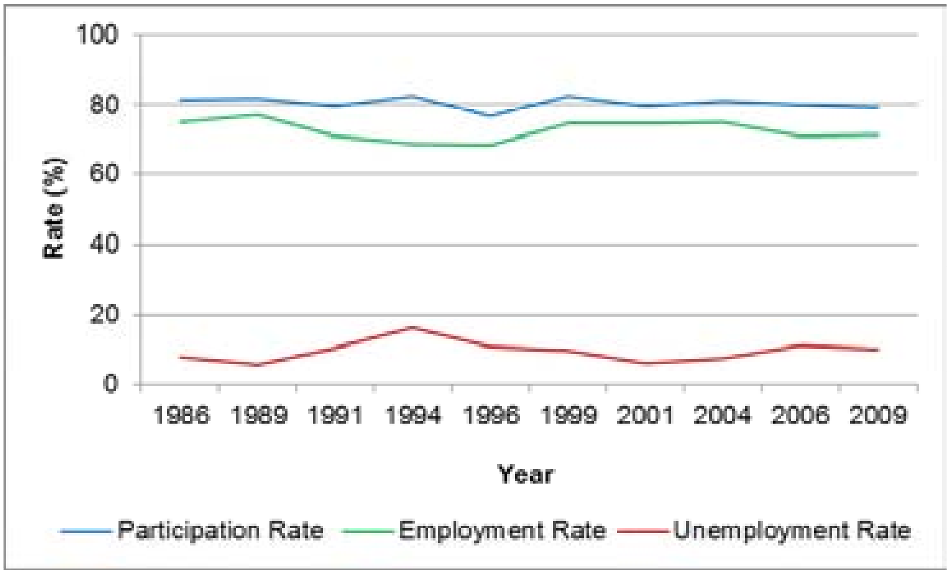
Community employment data for Tuktoyaktuk are provided in Figure 3.2.4-13. In 2009, 726 residents were aged 15 years and older. Employment data indicate that of those aged 15 years and older, 322 residents were employed, 113 residents were unemployed, and 291 residents were not in the labour force. This translates into an employment rate of 44% and an unemployment rate of 26%. Both employment and unemployment rates have fluctuated between 1986 and 2009, particularly in 1994 when the unemployment rate was higher than the employment rate. Overall employment increased slightly, while unemployment decreased slightly (GNWT Bureau of Statistics 2010k).



Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.4-13
Tuktoyaktuk Population (Aged 15 & Older) by Labour Force Activity, 1986 – 2009

Community employment data for Inuvik are provided in Figure 3.2.4-14. In 2009, 2,766 residents were aged 15 years and older. Employment data indicate that of the population aged 15 years and older, 1,969 residents were employed, 220 residents were unemployed, and 577 residents were not in the labour force. This translates into an employment rate of 71% and an unemployment rate of 10%. Both employment and unemployment rates have remained relatively stable between 1986 and 2009, with some fluctuations from 1994 to 2001 (GNWT Bureau of Statistics 2010l).

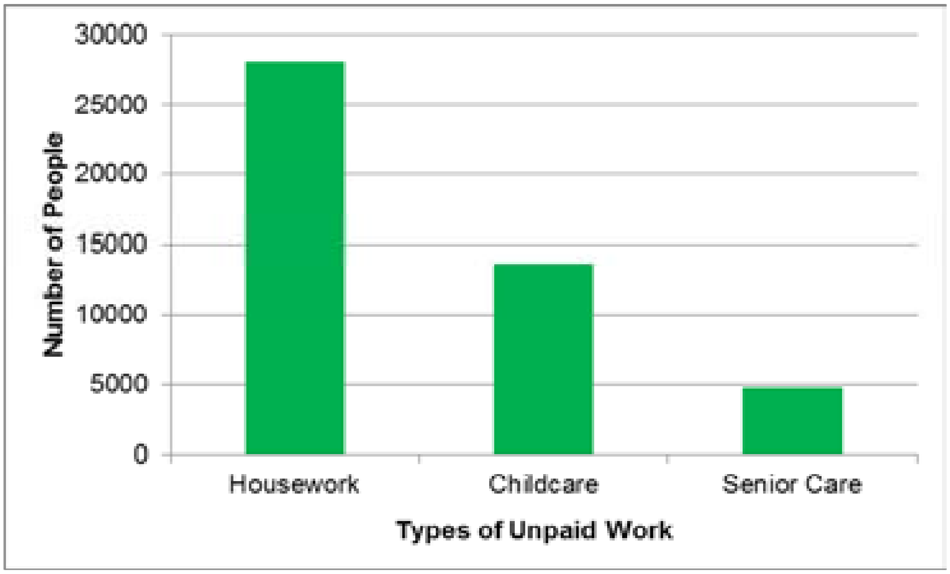


Source: GNWT Bureau of Statistics (2010l)

Figure 3.2.4-14
Inuvik Population (Aged 15 & Older) by Labour Force Activity, 1986 – 2009

The 2006 census conducted by Statistics Canada collected data for unpaid work. ThiS category includes: housework, childcare, and care of seniors. Unpaid services can either be provided to a worker's own household or to other family member households (Statistics Canada 2006a, 2006b).

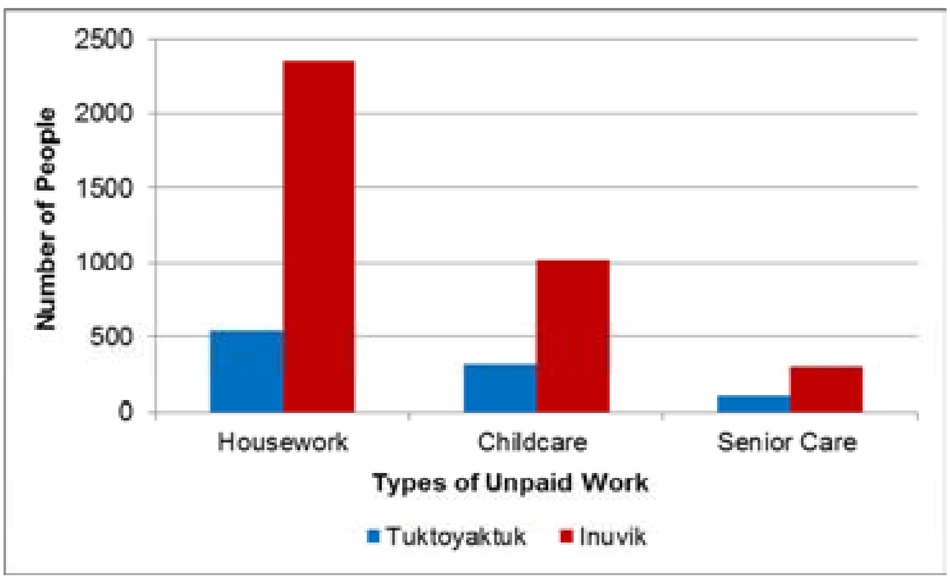
Figure 3.2.4-15 shows the categories of unpaid work for the NWT. The category of unpaid work with the greatest number of participants 15 years of age and older was housework with 27,980 participants. Senior care had the least number of participants, at 4,700 participants (Statistics Canada 2006).



Source: Statistics Canada (2006a)

Figure 3.2.4-15
NWT Population 15 Years and Older Reporting Unpaid Work, 2006

Figure 3.2.4-16 shows the categories of unpaid work for both Tuktoyaktuk and Inuvik. Housework was the category of unpaid work with the highest participation from people aged 15 years and older. In 2006, 540 people in Tuktoyaktuk (60% of the total population) and 2,345 people (64%) in Inuvik reported unpaid housework. Housework includes: general housework, yard work, and home maintenance (Statistics Canada 2006a, 2006b).



Source: Statistics Canada (2006a and 2006b)

Figure 3.2.4-16
Population 15 Years and Older Reporting Unpaid Work in Tuktoyaktuk and Inuvik, 2006

Based on the location, terrain, and environment in the region, there are limited renewable resource sector activities. In other parts of Canada, renewable resource sectors include forestry. The forests near Inuvik are relatively sparse, and no trees appear on the tundra. Traditional country foods harvesting is the primary renewable resource activity in the region and many households rely on this for subsistence. Detailed harvesting information is found in Section 3.2.8 (GNWT ENR ND).

Current and projected land or water based industrial operations, enterprises and economic activities in Tuktoyaktuk and Inuvik include:

- Oil and gas exploration and development;
- Tourism;
- Wildlife guiding/outfitting;
- Subsistence (unpaid) harvesting;
- Transporting goods by barge; and
- Recreational activities related to traditional use of the land.

Licensed Businesses

There are 133 licensed businesses on the Inuvialuit Business List (IBL) in the ISR. There is no maximum number of businesses on the IBL (A. Bourke, Cooperation and Benefits Agreement Manager, pers. comm., February 1, 2011).

In 2000, the Inuvialuit Regional Corporation (IRC) created a policy with criteria for including an Inuvialuit business on the IBL. Key criteria include:

- Inuvialuit ownership requirements;
- Physical presence; and
- Operational capacity (IRC 2007h).

Should a business fail to meet all criteria, it will not be included on the IBL. Therefore, 100% of businesses listed on the IBL are Inuvialuit-owned (IRC 2007h).

Inclusion on the IBL provides businesses with an opportunity to access:

- The contracting preferences as outlined in the *Inuvialuit Final Agreement*;
- Inuvialuit Land Administration permits;
- Co-operation, benefits and other economic agreements signed between IRC and both government and industry (Inuvialuit Regional Corporation 2007h).

Within the IBL, there is a special category of businesses listed in Schedule A of the IFA. Businesses listed in Schedule A include those that provide an essential service to Inuvialuit communities or those in which the Inuvialuit have made a significant investment. Companies on the Schedule A list include:

- Aklak Air Limited;
- Canadian Helicopters Limited;
- Northern Transportation Company Limited (NTCL);
- Canadian North Incorporated; and
- Akita Equtak Drilling Limited (IRC 2007h).

Priority is given to businesses listed in Schedule A. For example, a company requiring goods or services within the region should first try to acquire goods or services from businesses on the Schedule A list. If the Schedule A business cannot provide the good or service in an adequate amount of time or at a competitive rate, the company may contact any other Inuvialuit Businesses on the IBL (IRC 2007h).

Data regarding business ownership by gender are not available; however, based on the names of the company's primary contacts or principals, 77% of owners are males and 23% are females (IRC 2007h).

In Tuktoyaktuk, there were a total of 34 business licenses issued in 2010. Of those, 14 (41%) were listed on the IBL and 20 (59%) were not (C. Gordon, Economic Development Officer, Hamlet of Tuktoyaktuk, pers. comm., February 1, 2011).

In Inuvik, there were a total of 245 business licenses issued in 2010. Of those 245 licenses, 36 (15%) were listed on the IBL and 209 (85%) were not (P. Watters, Town of Inuvik, February 1, 2011).

Employment Related to Traditional Activities

Traditional activities range from the production of arts and crafts to harvesting country foods. The arts and crafts produced include: carvings, drawings or paintings, sewing or needlecraft, weaving or basket making, jewelry, performing arts, and writing books (GNWT Bureau of Statistics 2008d). Employment data related to traditional activities are generally not available since many of the traditional activities are produced for personal or cultural use, and are not paid employment. Available data related to employment and traditional activities are described in this section.

During 2008 there were a total of 2,948 people producing arts and crafts in the NWT; that is, 8.7% of the total number of persons aged 15 and older living in the NWT. In the Beaufort-Delta region, 727 (13%) of the 5,398 persons aged 15 and over produced arts and crafts in 2008, including 307 people or 42.2% selling their works (GNWT Bureau of Statistics 2008d).

Trapping is another traditional activity that generates revenue. Table 3.2.4-1 shows the average annual income received by trappers in 1987, 1993, 1999 and 2002. It is important to note that this income is solely from trapping and not from other employment (IOL et al. 2004).

TABLE 3.2.4-1: AVERAGE ANNUAL INCOME OF ACTIVE TRAPPERS IN INUVIK AND TUKTOYAKTUK

Location	Average Annual Income ($)			
	1987	1993	1999	2002
Tuktoyaktuk	1,415	1,132	438	807
Inuvik	1,821	432	729	676

Source: IOL et al. (2004)

Data regarding the sale of country foods is not available. It is known that some residents do sell their country foods, but this is likely through an informal system. Although not specific to employment, the GNWT Bureau of Statistics (2010k) identifies the 2008 level of involvement of NWT residents in traditional activities:

- 39.4% of residents (15 years of age and older) hunted and fished;
- 6.2% of residents (15 years of age and older) trapped;
- 8.7% of residents (15 years of age and older) produced arts and crafts; and
- 28.1% of households obtained half or more of the meat and fish they consumed through hunting and fishing.

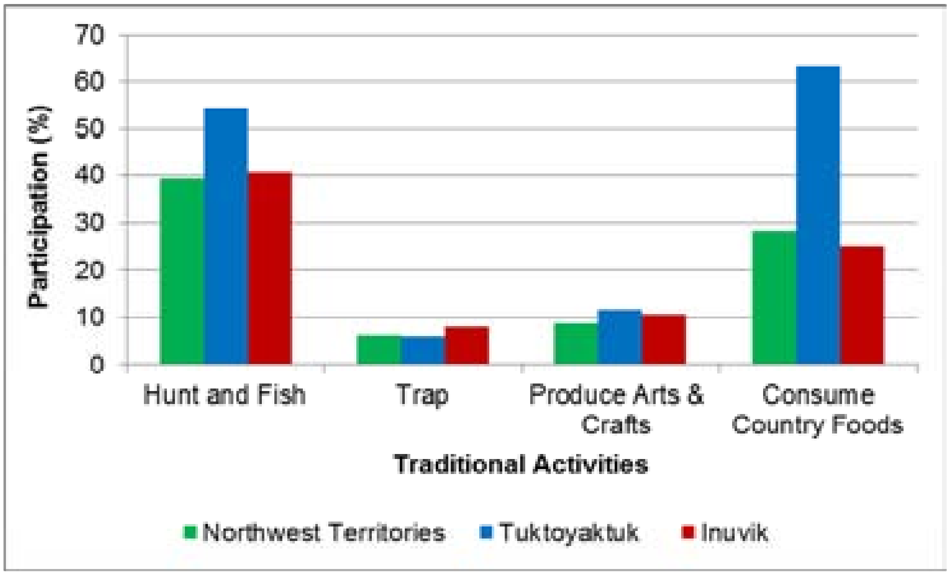
In Tuktoyaktuk, the 2008 level of involvement in traditional activities was generally higher than the NWT with the exception of trapping. Tuktoyaktuk levels of involvement in traditional activities are as follows:

- 54.4% of residents (15 years of age and older) hunted and fished;
- 5.8% of residents (15 years of age and older) trapped;
- 11.7% of residents (15 years of age and older) produced arts and crafts; and
- 63.3% of households obtained half or more of the meat and fish they consumed through hunting and fishing (GNWT Bureau of Statistics 2010k).

In Inuvik the 2008 level of involvement in traditional activities was also generally higher than the NWT with the exception of households obtaining half or more of the meat and fish they consumed through hunting or fishing. Inuvik levels of involvement in traditional activities are as follows:

- 40.8% of residents (15 years of age and older) hunted and fished;
- 7.9% of residents (15 years of age and older) trapped;
- 10.6% of residents (15 years of age and older) produced arts and crafts; and
- 25.2% of households obtained half or more of the meat and fish they consumed through hunting or fishing (GNWT Bureau of Statistics 2010l).

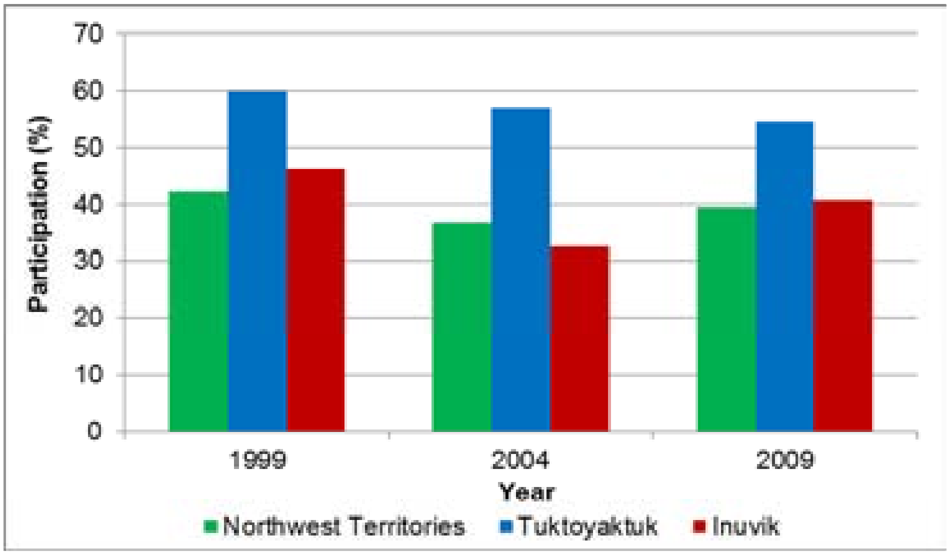
Figure 3.2.4-17 identifies the participation in traditional activities in Tuktoyaktuk and Inuvik in 2008 (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k and 2010l)

Figure 3.2.4-17
Participation in Traditional Activities, NWT, Tuktoyaktuk and Inuvik, 2008

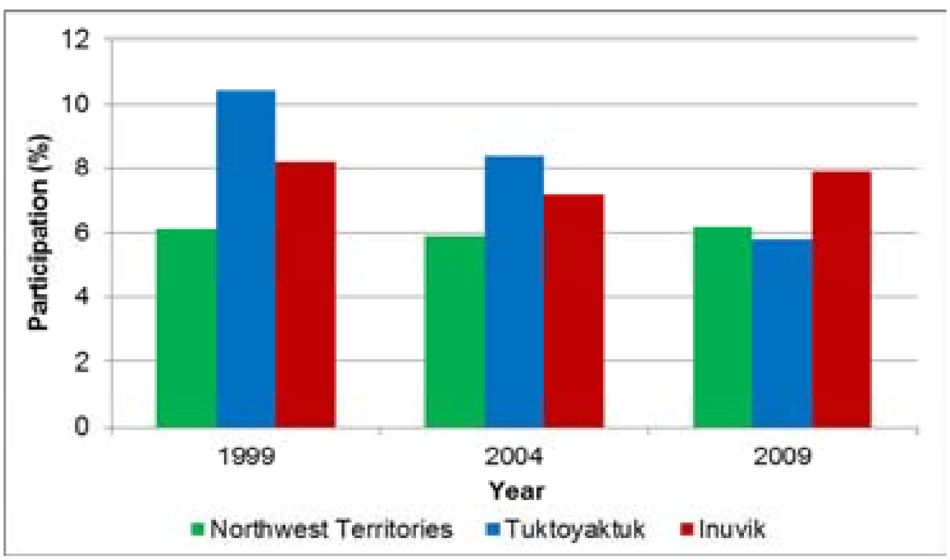
Figure 3.2.4-18 shows the percent participation of persons 15 years and over who hunted and fished. The participation rates for hunting and fishing activities in the NWT and Inuvik decreased from 1999 to 2004, and increased from 2004 to 2009. In Tuktoyaktuk, participation rates continuously decreased, but still maintained higher rates of participation than both the NWT and Inuvik (GNWT Bureau of Statistics 2010g).



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.4-18
Persons 15 and Over Who Hunted or Fished in Previous Years, 1999-2009

The NWT and Inuvik follow similar patterns for participation in trapping activities as they did for participation in hunting and fishing activities. Tuktoyaktuk also follows a similar pattern; however, in 2009 the Tuktoyaktuk participation rate drops below both the NWT and Inuvik. This can be observed in Figure 3.2.4-19 (GNWT Bureau of Statistics 2010g).



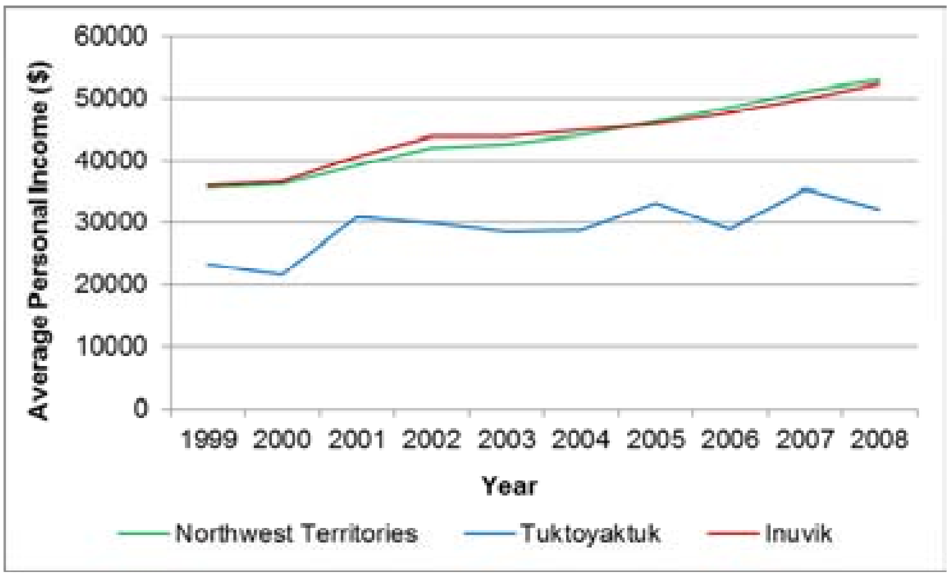
Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.4-19
Persons 15 and Over Who Trapped in Previous Years, 1999-2009

3.2.4.2 Income

Income and Earnings Growth

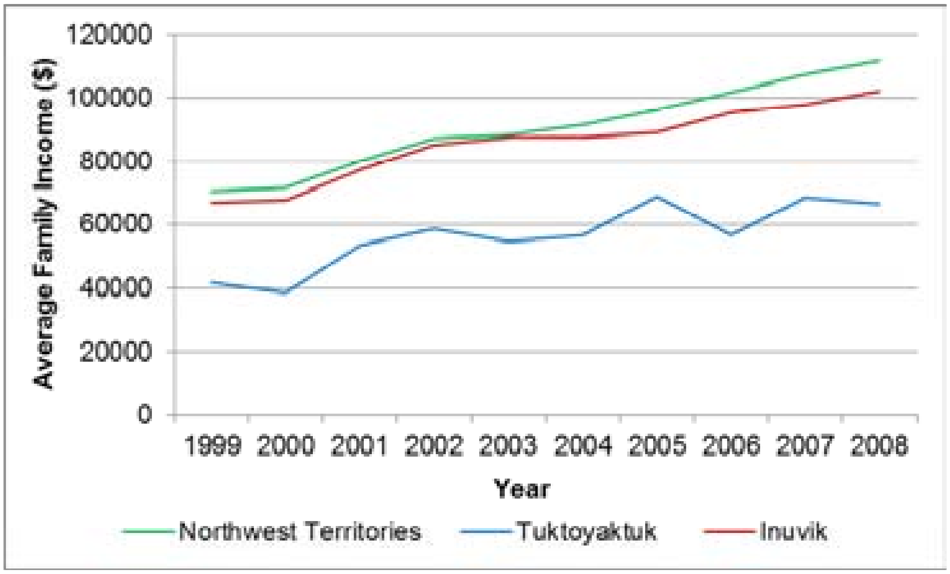
The average personal income for residents of the NWT, Tuktoyaktuk and Inuvik has increased since 1999 (Figure 3.2.4-20). Average personal income refers to the average monetary income from all sources for an individual (GNWT Bureau of Statistics 2009 a, 2009b). In the NWT, the average personal income increased from $35,650 in 1999 to $52,943 in 2008. In Tuktoyaktuk, average personal income increased from $23,273 to $32,204 in 2008. In Inuvik, average personal income increased from $36,060 in 1999 to $52,271 in 2008. The NWT and Inuvik follow similar trends with similar average values; however, the average personal income in Tuktoyaktuk is consistently lower and follows a less consistent trend (GNWT Bureau of Statistics 2010k and 2010l).



Source: GNWT Bureau of Statistics (2010k and 2010l)

Figure 3.2.4-20
Average Personal Income in Tuktoyaktuk and Inuvik, 1999 - 2008

Similar trends are observed in Figure 3.2.4-21 for the average family incomes in the NWT, Tuktoyaktuk, and Inuvik from 1999 to 2008 (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k and 2010l)

Figure 3.2.4-21
Average Family Income in the NWT Tuktoyaktuk and Inuvik, 1999-2008

Poverty and Social Assistance

Specific groups within a community that are more vulnerable to poverty include seniors, persons with disabilities, families led by single mothers and single people in general. Should an individual fall into more than one of these groups they have an even greater vulnerability to poverty (GNWT ECE 2007).

Men and women aged 65 and older are equally vulnerable to poverty. Possible reasons for this vulnerability include lower levels of education, type of work and work history, poor health, and marital break ups (GNWT ECE 2007).

Persons with disabilities typically have higher daily living costs. A person with a profound and prolonged disability is often able to collect supplemental benefits to compensate for the increased daily living costs. A person with a work-limiting disability is more vulnerable to poverty than those persons with profound prolonged disabilities (GNWT ECE 2007).

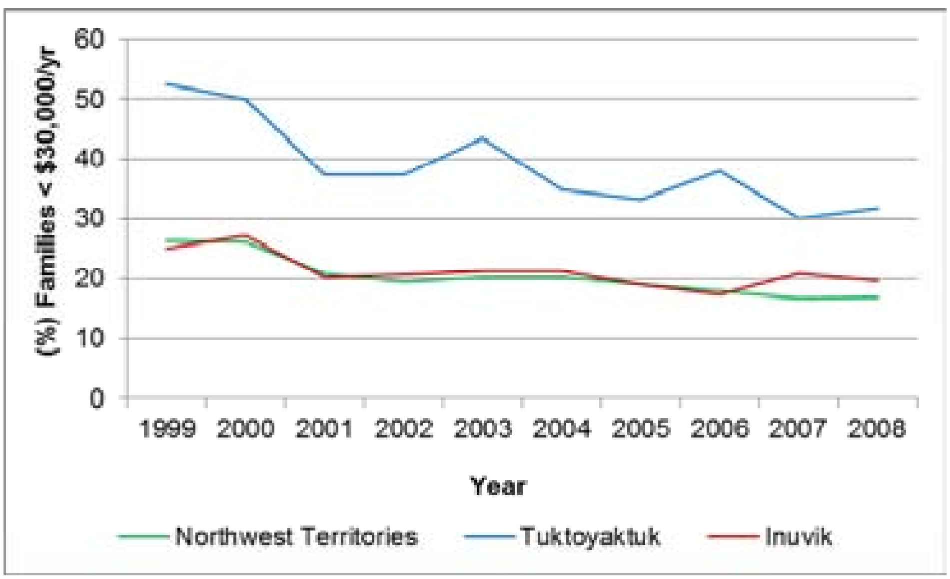
More social assistance programs exist for families and single parents to counteract the proven lifelong potential effects of growing up in poverty. However, there are fewer assistance programs for single persons living in poverty (GNWT ECE 2007).

Poverty is not specifically defined or monitored by Statistics Canada or the GNWT Bureau of Statistics. According to GNWT ECE (2007), it is generally agreed that poverty is not only the result of a lack of financial resources but also an inability to participate in social and economic activities.

According to the GNWT Department of Education, Culture and Employment (ECE), income is one of the most practical indicators of poverty. There is, however, no general consensus on the definition of low-income. Statistics Canada uses three statistical measures for low-income communities: Market Basket Measure (MBM), Low Income Cut Offs (LICO), and Low Income Measure (LIM). These measures are often used as poverty line indicators although Statistics Canada does not define them as such.

In the NWT, LIM is used as a general measure of poverty (as it allows for international comparison). LIM is a 50% fixed percentage of the median adjusted income for households in a specific region. The term "adjusted" indicates that household size and needs were accounted for when calculating income (Statistics Canada 2010a).

Figure 3.2.4-22 shows the percent of families in the NWT, Tuktoyaktuk, and Inuvik that earned less than $30,000 annually from 1999 to 2008. The NWT and Inuvik follow similar trends differing most significantly in 2007 and 2008 when Inuvik had a higher percentage than the NWT. Tuktoyaktuk had a greater percentage than both the NWT and Inuvik, peaking in 1999 at 52.4% then again in 2003 and 2006 at 43.5% and 38.1%, respectively. In general the percent of families earning less than $30,000 annually decreased in Tuktoyaktuk, Inuvik and the NWT from 1999 to 2008.



Source: GNWT Bureau of Statistics (2010k, 2010l)

Figure 3.2.4-22
Percent of Families with Annual Income less than $30,000, 1998 - 2008

Table 3.2.4-2 shows the percentage of households in the NWT with less than $30,000 income categorized by selected characteristics. The household characteristics include the number of people per household and whether the household includes a senior. The percentage of single person households earning less than $30,000 was a 31.9%, while the percentage of seniors' households earning less than $30,000 was 39.9% (GNWT ECE 2007).

TABLE 3.2.4-2: PERCENTAGE OF HOUSEHOLDS IN THE NWT WITH LESS THAN $30,000 INCOME, BY SELECTED CHARACTERISTICS, 2004

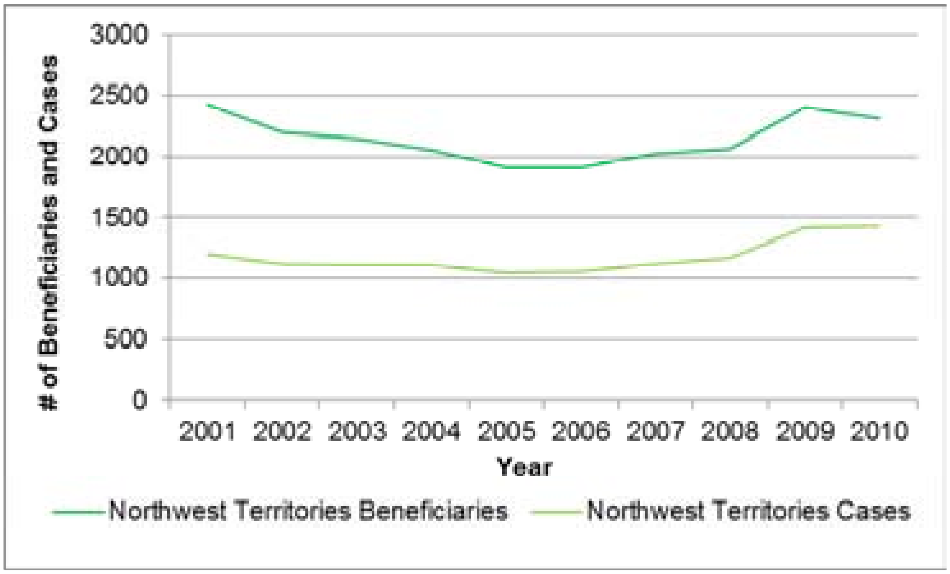
Characteristic	Percentage
One Person	31.9
Two or Three Persons	13.2
Four or Five Persons	8.9
Six or More Persons	9.4
Household with Senior	39.9
Household without Senior	10.8

Source: GNWT ECE (2007)

The GNWT Department of Education Culture and Employment categorizes the usage and monetary cost of income assistance according to:

- Beneficiaries - defined as "the monthly average number of recipients of income assistance and their dependants, if any, over the year";
- Case - defined as "the monthly average number of people receiving social assistance over the year"; and
- Payment – defined as "the total amount of payments made over the year (GNWT Bureau of Statistics 2009a).

In the NWT, the monthly average number of income assistance beneficiaries and cases decreased from 2001 to 2006, then increased from 2006 to 2010. This can be observed in Figure 3.2.4-23 (GNWT Bureau of Statistics 2010k).

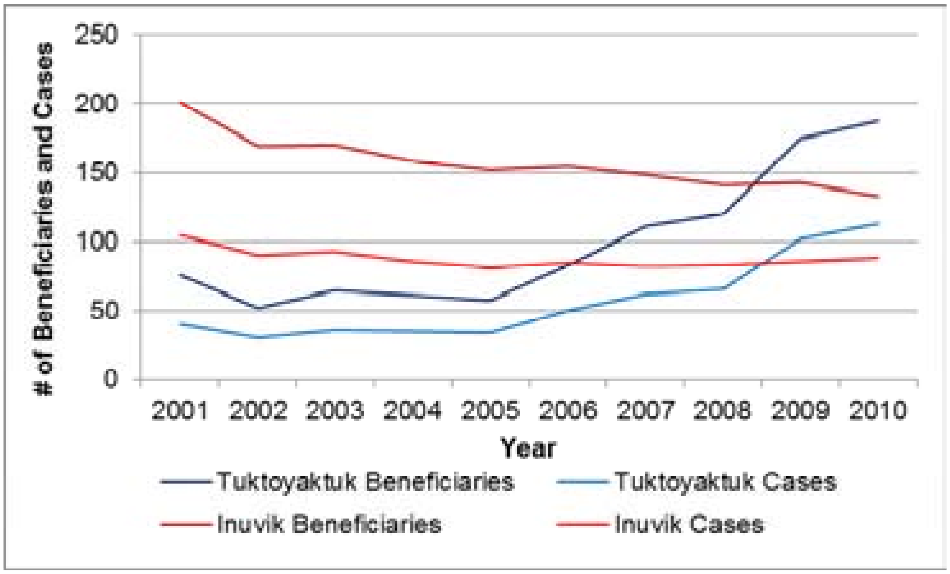


Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.4-23
NWT Income Assistance Cases and Beneficiaries, 2001 - 2010

In Tuktoyaktuk, both the monthly average number of income assistance beneficiaries and cases has increased from 2001 to 2010. Figure 3.2.4-24 indicates that although the monthly average beneficiaries and cases decreased from 2001 to 2002, they increased thereafter until 2010 (GNWT Bureau of Statistics 2010k).

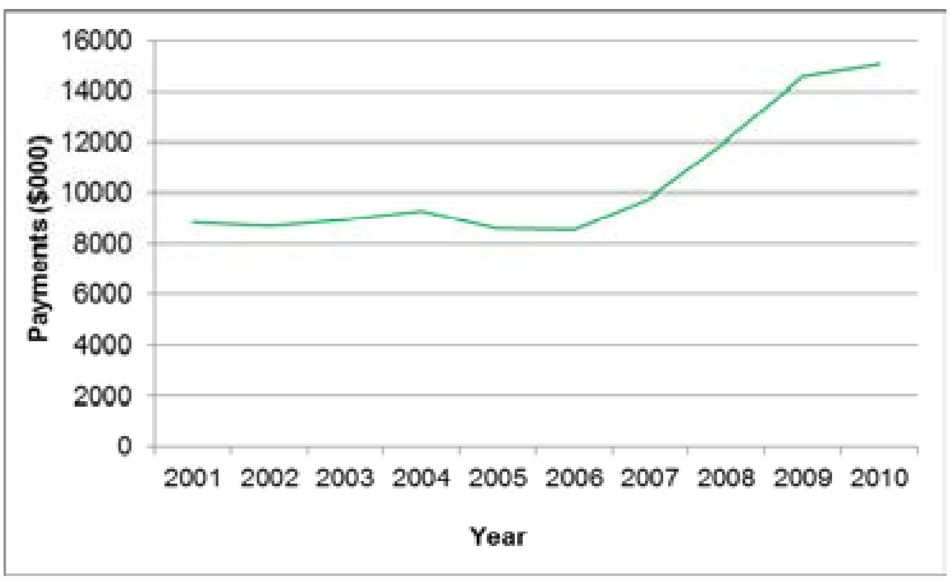
In Inuvik, the monthly average number of income assistance beneficiaries and cases has decreased between 2001 and 2010, as shown in Figure 3.2.4-24 (GNWT Bureau of Statistics 2010l).



Source: GNWT Bureau of Statistics (2010k and 2010l)

Figure 3.2.4-24
Tuktoyaktuk and Inuvik Income Assistance Cases and Beneficiaries, 2001 - 2010

In the NWT, payments from income assistance have increased from $8,840,000 in 2001 to $15,074,000 in 2010. The most drastic increase occurred from 2006 to 2009. This can be observed in Figure 3.2.4-25 (GNWT Bureau of Statistics 2010k).



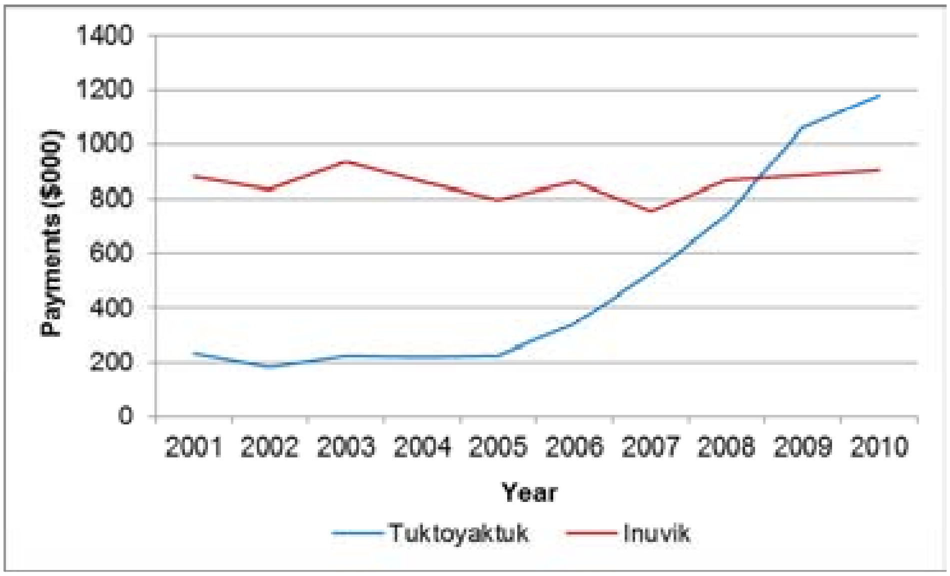
Source: GNWT Bureau of Statistics (2010k)

Figure 3.2.4-25
NWT Income Assistance Payments, 2001 - 2010

In Tuktoyaktuk, payments for income assistance increased from $231,000 in 2001 to $1,177,000 in 2010. The most drastic increased occurred from 2005 to 2009 (GNWT Bureau of Statistics 2010k).

In Inuvik, payments for income assistance increased from $878,000 in 2001 to $903,000 in 2010 (GNWT Bureau of Statistics 2010l).

The annual amount of social assistance benefits for Tuktoyaktuk or Inuvik are not available on a household or per capita basis.



Source: GNWT Bureau of Statistics (2010k and 2010l)

Figure 3.2.4-26
Tuktoyaktuk and Inuvik Income Assistance Payments, 2001 - 2010

Consumer Prices and Cost of Living

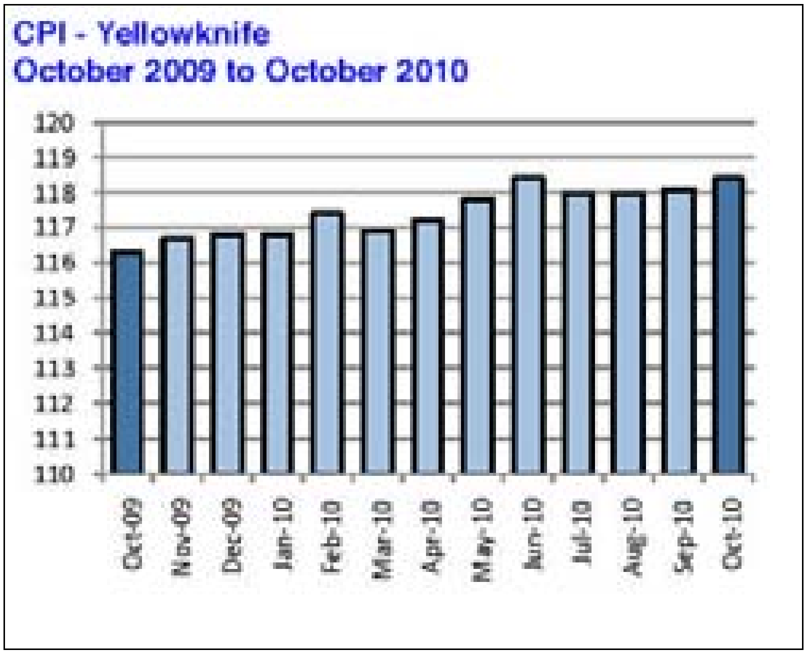
The cost of living in northern communities is a function of the distance from southern supply sources (IOL et al. 2004). Various indices are used to document cost of living, including the Consumer Price Index and the Community Price Index.

Consumer Price Index

According to Statistics Canada, the Consumer Price Index indicates change, or lack thereof, in consumer prices for a specific region. The Consumer Price Index is determined by comparing, over time, the cost of a fixed 'basket' of commodities, purchased by consumers. Because the basket is made up of commodities of unchanging or equivalent quantity and quality, the index reflects purely a change in price (Statistics Canada 2010c).

The Consumer Price Index for Tuktoyaktuk and Inuvik are not available; however, it is expected that the cost of the 'basket of commodities' would be higher in Tuktoyaktuk and Inuvik compared to Yellowknife due to the increased transportation costs. Therefore, the Consumer Price Index for Yellowknife is provided as a likely minimum comparison.

The Consumer Price Index for Yellowknife is reported each month. Figure 3.2.4-27 shows the Consumer Price Index for Yellowknife increasing from October 2009 to October 2010 (GNWT Bureau of Statistics 2010c).



Source: GNWT Bureau of Statistics (2010c)

Figure 3.2.4-27
Yellowknife Consumer Price Index, 2009-2010

Table 3.2.4-3 provides a detailed breakdown of Yellowknife's Consumer Price Index per index. The categories with the highest indices include alcoholic beverages and tobacco products (147.3), followed by shelter (136.2) and food (120.5). Between October 2009 and October 2010, the Consumer Price Index in Yellowknife increased by 1.8% (GNWT Bureau of Statistics 2010c).

TABLE 3.2.4-3: YELLOWKNIFE CONSUMER PRICE INDEX SELECTED INDEXES, 2010

Product	CPI October 2010	% Change from October 2009
All Items	**118.4**	**1.8**
Food	**120.5**	**1.9**
Food from Stores	118.6	0.9
Food from Restaurants	125.3	4.6
Shelter	**136.2**	**2.7**
Water, Fuel & Electricity	162.8	6.9
Household Operations & Furnishings	**108.3**	**2.1**

TABLE 3.2.4-3: YELLOWKNIFE CONSUMER PRICE INDEX SELECTED INDEXES, 2010		
Product	**CPI October 2010**	**% Change from October 2009**
Household Operations	115.1	2.7
Household Furnishings	93.5	0.8
Clothing & Footwear	**95.7**	**1.7**
Clothing	88.3	-3.1
Footwear	93.8	17.4
Clothing Accessories & Jewelry	133.2	8.6
Clothing Material, Notions & Services	111.4	1.1
Transportation	**107.7**	**1.6**
Private Transportation	106.4	3.4
Public Transportation	114.9	-5.1
Health & Personal Care	**112.1**	**1.0**
Health Care	117.6	-0.3
Personal Care	108.4	2.1
Recreation, Education & Reading	**99.0**	**-1.0**
Recreation	96.3	-0.8
Education & Reading	114.8	-2.1
Alcoholic Beverages & Tobacco Products	**147.3**	**1.0**
Alcoholic Beverages	136.1	-
Tobacco Products & Smoker Supplies	158.5	1.9

Source: GNWT Bureau of Statistics (2010c)

Community Price Index

The Community Price Index expresses the difference between the cost of food for a specific region and the cost of the same basket of goods in Yellowknife. The Community Price Index is a spatial index, unlike the Consumer Price Index which is temporal.

The Community Price Index should not be compared over time, but instead within one year as compared to. Yellowknife. A falling index does not indicate that food is getting less expensive in a community; it does, however, indicate that food is getting less expensive relative to Yellowknife. Should the Yellowknife prices go up, nothing is known about the direction of prices in the other communities.

Table 3.2.4.4 presents the Community Price Indexes for communities in the Beaufort-Delta region, using Yellowknife as the basis for comparison. The price of food has increased relative to Yellowknife for some of the communities in the Beaufort-Delta Region (GNWT Bureau of Statistics 2010d).

TABLE 3.2.4-4 COMMUNITY PRICE INDEX, 2000-2010				
	2010	**2004**	**2001**	**2000**
Aklavik	174	183	183	167
Fort McPherson	166	163	150	149
Inuvik	**150**	**140**	**147**	**146**
Paulatuk	196	222	193	174
Sachs Harbour	177	197	188	200
Tsiigehtchic	156	153	130	150
Tuktoyaktuk	**162**	**206**	**165**	**189**
Ulukhaktok	204	188	182	186
Yellowknife	**100**	**100**	**100**	**100**

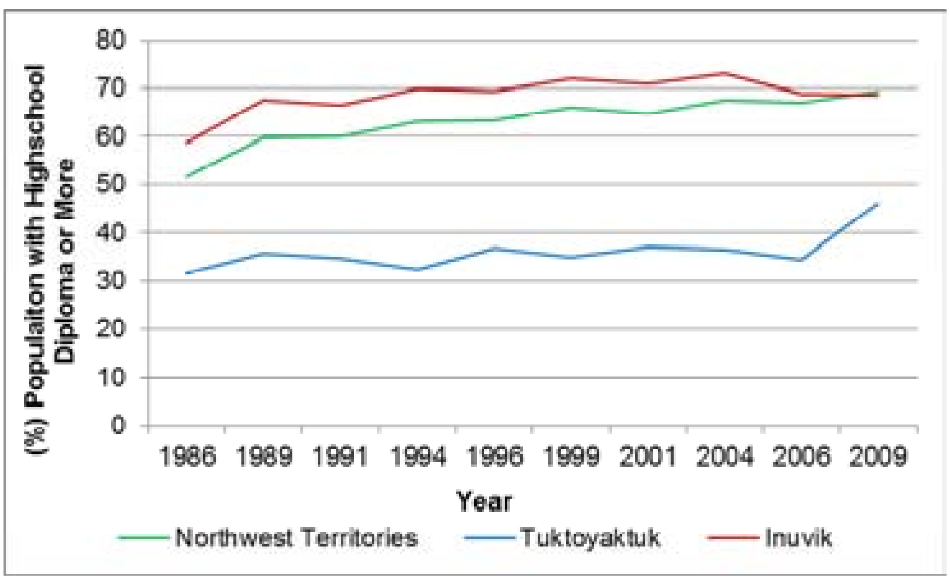
Source: GNWT Bureau of Statistics (2010d)

3.2.4.3 Education

Graduation Rates

The percent of the population with a high school diploma or more in the NWT, Tuktoyaktuk, and Inuvik has increased since 1986, as shown in Figure 3.2.4-28 (GNWT Bureau of Statistics 2010k, 2010l).

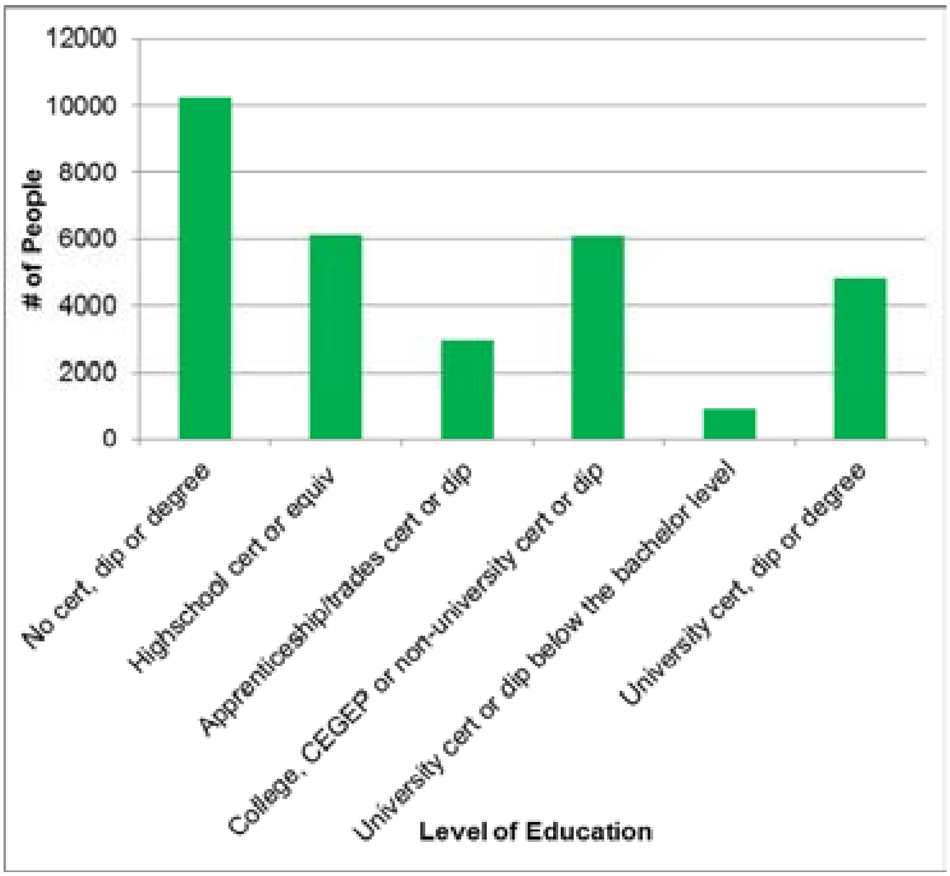
In 1986, 31.6% of Tuktoyaktuk's population had completed high school, compared to 46.1% in 2009. In 1986, 58.7% of Inuvik's population had completed high school, compared to 68.6% by 2009 (GNWT Bureau of Statistics 2010k, 2010l).



Source: GNWT Bureau of Statistics (2010k and 2010l)

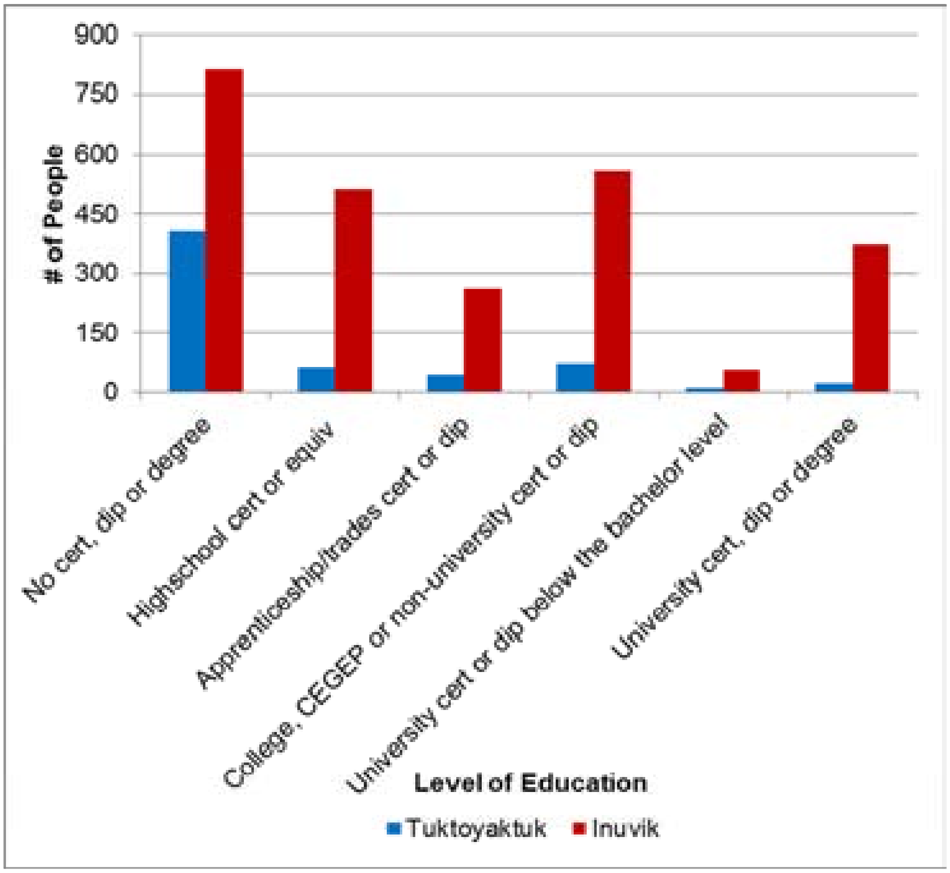
Figure 3.2.4-28
Percent of Population with High School Diploma or more in the NWT Tuktoyaktuk and Inuvik, 1986-2009

The 2006 Census conducted by Statistics Canada collected data on the level of education attained by Canadians. The data for the level of education attained by NWT, Tuktoyaktuk and Inuvik residents is presented in Figures 3.2.4-29 and 3.2.4-30.



Source: Statistics Canada (2006a)

Figure 3.2.4-29
Level of Education Attained by NWT Residents, 2006



Source: Statistics Canada (2006a and 2006b)

Figure 3.2.4-30
Level of Education Attained by Tuktoyaktuk and Inuvik Residents, 2006

Trade Certification Levels

The Aurora College campus in Inuvik offers a variety of programs with different levels of certification (A.M. Picek, Registration, Aurora College, pers. comm., January 26, 2011).

There are many preparation programs for trades, which include academic upgrading and work experience. The graduates of these programs received a record of achievement upon completion (A.M. Picek, Registration, Aurora College, pers. comm., January 26, 2011).

Other certifications that can be earned at this campus include:

- Environmental and Resource Diploma – two year program;
- Business Management Diploma – two year program;
- Office Administration Certificate – one year program;
- Office Administration Diploma – two year program;
- Personal Support Worker – one year program; and
- Aboriginal Language Instructor Program – two year program (A.M. Picek, Registration, Aurora College, pers. comm., January 26, 2011).

Beginning in the fall of 2011, Aurora College will offer a Teacher Education Degree program and a Practical Nurse Diploma. The school offers academic upgrading programs for adults covering grades 8 to 12, as well as entry level safety training courses (A.M. Picek, Registration, Aurora College, January 26, 2011).

Education Programs and Institutions

Tuktoyaktuk's Mangilaluk School offers education from Kindergarten to Grade 12. There are 196 students attending the school and 21 staff members (A. Cudmore, Principal, Mangilaluk School, pers. comm., January 25, 2011). Aurora College offers Adult Basic Education (ABE) or Adult Literacy and Basic Education (ALBE) programs in Tuktoyaktuk at the Community Learning Center (Aurora College 2009).

Inuvik has both an elementary and secondary school. Sir Alexander Mackenzie Elementary School offers Kindergarten to Grade 6 and has 358 students and 36 staff members. Samuel Hearne Secondary School offers Grade 7 to 12, and has 400 students, and 41 staff members (Beaufort-Delta Education Council ND). Aurora College operates a campus and research center in Inuvik.

Education and Training as it Relates to Employment Opportunity

Aurora College has three campuses in the NWT and 24 Community Learning Centres, and offers a variety of programs. According to Beaufort-Delta region Health and Social Services (ND), every program offered by the College applies to employment opportunities that exist in NWT communities. Table 3.2.4-5 compares programs offered at the Aurora College Inuvik campus to the different categories of occupations in the NWT (Aurora College 2009).

A variety of positions will likely be available for the Highway Project, including supervisors, environmental and wildlife monitors, scouts, clerks, engineers, construction staff, labourers, heavy equipment operators, heavy duty mechanics, camp staff, and a variety of other positions.

TABLE 3.2.4-5: COMPARISON OF PROGRAMS OFFERED AT AURORA COLLEGE TO OCCUPATION CATEGORIES

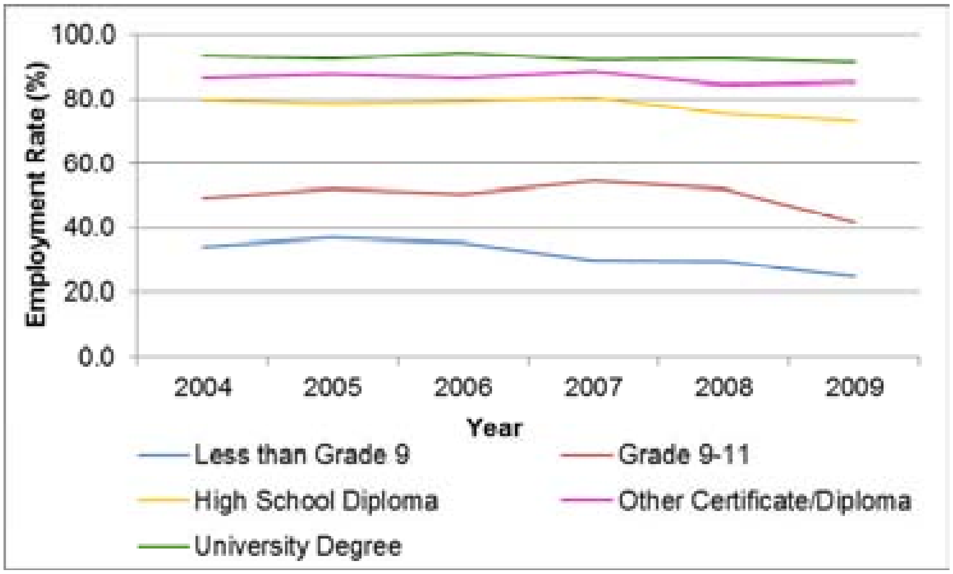
NWT Occupation Categories	Aurora College Programs Offered at Inuvik
Management	PMAC Diploma in Supply Management
Business Finance and Administration	Business Administration Business Administration Access Office Administration Office Administration – Community Office Procedures Program Office Administration – Computers in the Workplace Office Administration – Office Administration Certification Program Office Administration – Office Administration Mining Co-op Cert. Program

TABLE 3.2.4-5: COMPARISON OF PROGRAMS OFFERED AT AURORA COLLEGE TO OCCUPATION CATEGORIES

NWT Occupation Categories	Aurora College Programs Offered at Inuvik
Natural & Applied Sciences	Environment and Natural Resources Technology Access Environment and Natural Resources Technology Program Environmental Monitor Program Natural Resources Technology Access Program
Trades, Transportation & Equipment Operations	Apprenticeship Carpenter Apprenticeship Electrician Apprenticeship Heavy Duty Equipment Technician Apprenticeship Housing Maintainer Apprenticeship Plumber/Gasfitter Program Building Trades Helper Program Heavy Equipment Operator Program Oil Burner Mechanic (TQ) Special Pre-Employment Carpentry Pre-Technology Trades Access Trades Access II
Social Science, Education, Government Services & Religion	Bachelor of Education Program Certificate in Adult Education Developmental Studies (ABE) Early Childhood Education Observer/Communicator Training Program Personal Support Worker Social Work Social Work Access Teacher Education Access
Health	Bachelor of Science in Nursing Community Health Representative Community Health Worker Health and Human Services Access Program Master of Nursing, Nurse Practitioner Primary Health Care System Nursing Access
Art, Culture, Recreation & Sport	Traditional Arts Aboriginal Language and Cultural Instructor Program (ALCIP) II
Primary Industry	Introduction to Underground Mining Underground Miner Training Program
Sales & Service	Camp Cook

Source: Aurora College (2009)

Figure 3.2.4-31 demonstrates that the rate of employment in the NWT increases with the level of education. In 2009, the employment rate (i.e., the percentage of persons aged 15 years or older who were working) for those with a high school diploma or greater was 73-91%, depending on attendance and level of post-secondary education attained. The employment rate for those with less than a high school diploma was 25-42% depending on the grades completed. The employment rate for individuals with a university degree is almost three times greater than for individuals with less than a grade 9 level education (GNWT Bureau of Statistics 2010h).



Source: GNWT Bureau of Statistics (2010h)

Figure 3.2.4-31
NWT Employment Rate by Level of Education, 2004 – 2009

Adult Education

The Northwest Territories Literacy Council (NWTLC) works with individuals and families to promote literacy in all of the official languages of the NWT (NWTLC ND). Aurora College offers a Developmental Studies Program for adult basic education (ABE) (Aurora College 2009). ABE courses are offered both at the Aurora College campus in Inuvik and at the Community Learning Centre in Tuktoyaktuk. Since 1995 the ABE programs have experienced steady enrolment with a focus on English and mathematics courses (GNWT ECE 2005).

3.2.5 Infrastructure and Institutional Capacity Community Services

3.2.5.1 Government Services

This section provides an overview of the federal, territorial, local and Aboriginal governments with key roles in the Inuvialuit Settlement Region. Various government agencies are involved in providing financing, public services and/or maintaining local and regional organizations and infrastructure.

The *Inuvialuit Final Agreement* (IFA), signed in 1984, created the Inuvialuit Settlement Region (ISR) in Canada's western Arctic, spanning 906,430 km^2 (IRC 2009a). The Inuvialuit were the first to complete a land claim settlement process in the North. The Inuvialuit Regional Corporation (IRC) was created to administer the IFA, and to oversee various claim-related responsibilities through several corporations, as outlined in Table 3.2.5-1 below.

Each ISR community has its own Mayor and Council, elected by the residents of each community. In addition, each community in the ISR has a community corporation. The community corporation is the local branch of the Inuvialuit Regional Corporation, elected by the Inuvialuit residents of the municipality to deal with the interests and issues resulting from the IFA.

An Agreement-in-Principle (AIP) for self-government was signed in April 2003 by the Government of Canada, Government of the Northwest Territories, and the Inuvialuit Regional Corporation. On January 26, 2011, the Government of Canada, the Government of the Northwest Territories and the Inuvialuit Regional Corporation signed an AIP for devolution of lands, resources, and administrative responsibilities from Canada to the Government of the Northwest Territories. The final Devolution Agreement will include the transfer of administration, control and management of land, water, mines, minerals, and oil and gas in the Northwest Territories (INAC 2011a).

In the interim, federal and territorial agencies and departments offer direct programs and services in areas ranging from resource management to community well-being and education, and collaborate directly with Inuvialuit organizations. These public services are delivered by several agencies and organizations from multiple levels of government, as noted in Table 3.2.5-1 below.

TABLE 3.2.5-1: GOVERNMENT SERVICES

Organizations and Infrastructure	Public Services Delivered (as relates to the Project)	Funding Role
Federal – Government of Canada		
Federal Agencies	Responsible for federal programs, funding and regulations that are implemented across Canada.	Provides funding to GNWT and directly through federal agencies for distribution to programs throughout the Territory.
Indian and Northern Affairs Canada (INAC)	• Administers funding and monitoring to ensure ISR land claim agreement compliance • Northern Affairs Program - administers legislation concerning use of Crown lands and resources within the NWT • Uses IRC and Inuvialuit Joint Secretariat to administer funds	Funds capacity building, business development and support in the ISR

TABLE 3.2.5-1: GOVERNMENT SERVICES

Organizations and Infrastructure	Public Services Delivered (as relates to the Project)	Funding Role
Department of Fisheries and Oceans (DFO)	• Provides support to the FJMC • Responsible for policy and regulatory changes to accommodate Inuvialuit rights for fish and marine mammal resources in ISR • Promotes cooperative management of ISR fisheries resources	Provides support to the FJMC
Environment Canada	• Reviews and screens development proposals in the ISR region as part of the environmental assessment process • Funds and carries out studies including those for migratory birds • Prioritizes contracts to Inuvialuit-owned entities (half) • Environment Canada - Canadian Wildlife Service (CWS), is on wildlife management Advisory Councils which deal with wildlife issues in the ISR	Funds (federally managed) wildlife studies
Parks Canada	• Responsible for the protection of natural and cultural resources, including the wildlife populations and habitat of three national parks in the ISR • Carries out research and monitoring • Review management plans related to Parks Canada properties	
Public Works and Government Services Canada	• Provides services to the federal government in the areas of centralized purchasing, payments and pensions, property and buildings, security and information services, technology and translation. • Ensures Inuvialuit firms have opportunity to bid on government contracts • Notifies IFA claimants of goods, services and construction opportunities in the ISR	Awards contracts to Inuvialuit-owned businesses
Human Resources Development Canada	• Supports implementation of IFA through career training, childcare and capacity building, under the Aboriginal Human Resources Development Agreement • Funds labour market training for Aboriginal residents of the ISR	Funds Aboriginal programs including career training, childcare, and capacity building
Natural Resources Canada	• Seeks to enhance the responsible development, use and the competitiveness of Canada's natural resources and products related to energy, forests, and minerals and metals.	

TABLE 3.2.5-1: GOVERNMENT SERVICES		
Organizations and Infrastructure	**Public Services Delivered (as relates to the Project)**	**Funding Role**
	• Initiated remediation of their leased Tuktoyaktuk research station beginning September 2010	
National Energy Board	• Regulates cross-border pipelines, electrical power lines and frontier exploration and development in the Canadian public interest. • Funds related environmental studies research, including research in the ISR • Recently approved the Mackenzie Gas Project • Currently engaged in a review of offshore Beaufort Sea petroleum drilling	
Royal Canadian Mounted Police (RCMP)	• Funds and staffs detachments in Tuktoyaktuk and Inuvik	
Territorial - Government of Northwest Territories (GNWT)		
GNWT Departments	Responsible for programs and infrastructure, as indicated by departmental title, across the NWT.	Funds territorial departments which implement programs throughout the NWT
Ministry of Aboriginal Affairs	• Works with GNWT departments and the Inuvialuit Joint Secretariat to implement funding, monitor budgets and facilitate land trades for municipal infrastructure located on Inuvialuit-owned lands	
Education, Culture & Employment	• Develops programs for cultural, heritage and language education, early childhood through to post-secondary education, and career development • Published an Aboriginal Languages Plan with the goal to increase the number of Aboriginal language speakers by 20%	Funds educational, cultural, language, and career development programs
Environment & Natural Resources	• Promotes and supports sustainable use and development of natural resources in the NWT, including the ISR • Services provided include bear response, wildlife population information, and mitigation advice, etc. • Recently instituted a partial ban on caribou hunting in the NWT	
Health & Social Services	• Provides health and social services funding for the NWT and the ISR, including transfer of federal funds to IRC through programs such as Brighter Futures	Provides transfer of federal funds to IRC for programs, such as Brighter Futures

TABLE 3.2.5-1: GOVERNMENT SERVICES		
Organizations and Infrastructure	**Public Services Delivered (as relates to the Project)**	**Funding Role**
Justice	• Contributes to implementation of the IFA by providing legal advice on government usage of Inuvialuit languages, proposed land exchanges, IFA amendments, and proposed changes to the NWT *Wildlife Act*	
Industry, Tourism & Investment	• Partners with local government and the IRC to provide programs and services that promote and support NWT economic prosperity and community self-reliance	Funds local wildlife committees, Take a Kid Hunting/Trapping programs, a part-time position for the Inuvik Petroleum Show, and entrepreneurial pursuits
Municipal & Community Affairs	• Works with community governments, including Inuvik and Tuktoyaktuk, as they organize and manage democratic, responsible and accountable community governments. • Services offered include land administration, office of the fire marshal, emergency management, consumer affairs, licensing, legislation, sports, recreation, youth, volunteerism, water and sewage services	Provides financing for services as listed
Public Works & Services	• Meets economic measures provisions in IFA to issue preferential contracting policies and procedures intended to maximize, local, regional and northern employment and business opportunities in the ISR	Provides contracts to Inuvialuit-owned businesses for services Funding for long term office space leases and work outside the ISR are also provided to Inuvialuit-owned ISR businesses
Transportation	• Oversees the maintenance and development of transportation modes including airports, highways and roads, and ferries	Recently partnered with Hamlet of Tuktoyaktuk on the construction of the Tuktoyaktuk to Source 177 Access Road. Employs a number of beneficiaries and several local contractors
Organizations Operating in the NWT	Responsible for programs and services related to the ISR.	
Beaufort-Delta Health & Social Services •Authority	• Provides regional health and social services to the region through a hospital in Inuvik, a health centre in Tuktoyaktuk and other programs and services.	
Aurora College	• Offers college-level education and upgrading services in the ISR, such as Adult Basic Education, Aboriginal language, business	

TABLE 3.2.5-1: GOVERNMENT SERVICES

Organizations and Infrastructure	Public Services Delivered (as relates to the Project)	Funding Role
	administration and other certificate, diploma and degree programs • Has an Inuvik regional campus and Community Learning Centre in Tuktoyaktuk.	
Regional Joint Implementing Bodies (Inter-governmental)	Co-management bodies established by the Inuvialuit, federal and territorial governments to provide support services to the wildlife and environmental institutions of public government and the Inuvialuit Game Council (IGC) in the ISR as per the IFA.	
Joint Secretariat	• Administers funding for Joint Implementing Bodies (as listed below) and provides administrative and technical support	Funds Wildlife Management Advisory Council, Fisheries Joint Management Committee, Fisheries Joint Management Committee, Environmental Impact Screening Committee and Review Board, and the Inuvialuit Game Council
Wildlife Management Advisory Council (NWT)	• Provides wildlife management advice pertaining to the NWT, including the ISR • Prepares wildlife conservation and management plans • Recommends appropriate wildlife harvest quotas in conjunction with Hunter Trapper Committees.	
Fisheries Joint Management Committee	• Assists DFO in the management of fisheries • Responsible for collecting harvest information and making recommendations on subsistence quotas for fish and harvestable quotas for marine mammals • Implemented and manages a system to monitor sports fishing on both Crown and Inuvialuit owned lands • Developed and manages a student mentoring program	
Environmental Impact Screening Committee	• Screens all development proposals within the ISR to determine if an environmental assessment is required (by the EIRB)	
Environmental Impact Review Board	• Responsible for carrying out environmental assessments of development projects	

TABLE 3.2.5-1: GOVERNMENT SERVICES		
Organizations and Infrastructure	**Public Services Delivered (as relates to the Project)**	**Funding Role**
Inuvialuit Game Council	• Represents collective Inuvialuit interest in wildlife and renewable resources in the ISR • Works in parallel with the IRC to implement the IFA • As a regulator, administers and enforces Inuvialuit harvesting rights	
Regional/Aboriginal – Inuvialuit Settlement Region		
Inuvialuit Regional Corporation	• Receives and manages IFA benefits and revenues • Several corporations (as noted below) receive funding from the IRC	Funds Inuvialuit programs delivered through the various corporations Distributes portions of investment equity directly to Inuvialuit beneficiaries
Inuvialuit Investment Corporation	• Oversees management of a diverse securities portfolio that was established with proceeds from the IFA	
Inuvialuit Development Corporation	• Invests in over 20 Inuvialuit companies with complementary industries and visions	Invests in Inuvialuit companies
Inuvialuit Petroleum Corporation	• Establishing itself as a diversified petroleum company • Currently investing proceeds until appropriate hydrocarbon related opportunities arise in the ISR	N/A
Inuvialuit Land Corporation	• Holds title to the Inuvialuit lands received under the IFA. Lands consist of 90,649 km^2, including 13,000 km^2 with sub-surface rights, some in the Beaufort Sea	N/A
Inuvialuit Land Administration	• Responsible for managing and administering Inuvialuit-owned lands in the ISR, including reviewing applications for land and water permits	N/A
Inuvialuit Trust	• Manages financial distribution of benefits to Inuvialuit beneficiaries	Distributes benefits to the Inuvialuit beneficiaries
Community Corporations (Inuvik and Tuktoyaktuk)	• Administers, supervises, governs, and regulates matters of local concerns to the members of the Corporation • Manages Community Corporation membership • Distributes for community-oriented projects • Determines membership of Hunters and Trappers Committees	Distributes funding for community-oriented programs

TABLE 3.2.5-1: GOVERNMENT SERVICES		
Organizations and Infrastructure	**Public Services Delivered (as relates to the Project)**	**Funding Role**
Hunters and Trappers Committee	• Represents the collective Inuvialuit interest in wildlife and upholds harvest rights	
Municipal		
Town of Inuvik & Hamlet of Tuktoyaktuk	• Provides services including utilities, roads, fire protection, parks and community centres, and tourist services	
Sources: INAC (2004a,2006); NWT Board Forum (ND); GNWT Finance (2010b); Public Works and Government Services Canada (2010); AMEC Earth and Environmental (2009); NRC (2010a); GNWT ECE 2010b,2010c); GNWT HSS (2009); GNWT ITI (2010); Joint Secretariat (2010a, 2010b); IRC (2007e,2007f,2007g,2010a); Town of Inuvik (2010f)		

3.2.5.2 Status of Community and Local Government Institutions and Organizations

The potential effects from the Highway on community and local government institutions and organizations institutions and organizations will be addressed in Section 4.3.

3.2.5.3 Health Facilities and Services

Both Inuvik and Tuktoyaktuk have access to Telehealth Services available from Stanton Territorial Hospital in Yellowknife. Services include consultation with a doctor in Inuvik or a specialist in Edmonton or Yellowknife, as well as education sessions for staff. Telehealth bridges geographical distances, improving the access to and delivery of health and social services and health education (BDHSS 2010d).

Medevac services are delivered through business partnerships under contract with the GNWT Department of Health and Social Services (HSS). Medical teams are provided by Medic North Emergency Services Ltd. (Medic North), while aircraft and flight crews are provided by Air Tindi in Yellowknife and Aklak Air in Inuvik. The Inuvik Medic North aircraft extends services to Tuktoyaktuk and the surrounding community (M. Cross, Base Manager, Medic North, pers. comm., January 26, 2011).

Emergency Department Physicians at a receiving hospital (i.e., Inuvik) determine the need for air medical transport either from their own department, or from a Community Health Centre (i.e., Tuktoyaktuk) after consultation with staff there. Approximately 1,200 annual medical transports are conducted each year from 33 communities throughout the NWT. Of those transported, critical and emergent patients in Inuvik constitute 27% (or 72 patients) (Medic North Emergency Services Ltd. 2010).

The GNWT HSS provides Suicide Prevention Training Programs in the Beaufort-Delta to residents interested in learning suicide prevention and intervention skills to help others. The one-week curriculum consists of three culturally-relevant and community-based phases, including grieving and healing work, community asset mapping, and planning to help communities address the issue of suicide.

Tuktoyaktuk

The Rosie Ovayouk Health Centre, located in Tuktoyaktuk, has eight staff including four nurses. Health Centre services include emergency treatment; school health program; chronic disease clinic; immunization programs; wellness clinic; pre and post natal care; health promotion and disease prevention initiatives; diagnostic, restorative, rehabilitative and palliative care services; and home care. Regional providers work in partnership with health centre staff and/or travel to Tuktoyaktuk to provide additional services such as dental therapy, rehabilitation services, nutrition, diabetes education and health promotion. Visiting health services are also provided for eye care and more complicated dental and orthodontic work. The Inuvik Regional Hospital also services the population of Tuktoyaktuk (BDHSS 2010a).

Social services and a counselling program are located in the Government Building. Three community social service workers provide the following services:

- Child protection, child and family services;
- Voluntary family support and adoptions;
- Family violence intervention;
- Community development;
- Mental health and addiction; and
- Services for the aged or those with disabilities.

The Community Counselling Program is implemented by one counsellor and two community wellness workers, and provides crisis intervention, therapeutic counselling, education, and referrals to resources (BDHSS 2010a).

Inuvik

There are several regional health care facilities located in Inuvik. Facilities include the Inuvik Regional Hospital, Public Health Services (Semmler Building), Billy Moore and Charlotte Vehus Homes (group homes for disabled adults), assisted living units, and a Family Counselling Centre.

The 51 bed hospital provides the following services:

- 24/7 emergency room;
- Operating room;
- Obstetrical care;

- Acute and long-term care;
- Pharmacy;
- Diagnostic imaging;
- Laboratory;
- Physician family clinics; and
- Visiting specialist clinics and medical referrals to southern facilities (BDHSSA 2010b).

Other services provided by the hospital for regional use include rehabilitation, nutrition, mental health and addition and telehealth.

The Public Health Services unit is staffed by nine employees, including five nurses. They offer services including a school health program, a chronic disease clinic, immunization programs, wellness clinics, pre- and post-natal care, health promotion and disease prevention initiatives, and home care (BDHSSA 2010c).

Social services programs are located at the Inuvik Regional Hospital and are implemented by seven employees, including five community social service workers. The following services are offered:

- Child protection;
- Child and family services (voluntary family support, foster care, adoptions);
- Services for aged and disabled;
- Family violence intervention;
- Community development;
- Mental health and addition services; and
- Home care support (BDHSSA 2010c).

3.2.5.4 Emergency Response and Law Enforcement Services

Tuktoyaktuk

The Hamlet of Tuktoyaktuk has an emergency response plan, a part time paid Fire Chief, and 10 volunteer firefighters (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., January 14, 2011).

Law enforcement services are provided by the Royal Canadian Mounted Police's (RCMP) five-member detachment (BDHSS 2010e). The police facility has five cells, which can hold up to a maximum of 10 people (C. Roberts, Sergeant, Tuktoyaktuk RCMP, pers. comm., January 25, 2011).

Inuvik

The Town of Inuvik has an emergency plan. Fire fighting services are provided by two professional firefighters and 24 volunteer firefighters (Town of Inuvik 2010a).

Law enforcement services are provided by the RCMP. The 13-person detachment and two support staff serves the Inuvik Region, Holman Island, Paulatuk and a portion of the Dempster Highway (Town of Inuvik 2010a). The police facility has nine cells with a maximum capacity of 18 people, and 40 people in the holding cell.

3.2.5.5 Waste Disposal and Management

Tuktoyaktuk

The Hamlet of Tuktoyaktuk operates a 1,000 m^2 (0.1 ha) solid waste disposal site, adjacent to Kugmallit Bay. Bulky and metal wastes are placed in a 500 m^2 area next to the site. Combustible materials are burned during the summer. The Hamlet also operates a beverage recycling depot (GNWT ENR 2010c) as part of the Beverage Container Program, which was the first waste reduction initiative implemented as part of the 2003 NWT *Waste Reduction and Recovery Act* (GNWT ENR 2010d).

Inuvik

The Town of Inuvik operates a 175,000 m^2 (17.5 ha) modified landfill site. A full-time attendant supervises landfill operations and provides capping on a regular basis. Tipping fees at the dump are payable only by commercial, institutional and industrial users (Town of Inuvik 2010b).

The Town currently collects waste from approximately 300 dumpsters. Residential areas are serviced by dumpsters and curbside pick-up (Town of Inuvik 2010b).

Within the town, there is a local recycling depot and a beverage container processing center that is currently being rebuilt due to a fire (GNWT ENR 2010g).

3.2.5.6 Water and Sewage Facilities

Tuktoyaktuk

The Hamlet of Tuktoyaktuk's water source is Kudlak Lake. Water for winter use is pumped from Kudlak Lake to a raw water storage reservoir (Earth Tech 2005; AECOM 2009). The total capacity is about 100,500 cubic metres (m^3), with a storage capacity of about 90,300 m^3 (GNWT MACA NDb).

The Hamlet has a Class 1 water treatment plant consisting of a seasonal fill reservoir, a pump service building and a truckfill station. Water is treated using pressure filtration with ultraviolet and liquid chlorine disinfection (GNWT MACA 2010). The Hamlet has three water delivery trucks.

Sewage collection is handled by a private contractor who operates vacuum trucks seven days a week collecting all municipal wastewater and transporting it to the municipal sewage lagoon located approximately 5.0 km from the community. The lagoon is a natural lake, approximately 5.9 ha in area. It has been modified with a perimeter berm at the south edge for retention purposes. The lagoon is discharged to an adjacent ocean inlet once a year in the fall season. A temporary pump is set up on top of the berm to accomplish the discharge

(IEG Environmental 2006). The sewage treatment facility is estimated to have a capacity to serve a population of 1,900 depending upon the level of commercial and industrial activity that occurs in the future (Earth Tech 2005).

Inuvik

The Town of Inuvik's water source is the Mackenzie River and 3 Mile Lake (during winter), and Hidden Lake (during summer). Inuvik requires different water sources during winter and summer due to the higher turbidity of the Mackenzie River during the ice-free period.

The Town has a Class 2 water treatment plant using sand filters (winter only), tempering[5], gaseous chlorine disinfection, liquid fluoridation[6] and storage. Class 2 systems are more complex than a Class 1 Water Treatment System. A typical NWT Class 2 water treatment process may begin with screening to remove coarse suspended particles. The water then moves into a mixing chamber for flash mixing where a coagulant is added to help bind small particles together to form slightly larger particles called 'micro flocs'. The chemically treated water then flows into a flocculating chamber where another chemical, called coagulant aid, is added and the water is slowly stirred. This action will encourage and promote larger flocs to form that can be settled out more easily when the water passes through the sedimentation tank. After sedimentation, the water flows through a multi-media filter as a final polishing step to remove any flocs that may get carried over into the filter. As a final treatment step, chlorine is added to the water to disinfect it before it is stored for distribution (GNWT MACA NDa).

In Inuvik, water distribution and sewage lines are located above-ground in utilidors (Town of Inuvik 2010c). The total length of Inuvik's water distribution network is 15.9 km. This includes 1.1 km of trunk mains, most of which are 300 mm (12 in) in diameter, and 14.8 km of distribution mains, most of which are 200 mm (8 inch), the normal minimum size for fire protection (Earth Tech Canada Inc. 2008).

Inuvik's sewage is treated in a multi-cell lagoon system before being discharged into the Mackenzie River. Active wastewater treatment cells include two primary sedimentation cells, and a large pond which operates as a facultative lagoon in summer. Two additional cells just east of the primary lagoons are used for sludge storage (Earth Tech Canada Inc. 2008).

3.2.5.7 Power and Fuel Services

Given the low density population spread over nearly 1.2 million km^2, operating on a grid system with hydro-electricity is not feasible (NTPC 2010). Therefore, each community has its own power plant and facilities, owned and operated by Northwest Territories Power Corporation, to generate electricity regardless of conditions.

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[5] Tempering means heating the water to protect against freezing.

[6] The addition of fluoride to the water helps to prevent dental cavities.

Tuktoyaktuk

The three diesel generators in Tuktoyaktuk have a total installed capacity of 2,205 kilowatts (kW) (NTPC 2010). In 2009, Tuktoyaktuk residents paid a rate of $0.074 per kilowatt hour (kW·h) while commercial rates were $0.066 per KWH (GNWT ITI 2009).

Inuvik

The Thermal Operations regional office complex, located in Inuvik, includes two power plants that consist of:

- Three natural gas generators that generate 2.8 megawatts (MW), 2.8 MW, and 2.1 MW, respectively;
- Four diesel generators that generate 2.5 MW, 2.5 MW, 760 kW and 300 kW, respectively.

In 2009, Inuvik residents paid a rate of $0.063 per kW·h while commercial rates were $0.056 per kW·h (GNWT ITI 2009).

3.2.5.8 Transportation Systems

Table 3.2.5-2 provides a summary of the transportation systems available in each community. Detailed descriptions of each system are provided in the following subsections.

TABLE 3.2.5-2: TRANSPORTATION INFRASTRUCTURE

Transportation Mode	Inuvik	Tuktoyaktuk
Road		
Highway	Dempster Highway No. 8 (all-weather highway, seasonally restricted)	Tuktoyaktuk Winter Road to Inuvik
Average Daily Traffic (Number of vehicles)	2006-2008 = 1,370 2005 = 1,370 2003 = 1,270 2004 = No data 2002 = 1,210 2001 = 1,120 2000 = 1,120	2009 = 139 1997 = 45 1996 = 74
Road Surfaces (km)	Paved, dust-controlled gravel, untreated gravel	Ice and Snow
Winter Roads (Avg. open and close dates)	Nov 28 to April 29	December 17 to April 29 (2004-2009 5 year avg.)

TABLE 3.2.5-2: TRANSPORTATION INFRASTRUCTURE		
Transportation Mode	**Inuvik**	**Tuktoyaktuk**
Water		
Marine Resupply (Deliveries per week, summer only)	2-7	2-6
Ownership of Facility	Federal government owned, privately owned	Federal government owned, privately owned
Water Facility Resupply Classification	A	A
Small Boating Facilities	Jet boat float dock, private docks, boat launch	Jet boat float dock, boat launch
Air		
Runway Dimensions	1,829 m (6000 ft)	1,527 m (5000 ft)
Runway Surface	Asphalt	Gravel
Owner	GNWT	GNWT
Operator	GNWT	E. Gruben's Transport
Critical Aircraft (maximum size of aircraft for runway)	B737	B737 (equipped for gravel)
Weather and Communication Type	Flight service station	Community airport radio station
Navigational Aids	Instrumental landing system, distance measuring equipment, non-directional beacon	Distance measuring equipment

Sources: GNWT DOT (2008), IOL et al. (2005)

Notes:

A = >10,000 t cargo and fuel in and out per year, protected access at all water levels, secure moorage for loading and unloading, access for heavy equipment, secure marshalling and storage site

Roads

Tuktoyaktuk

Tuktoyaktuk is accessible by winter road from Inuvik. The road is typically open from mid-December through the end of April each winter. The average daily traffic in 2009 was 139 vehicles per day (GNWT DOT 2008a). During winter, bus services are provided between Inuvik and Tuktoyaktuk (Northwest Territories Tourism ND). All-weather roads are limited to the Hamlet's boundaries and to Source 177 Access Road.

Most residents use snowmachines during winter to travel to various areas in the region, such as the Husky Lakes or even Inuvik.

Inuvik

Inuvik has year-round access to the Dempster Highway (Highway 8). The highway leads to the Yukon by way of Tsiigehtchic and Fort McPherson. The estimated average daily traffic on the Dempster Highway 1.3 km south of Inuvik is 1,370 vehicles per day (GNWT DOT 2008a). Bus service is available between Whitehorse (Yukon) and Inuvik.

Tug and Barge Service

Tug and barges operate when waterways are free of ice, which is generally from mid-June to mid-October (Horizon 2008). Barged cargo delivery is available between June and September to both Inuvik and Tuktoyaktuk (NTCL 2009a). Services typically originate from Hay River and use the Mackenzie River as the transportation channel (Rescan 1999a). Barges transport community and industrial goods ranging from vehicles, boats, general merchandise, and personal effects to heavy equipment and construction materials (NTCL 2009b). Both community ports have a Class A resupply classification, which means they can accept more than 10,000 tonnes of cargo and fuel in and out per year, have protected access at all water levels, secure moorage, access for heavy equipment, and secure marshalling and storage sites. During summer, Inuvik receives up to seven deliveries each week and Tuktoyaktuk receives up to six deliveries each week (IOL et al. 2005). Diesel used by the Tuktoyaktuk community is brought in by barge by E Gruben's Transport Ltd., which delivers approximately 3,200,000 litres to tank farms for storage (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010). Bulk fuel constitutes 75% of all cargo delivered by the Northern Transportation Company Ltd. in the NWT (GNWT ITI 2009).

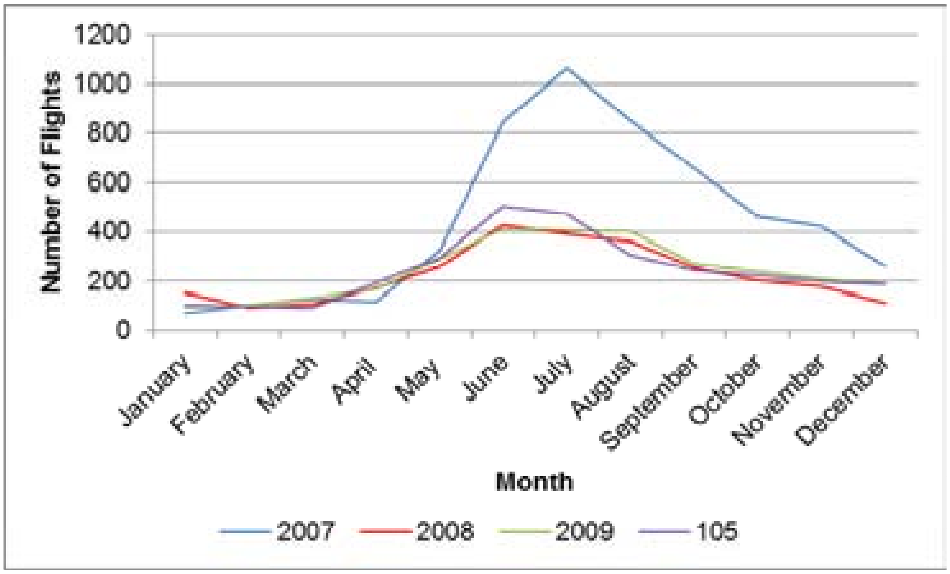
Air Travel

Tuktoyaktuk

The Tuktoyaktuk Airport was built in 1955 and is located next to the Hamlet. It has a 1,527 m (5,000 ft) gravel runway and an air terminal building. Scheduled flights to Inuvik are operated by Aklak Air, North-Wright Airways Ltd. (GNWT DOT ND and GNWT DOT 2005a). Flights are scheduled twice daily, are subject to demand, and weekend flights are not available when the winter road is open between December and April (Borek Air ND). In the Mackenzie region, especially Tuktoyaktuk, air charter carriers also play a significant role, operating to all communities and industrial sites (CHMC ND).

While 15-passenger planes are typically used, the airport has the capacity to handle aircraft as large as Boeing 737s that are specially equipped for gravel runways (Explore North 2010).

The Tuktoyaktuk Airport has an average estimated total aircraft movements of 3,300 per year, based on an average from 2004-2009 (Statistics Canada 2009c). Flights more than double during the road closure in summer than when the winter road is open, as noted in Figure 3.2.5-1. This may also be influenced by such factors as fair weather, longer days, and increased tourism activity.



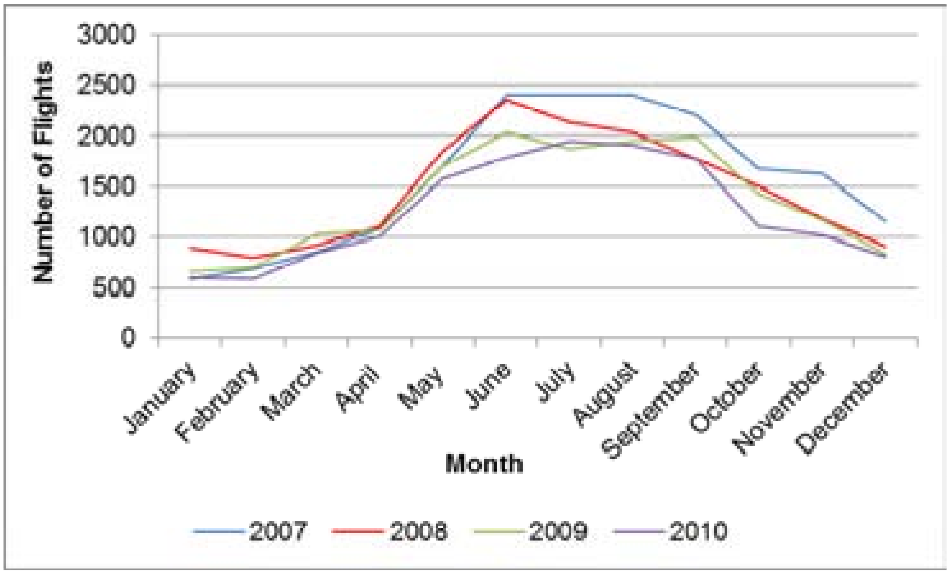
Source: Transport Canada (2010)

Figure 3.2.5-1
Tuktoyaktuk Airport – Aircraft Movement Compared by Year

Inuvik

Twelve kilometres east of the community, the Inuvik full-service airport was built in 1958 and operates as a regional hub. It has a 1,829 m (6000 ft) asphalt runway and an air terminal building (GNWT DOT ND). A number of scheduled and charter flights operate daily. Seven air carriers provide service from Inuvik: Air North, Aklak Air, Canadian North, First Air, North Wright Airways, Canadian Helicopters and Gwich'in Helicopters (GNWT DOT 2005b).

The Inuvik Airport has an average estimated total aircraft movements of 17,000 per year, based on data from 2005-2010 (Statistics Canada 2010j). Flights more than triple during the road closure in summer, as noted in Figure 3.2.5-2. This may also be influenced by such factors as: fair weather, longer days, and increased tourism activity.



Source: Transport Canada (2010)

Figure 3.2.5-2
Inuvik Airport – Aircraft Movement Compared by Year

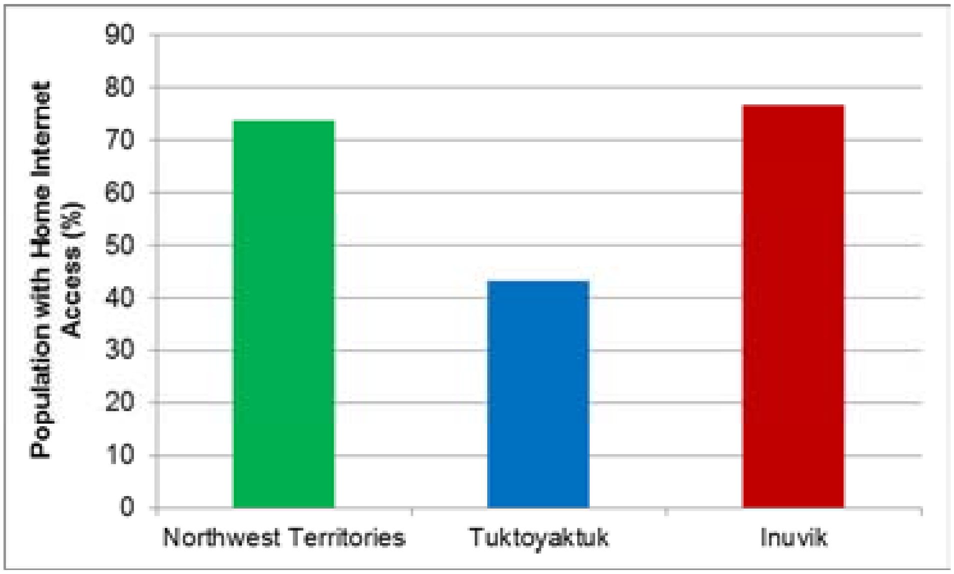
3.2.5.9 Telephone and Communication Services

Telecommunications

Northwestel provides residential and business phone services in the NWT. Cell phone services are provided in Inuvik and Tuktoyaktuk by Northwestel, Ice Wireless and Bell Canada. According to a Northwestel representative, cell phone services function within city limits in Inuvik and Tuktoyaktuk (A. Lee, Representative, Northwestel Latitude Wireless, pers. comm., January 26, 2011). Satellite telephones are also used throughout remote areas of the NWT.

Internet service development is a priority in the NWT. In 2010, Falcon Communications and SSI Micro, the service providers, installed high-speed satellite internet receiving stations in 30 communities. The project was partly funded by the GNWT and Canada. Residents and businesses, including those at remote camps, can also use Northwestel's Netkaster broadband satellite Internet service (GNWT ITI 2009).

The GNWT Bureau of Statistics surveyed NWT communities in 2009 to determine the percentage of the population with access to the internet from home. The results of that survey for the NWT, Tuktoyaktuk and Inuvik are presented in Figure 3.2.5-3.



Source: GNWT Bureau of Statistics 2009c

Figure 3.2.5-3
Percent of Population in NWT, Tuktoyaktuk and Inuvik with Home Internet Access, 2009

For residents and businesses in the NWT, access to the internet provides real advantages:

- It reduces the cost of communications;
- Provides access to world markets at reduced costs;
- Provides access to banking, tax and other financial services; and
- Allows businesses to access new suppliers and services.

3.2.5.10 Fire Protection and Emergency Response

Tuktoyaktuk

The Tuktoyaktuk Volunteer Fire Department has one part-time paid fire chief and 10 volunteer firefighters. There are typically 2-3 fires per year, and the fire department also responds to a few false alarm calls from various institutional buildings (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., January 14, 2011).

Ambulance services are not available in Tuktoyaktuk. Instead, the Health Centre has a ground transportation contract with the local taxi service to transport residents who require medical attention (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., January 14, 2011). The Hamlet has an emergency response plan.

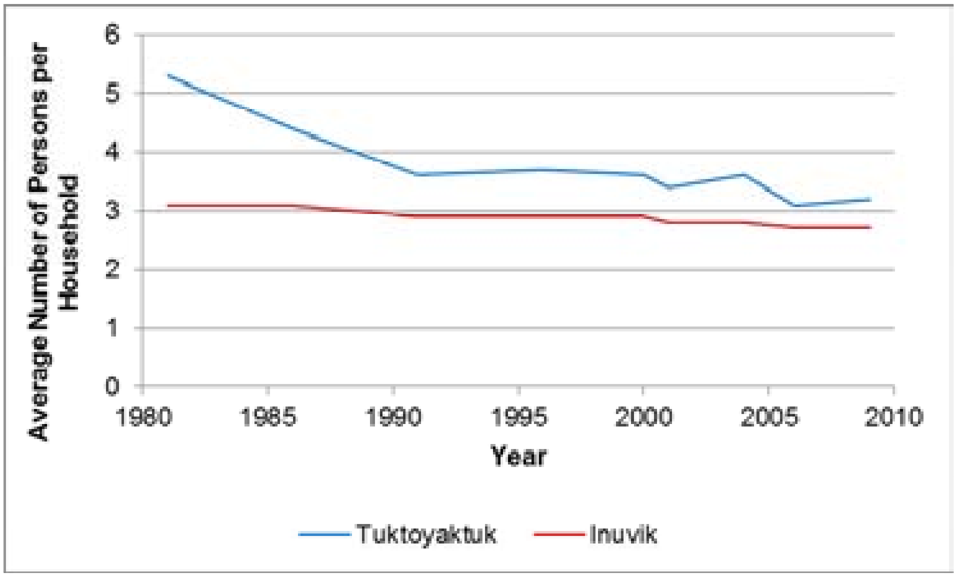
Inuvik

The Inuvik Volunteer Fire Department has one full-time paid fire chief and 30 volunteer firefighters, serving 3,500 residents. Of the volunteers, two are deputy chiefs, two are captains, three are lieutenants, and one is a safety officer. The fire chief and one deputy chief have certification through the National Fire Protection Association while the remaining volunteers are working to complete the first level of that certification process. Additional emergency response team members include five nurses and one emergency medical technician (J. Miller, Deputy Fire Chief, Inuvik Volunteer Fire Department, pers. comm., January 14, 2011).

The Inuvik Volunteer Fire Department plays an active role in the community through fire prevention initiatives, special events, and offering support to other communities in the Beaufort-Delta Region (Town of Inuvik 2010d). The Fire Department uses a manual system to track calls so does not have an estimate of emergency calls at this time. In 2010, approximately 85% of emergency calls were fire-related, with the balance being water-related rescue calls. There are no determined geographic boundaries between municipal emergency response departments for the ice road. For example, if Tuktoyaktuk's fire department is unable to respond to the situation, then Inuvik's fire department will respond. According to the Deputy Fire Chief, in the past 13 years, Inuvik has responded to two motor vehicle incidents on the ice road between Inuvik and Tuktoyaktuk (J. Miller, Deputy Fire Chief, Inuvik Volunteer Fire Department, pers. comm., January 14, 2011, February 3, 2011). Inuvik also has an emergency plan.

3.2.5.11 Housing

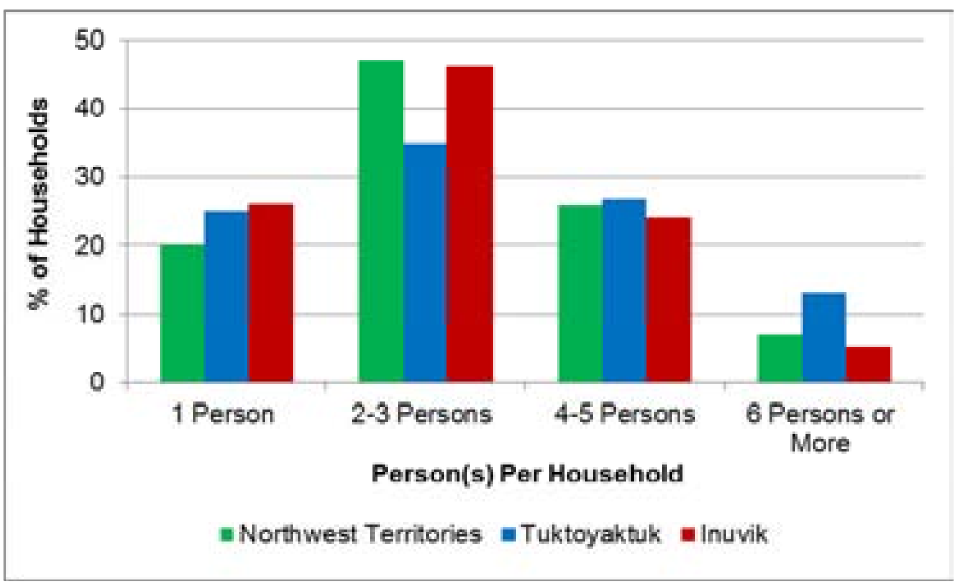
The average number of persons per household has varied in Tuktoyaktuk and Inuvik from 1981 to 2009. In Tuktoyaktuk the average number of persons per household has decreased from 5.3 in 1981 to 3.2 in 2009. The average number of persons per household in Inuvik has remained relatively stable, decreasing from 3.1 in 1981 to 2.7 in 2009, as shown in Figure 3.2.5-4 (GNWT Bureau of Statistics 2010e).



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.5-4
Average Number of Persons per Household in Tuktoyaktuk and Inuvik, 1981-2009

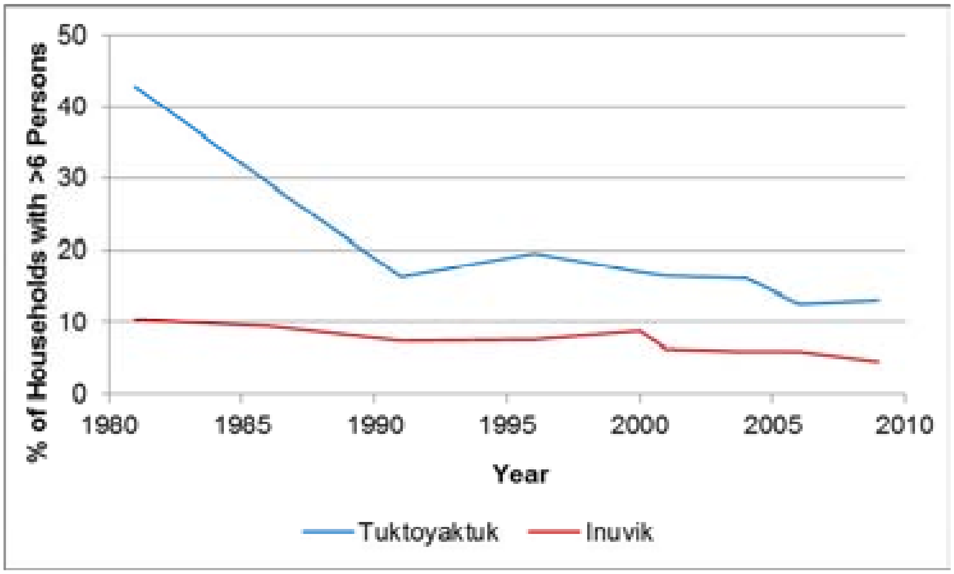
The majority of households in the NWT, Tuktoyaktuk, and Inuvik have three or fewer people; the highest percentage of households have 2-3 persons. Tuktoyaktuk had the highest percentage of households with 4-5 persons and 6 persons or more, as shown in Figure 3.2.5-5 (GNWT Bureau of Statistics 2010e).



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.5-5
Households by Number of Residents, NWT, Tuktoyaktuk and Inuvik, 2009

In Tuktoyaktuk and Inuvik, the percentage of households with more than six people has decreased from 1981 to 2009, as shown in Figure 3.2.5-6. In Tuktoyaktuk, the percentage of households with more than six people has decreased from 42.9% in 1981 to 13.0% in 2009 (GNWT Bureau of Statistics 2010e). Similarly, in Inuvik 10.3% of households had more than six people in 1981; by 2009, this percentage had declined to 4.5% (GNWT Bureau of Statistics 2010e).

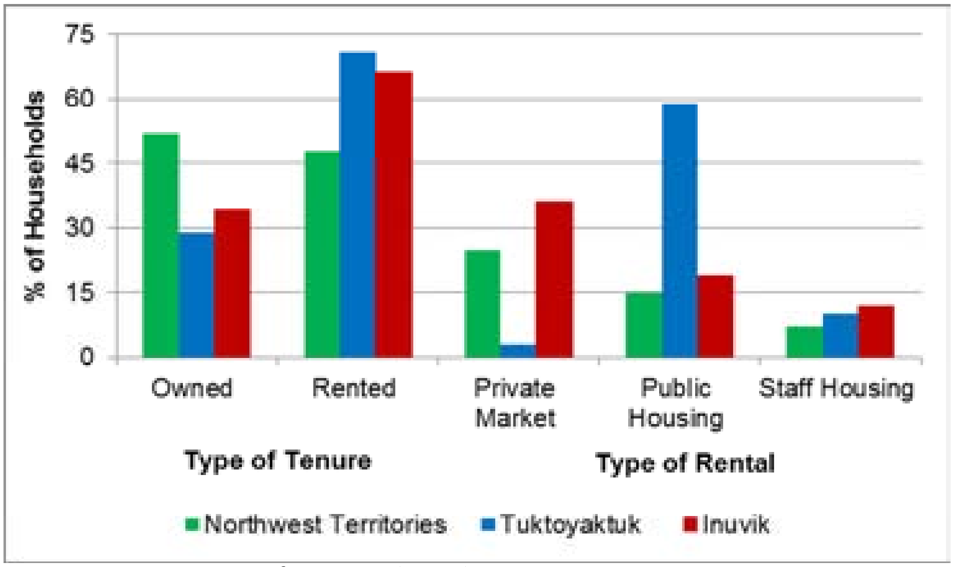


Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.5-6
Percent of Households with 6 Persons or More in Tuktoyaktuk and Inuvik, 1981-2009

There are 14,522 households in the NWT, 283 in Tuktoyaktuk and 1,280 in Inuvik. Of the total in the NWT, 7,623 (52%) are owned and 6,899 (48%) are rented. In Tuktoyaktuk, 81 (29%) are owned and 202 (71%) are rented, and in Inuvik, 432 (34%) are owned and 848 (66%) are rented. Figure 3.2.5-7 shows the percentage of households by tenure for the NWT, Tuktoyaktuk and Inuvik (GNWT Bureau of Statistics 2010e).

According to the GNWT Bureau of Statistics (2010e), there are three types of rental housing: private market, public housing and staff housing. Private market housing includes housing that is owned privately and rented out. Public housing includes government subsidized housing geared towards low-income households. Staff housing includes facilities such as nurses' residences, RCMP residences or residences for those involved in various industrial activities in the region. There is a greater percentage of private market rental housing available in Inuvik, compared to Tuktoyaktuk, but there is a greater percentage of public housing in Tuktoyaktuk compared to Inuvik. Figure 3.2.5-7 identifies the percentage of rental housing by type in the NWT, Tuktoyaktuk and Inuvik (K. Odziemkowska, Labour Market Statistician, GNWT Bureau of Statistics, pers. comm., January 28, 2011).



Source: GNWT Bureau of Statistics (2010e)

Figure 3.2.5-7
Beaufort-Delta Region and Communities, Households by Tenure, 2009

3.2.5.12 Safe Houses and Shelters

Tuktoyaktuk

Tuktoyaktuk Women's and Children's Shelter (Transition House) has eight beds and provides a safe environment for those fleeing family violence. The Hamlet also sponsors a Community Counselling Program with one counsellor and two community wellness workers (BDHSS 2010a).

Inuvik

The Inuvik Transition House is an eight-bed shelter that provides safety for women and children fleeing family violence. A&E Enterprises – Child Welfare Group Home operates a six-bed facility that also provides safe placements for children in care (BDHSS 2010c).

3.2.5.13 Child Care and Elder Care Services

The Inuvialuit Child Care Program works with Child Development Centres across the ISR, including Tuktoyaktuk and Inuvik, providing administration, support, and training to ensure programs comply with the NWT's *Child Day Care Act* and the guidelines of funding bodies. Funding is received from Inuit Child Care, Aboriginal Head Start, and the territorial Healthy Children's Initiative. To encourage daily use of Inuvialuktun (the Inuvialuit language), the Inuvialuit Cultural Resource Centre also funds fluent-speaker staff positions in each centre (IRC 2007c).

Tuktoyaktuk

The Hamlet has a Child Development Centre with a capacity of 8 infants/toddlers and 14 preschoolers with a waiting list of six infants/toddlers (A. Thrasher, Director, IRC Childcare, pers. comm., January 31, 2011).

Through one home support worker, the Rosie Ovayouk Health Centre provides home and palliative care for Elders, coordinated respite care, home management and personal care, and caregiver support and education (BDHSS 2010a).

Inuvik

The Town has four child care centres with varying capacity (P. Jellema, Director, Inuvik CDC, pers. comm., January 18, 2011):

- Inuvik Child Development Centre
  Enrolment: 26 preschool (45 on wait list), 20 afterschool;
- Inuvik Preschool
  Enrolment: 14 preschool, 14 after school (at capacity, no wait list);
- Aboriginal Head Start
  Enrolment: 19 preschool (12 on waitlist); and
- Tot Spot
  Enrolment: 4 infants (2 spots available), 8 preschoolers.

Long-term care facilities at Inuvik Regional Hospital provide care for residents who have substantial physical and/or mental functional disability that require daily treatment or supervision by nursing staff or other trained staff, such as rehabilitation or nutritional services. There are 25 beds in the long-term care facility, two of which are reserved as respite beds to provide occasional relief to caregiver family members (GNWT HSS 2010a).

The Elderly Day Program focuses on the social, rehabilitation, and activity needs of Elders in Inuvik. Located at the Inuvik Hospital, the program targets long-term care residents and community members. Elderly community members are provided transportation to the hospital where lunch and activities are provided. The program operates Monday to Thursday each week (GNWT Seniors' Society 2009).

The Residential School Survivors Support Team offers an Aboriginal Elders Program that provides peer support for Elders involved in residential school compensation processes or who have emotional issues related to their residential school experience. The program also links Elders to resources in the community (GNWT Seniors' Society 2009).

3.2.5.14 School and Education Services

The NWT Literacy Council works with individuals and families to promote literacy in all of the official languages of the NWT (NWTLC ND). Aurora College offers a Developmental Studies Program for Adult Basic Education (ABE) (Aurora College 2009). The ABLE programs have experienced steady enrolment, particularly in English and mathematics courses (GNWT ECE 2005).

In 2009, funding was awarded for afterschool programs at three schools, including schools in Tuktoyaktuk and Inuvik (GNWT MACA 2009).

Tuktoyaktuk

Mangilaluk School is the only school operating in Tuktoyaktuk, teaching Kindergarten to Grade 12. There are approximately 200 students attending the school and 24 staff members (Beaufort-Delta Education Council ND). Aurora College offers Adult Basic Education (ABE) programs in Tuktoyaktuk through the local Community Learning Centre (Aurora College 2009).

Inuvik

Inuvik has both an elementary and a secondary school. Sir Alexander Mackenzie Elementary School teaches Kindergarten to Grade 6, and had an estimated 320 students and 36 staff members in 2010. Samuel Hearne Secondary School teaches Grade 7 to Grade 12, and had an estimated 340 students and 42 staff members in 2010 (R. Mahnic, Principal, Inuvik Secondary School, pers. comm., January 25, 2011). Aurora College operates a campus and a research centre in Inuvik with 150 full-time students (Aurora College 2009).

According to the 2010 Assessment of Services and Self-Government Survey by the Inuvik CC, approximately 7% of Inuvik students aged 6-17 years do not attend school. Forty percent of those truancies were because students fell behind in their schoolwork and found it too difficult to catch up (IRC 2007e).

3.2.5.15 Recreation Services

Tuktoyaktuk

Indoor recreational facilities in Tuktoyaktuk include Kitti Hall, a 250-person capacity community centre, and an ice arena (The Hamlet of Tuktoyaktuk 2006). A recreational coordinator oversees programs for the community and works with recreation staff and volunteers to plan and implement activities. Recreational activities offered in the community include sports, family games nights, drum dancing, and cooking sessions. Outdoor recreation areas include the school playground and a golf course.

Inuvik

Inuvik's Midnight Sun Complex & Conference Centre is a modern, multi-use facility is used for community recreational activities such as fitness, swimming, hockey, and curling, conferences, tradeshows, workshops, seminars, meetings, cultural events, public forums, banquets, and other activities. The conference centre is located within walking distance of accommodations and downtown facilities, with parking available outside the building. The centre includes a full stage and banquet facilities to accommodate up to 325 people.

Inuvik has over 20 outdoor recreational spaces, which include parks and playgrounds, trails, boat launch, basketball court, skateboard park and tennis courts (Town of Inuvik 2010e).

3.2.5.16 Management of Renewable Resources

Renewable resources, such as wildlife, fish, and plants, are very important to the people of the ISR and the NWT. Historically, resources from the land were closely linked to the Aboriginal economy and to cultural and spiritual values. Hunting, fishing, trapping and recreational use of these resources remain integral components of traditional lifestyles and economies. Similarly, many non-Aboriginal residents of the NWT and visitors from outside the NWT associate important social, spiritual, and environmental values with their use of renewable resources (GNWT ENR 2005i).

The Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans state that "subsistence and recreational use of well-managed renewable resources is desirable and consistent with their conservation" (Community of Tuktoyaktuk et al. 2008, p. 139; Community of Inuvik et al. 2008, p. 159). The Community Conservation Plans note that Inuvialuit knowledge and experience are essential elements in the proper management of renewable resources in the Settlement Region (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

According to the Community Conservation Plans, the proposed Highway alignment passes through several special management areas designated Management Categories "B", "C", and "E".

Management Category "B" refers to the "lands and waters where there are cultural or renewable resources of some significance and sensitivity but where terms and conditions associated with permits and leases shall assure the conservation of these resources."

Management Category "C" refers to the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption."

Management Category "E" refers to "lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection in this document."

Specific information related to land use and harvesting are found in Sections 3.2.9 and 3.2.8.5 of the Environmental Impact Statement, respectively.

Level of use and sustainability of renewable resources are monitored by the GNWT Department of Environment and Natural Resources (ENR) using indicators ranging from hunting and fishing to eco-tourism (GNWT ENR 2005i). Monitoring in the ISR is done in conjunction with various groups including Wildlife Management Advisory Councils (NWT and North Slope), Fisheries Joint Management Committee, Inuvialuit Game Council, and

Hunters and Trappers Committees. Decisions regarding land use that may affect renewable resources are made by the Inuvialuit Land Administration, the Environmental Impact Screening Committee, and the Environmental Impact Review Board.

Baseline information regarding valued wildlife, bird and fish resources is provided in the Section 3.1.

3.2.5.17 Supply of Aggregate and Granular Materials

The investigation and evaluation of granular material resources in the Mackenzie Delta region has been conducted since the 1950s by government and private industry. Locations of available aggregate and granular materials have been mapped and the approximate amount of available resources has been identified. The most recent surficial geology mapping of the Project study area, and the one used to perform this work, was prepared by Rampton (1987).

During the 1980s and early 1990s, the focus of the various studies and investigations of granular materials was directed to issues dealing with Aboriginal land claims. In this regard, the work in the Mackenzie Delta region was primarily directed to the *Inuvialuit Final Agreement* (IFA). The granular materials inventory work completed by EBA Engineering Ltd. (EBA) in 1987 for Indian and Northern Affairs Canada (INAC) formed part of the IFA. The comprehensive granular materials inventory was assembled for resources within the Inuvialuit Settlement Region (ISR) using the available information collected over the years.

Under the IFA, signed by the Government of Canada and the Inuvialuit in 1984, ownership of most of the accessible granular material deposits in the ISR was transferred to the Inuvialuit (IRC 1987). Management of this resource is now the responsibility of the Inuvialuit Land Administration (ILA) in consultation with local groups such as the Community Corporations and Hunters and Trappers Committees.

The borrow sources for the Highway development are in relatively close proximity to Inuvik and Tuktoyaktuk and access to these resources could benefit the communities' future development projects. Further information regarding borrow sources is located in Section 2.6.8.

3.2.5.18 Planned Projects

Major social and institutional projects are regularly planned throughout the ISR. Below is a summary of projects currently planned or implemented in the ISR, Tuktoyaktuk and Inuvik. Project funding comes from a combination of resources including the federal government, territorial government, and the Inuvialuit Regional Corporation.

Some social projects are informed by government directives or government initiatives and strategic plans, which are then funded accordingly. Examples include the *Brighter Futures* federal wellness program (GNWT HSS 2010b), Northwest Territories Health and Social Services System Strategic Plan (GNWT HSS 2010c), and the Building on Our Success Strategic Plan 2005-2015 (GNWT ECE 2009). From the review of these documents, it was determined that ongoing programming is being funded, but that no major new social programs were scheduled for implementation in the Project area.

The largest proposed capital projects in the region are the Mackenzie Gas Project, the proposed Mackenzie Valley Highway, and the proposed Inuvik to Tuktoyaktuk Highway. If the Mackenzie Gas Project is constructed, there will be processing facilities and pipelines constructed in the ISR that extend to northern Alberta. In 2006, the federal government established a $500 million Mackenzie Gas Project Impact Fund to be utilized should the project move forward. The purpose of this fund is to support regional projects that can alleviate potential socio-economic impacts on NWT communities affected by the proposed project, during the planning, construction and operation of the Mackenzie Gas Project. This fund will also deal with existing conditions that may be affected by the project. The release of funding is contingent on the Mackenzie Gas Project proceeding (INAC 2010a).

The all-weather portion of the Mackenzie Valley Highway currently extends from the Alberta border to Wrigley, NWT. The GNWT, with its local partners, are proposing to construct the remaining all-weather sections of the highway from Wrigley to Inuvik, linking the southern NWT to Inuvik, and potentially to Tuktoyaktuk, if the Inuvik to Tuktoyaktuk Highway is approved and constructed. If all proposed sections of the Mackenzie Valley Highway are completed, it will be possible to drive from Fort Smith to Tuktoyaktuk entirely within the borders of the NWT

Potential municipal projects are discussed in the following subsections.

Tuktoyaktuk

The GNWT is providing capital funding for the following projects in the 2011-2012 Fiscal Year (GNWT Finance 2010a):

- Public Housing - 4 units replaced, 15 retrofitted, warehouse plan and design;
- Public Works and Services – mechanic shop replacement; and
- Transportation – 19 km gravel access road.

There are several infrastructure and land development capital projects proposed for 2011. A Curling Club building exists but needs engineering. Council is pursuing preliminary work on a new solid waste site estimated to cost over $3 million. Canadian Northern Development Agency has been pursuing a wind mill project, new hotel and other infrastructure (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., February 2, 2011).

Inuvik

The GNWT is providing capital funding for the following projects in the 2011-2012 fiscal year:

- Public Housing:
  - Retrofit five housing units.
  - Construct one new housing unit.

- Public Works and Services:
  - Ongoing construction of GNWT Office and Record Centre/Warehouse/Data Centre - 3,470 m².
  - Ongoing construction of GNWT Records Storage Facility - 940 m².
- Health and Social Services:
  - Improvements to GNWT Office and Record Centre for Health & Social Services Warehouse Area - 384 m²:
  - Purchase of medical equipment for the Inuvik Regional Hospital including: hematology analyzer, ultrasound, laproscopy, operating microscopes.
- Education and Culture – Construction/ replacement of Sir Alexander Mackenzie Elementary School and Samuel Hearne Secondary School - 11,900 m².
- Airports – purchase of a vibratory packer.
- Industry Tourism and Investment:
  - Improvements to Jak Park Territorial park hiking trails.
  - Improvements to Gwich'in Territorial Park boat dock slip way.
- Environment and Natural Resources – design, acquire, transport and construct East Hans Lake Enforcement and Compliance Facility (all-weather cabin) - 38m² (GNWT Finance 2010a).

Current and future major capital projects are as follows:

- Completion of the new combined elementary and secondary school is planned for 2013. It will have capacity for 900-1000 students (current combined enrolment for 2010-11 is 660).
- Planning for a new child care centre by the Children's First Society is underway. Land has been purchased and a building design is being prepared. The project will be grant funded.
- The Town of Inuvik is setting aside capital funds each year for a for a new water plant. Currently all water is chlorinated, and winter water from the Mackenzie River is filtered.
- A future project is to extend the Inuvik airport runway to better accommodate larger planes, such as those used for the military (R. Campbell, Director, Inuvik Public Services, pers. comm., February 4, 2011).

In April 14, 2010, the Inuvik Community Corporation purchased the Inuvik Youth Centre property from the Town of Inuvik. IRC plans to convert it to a multi-use building designed to hold cultural activities, office space, and possibly retail space (IRC 2007e). The plan has not yet been finalized, and the property will not be converted until the Inuvik Youth Centre moves to a new space (V. Kasook, Corporate Manager, Inuvik Community Corporation, pers. comm., February 2, 2011).

3.2.6 Human Health and Community Wellness

3.2.6.1 Age, Gender and Ethnicity

Data for age, gender and ethnicity in the Beaufort-Delta region and communities of Tuktoyaktuk and Inuvik are described in the Demographics section of this document (Section 3.2.2).

3.2.6.2 Mortality, Morbidity and Relevant Non-Communicable and Infectious Diseases

Mortality is defined as a fatal outcome or death (Medicine Net 2011a). The mortality rates, measured as the "Number of Deaths" by GNWT Bureau of Statistics for Tuktoyaktuk and Inuvik are described in the Demographics section of this report.

Morbidity is defined as illness or disease (Medicine Net 2011b). Table 3.2.6-1 provides the morbidity rates by age and gender for four common illnesses and diseases in the ISR: diabetes, cancer, high blood pressure, and high cholesterol.

The Inuit Health Survey 2007-2008, was conducted by G.M. Egeland. A total of 288 households or 362 individuals participated, with 244 of the participants being female and 118 being male. Participants of the survey were from the communities of Aklavik, Inuvik, Tuktoyaktuk, Sachs Harbour, Paulatuk, and Ulukhaktok.

TABLE 3.2.6-1: HEALTH HISTORY FOR THE PARTICIPANTS OF THE INUIT HEALTH SURVEY, 2007

Health Problem Reported by Participants	Age		Gender	
	<40 yr	≥40 yr	Male	Female
Diabetes	0.0%	8.0%	4.8%	5.0%
Cancer	1.0%	10.4%	3.6%	8.3%
High Blood Pressure	9.1%	32.3%	26.5%	22.0%
High Cholesterol	3.0%	21.3%	14.3%	14.1%

Source: Egeland (2010)

The Inuit Health Survey found that 8% of participants aged 40 years and older reported having diabetes. No participants aged less than 40 reported reported having diabetes (Egeland 2010).

More than 10% of participants over the age of 40 reported having cancer. Rates of cancer were higher in the female participants (8.3%) than in the male participants (3.6%) (Egeland 2010). Types of cancer were not specified in the survey.

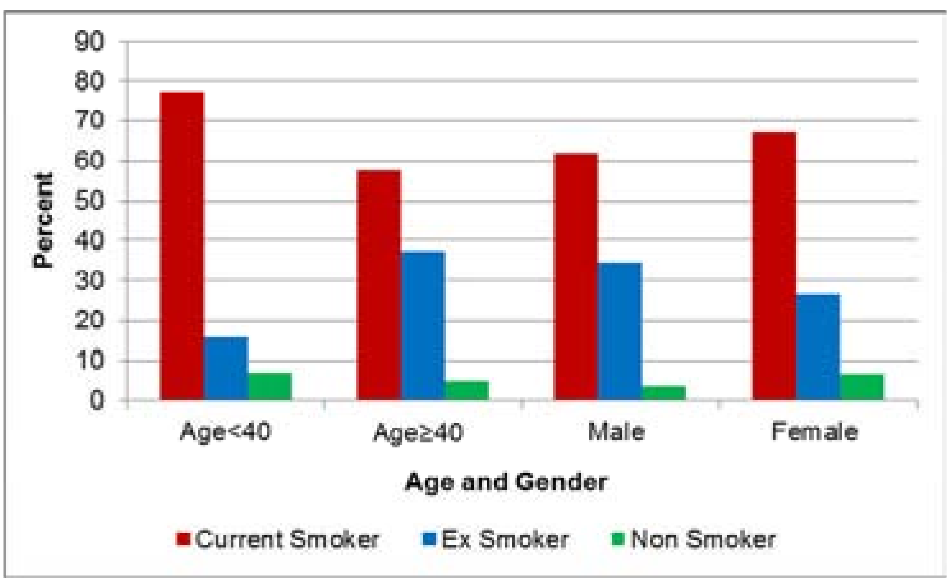
More than 30% of participants over the age of 40 reported having high blood pressure; this was the most common health concern among participants. In comparison, approximately 16% of Canadians reported having high blood pressure in 2007. High blood pressure is primarily treated through medication, exercise and diet (Egeland 2010).

A much higher percentage (21.3%) of participants over the age of 40 reported having high cholesterol compared to 3.0% of participants age 40 or younger. There appeared to be almost no gender variation, although reporting rates for males were slightly higher than for females: 14.3% and 14.1%, respectively (Egeland 2010).

The GNWT Health and Social Services (HSS) has established the Health Promotion Strategy, which provides a framework for increased investment in promotion and prevention activities at the territorial, regional, local and individual levels (GNWT HSS 2006b).

A recent and significant achievement for HSS is the reduction in new cases of tuberculosis, which was a very serious health concern for northern communities until recently. The number of new cases of tuberculosis has been decreasing steadily from 24 cases in 1996 to four cases in 2002 (IOL et al. 2004).

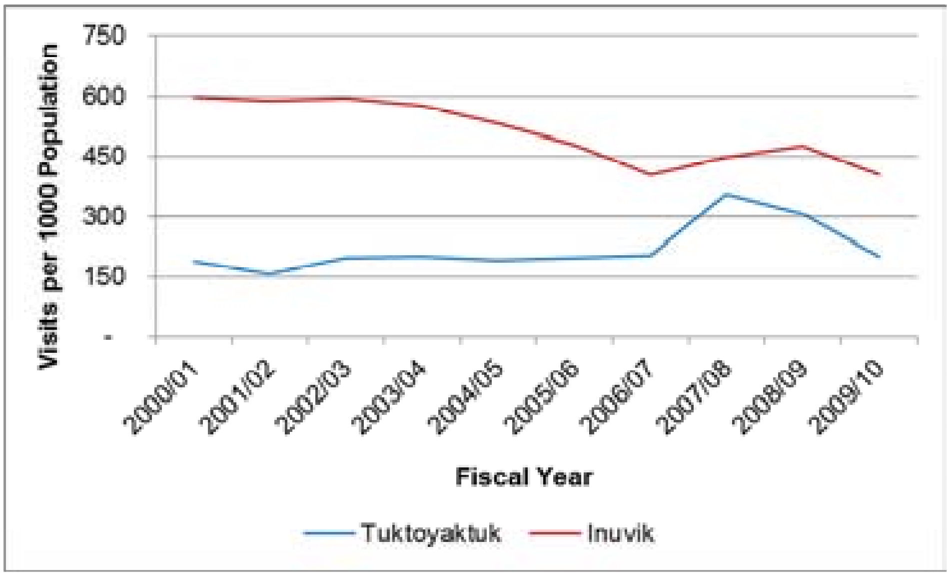
There are high rates of smoking in the ISR. The Inuit Health Survey reported that 65% of participants smoked cigarettes in 2007, compared to 22% for all Canadians in the same year. The daily average number of cigarettes smoked by Inuit men was 13 and for women was 10. The average age that participants began smoking was 15.5 years old. Figure 3.2.6-1 shows the average number of ex-smokers, current smokers and non-smokers by age and gender. Young (<40 year old) females appear to have the greatest tendency to be smokers (Egeland 2010).



Source: Egeland (2010)

Figure 3.2.6-1
Percent of Ex-Smokers, Current Smokers, and Smokers by Age and Gender, 2007-2008

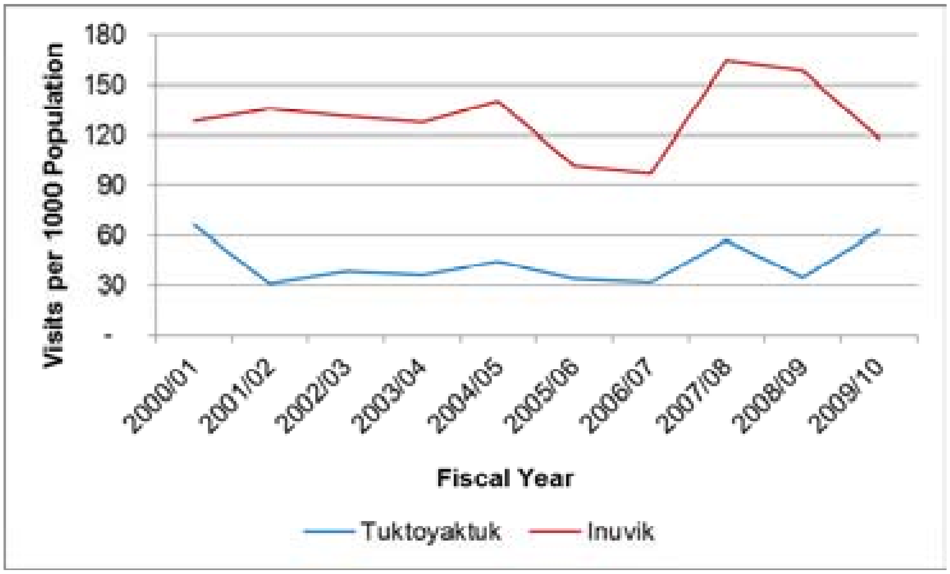
The high rates of smoking, 53% in Inuvik compared with 42% in the NWT, contributes to higher rates of respiratory diseases such as chronic obstructive pulmonary disease. Figure 3.2.6-2 identifies the number of cases of respiratory diseases treated by physicians in Tuktoyaktuk and Inuvik from the fiscal year of 2000/01 to 2009/10. In general, Tuktoyaktuk had a lower number of visits to physicians per 1,000 population than Inuvik. Both communities experienced a spike then decline in number of visits between 2006 and 2010 (GNWT HSS 2010e).



Source: GNWT HSS (2010e)

Figure 3.2.6-2
Cases of Respiratory Diseases Treated by Physicians, 2000 – 2010

Figure 3.2.6-3 shows the number of cases of infectious and parasitic disease per 1,000 individual in Tuktoyaktuk and Inuvik. In general, Tuktoyaktuk had fewer number of visits to physicians per 1,000 residents than Inuvik. However, both communities experienced an increase in visits to physicians in the fiscal year 2006/07(GNWT HSS 2010e).

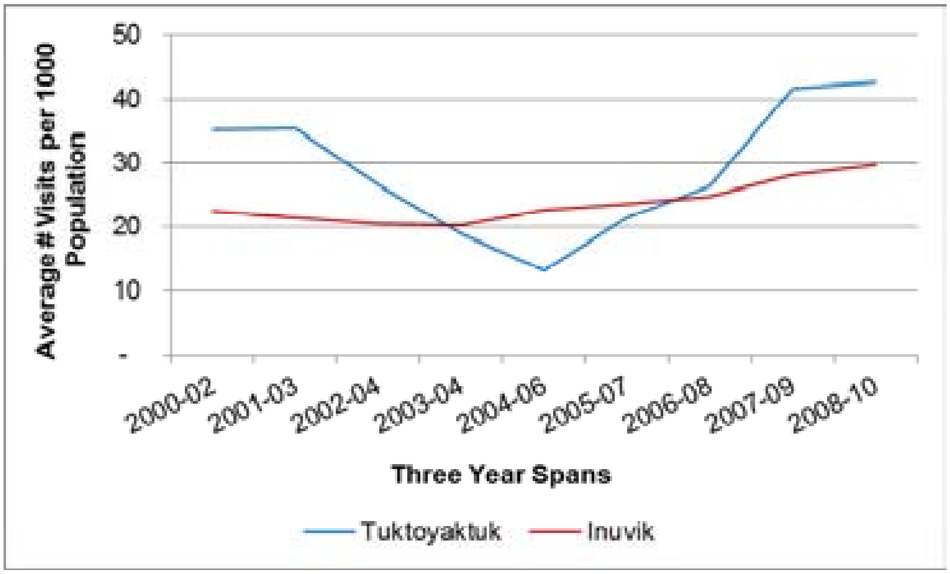


Source: GNWT HSS (2010e)

Figure 3.2.6-3
Cases of Infectious and Parasitic Diseases Treated by Physicians, 2000 – 2010

Figure 3.2.6-4 shows the three-year average number of sexually transmitted infections treated by physicians in Tuktoyaktuk and Inuvik. The three-year average number of cases is typically higher in Tuktoyaktuk than Inuvik, with the exception of 2004 to 2006. The number of cases have increased in both communities from 2000 to 2010 (GNWT HSS 2010e).

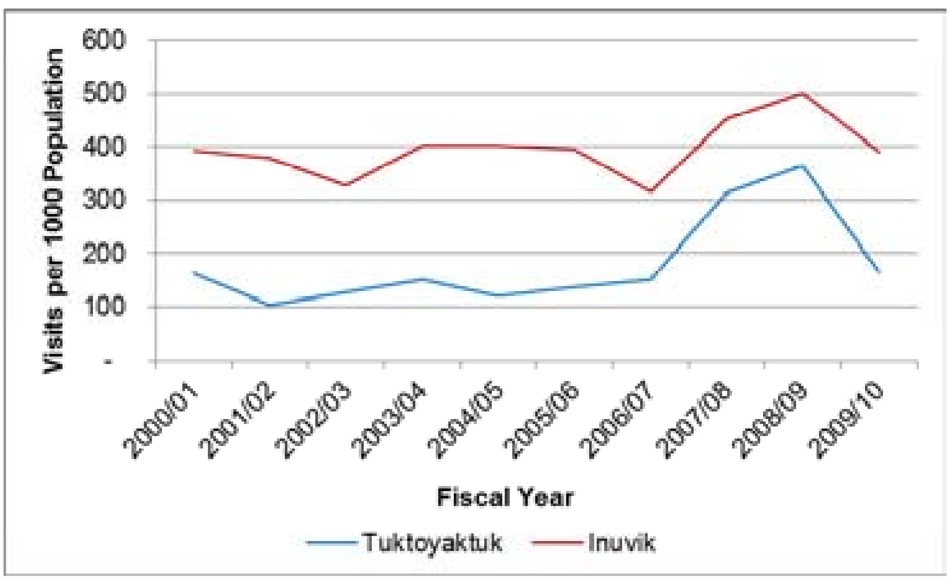
According to M. Heffel, Head Nurse at the Rosie Ovayouk Health Centre in Tuktoyaktuk, the number of cases of sexually transmitted infections increases during the winter months when the winter road is in operation (pers. comm., January 18, 2011).



Source: GNWT HSS (2010e)

Figure 3.2.6-4
Three-Year Average Number of Sexually Transmitted Infections[7] Treated by Physicians in Tuktoyaktuk and Inuvik, 2000 - 2010

The average number of cases per 1,000 individuals of accidents, injuries or poisonings follows a similar trend in both Tuktoyaktuk and Inuvik as shown in Figure 3.2.6-5 (GNWT HSS 2010e).

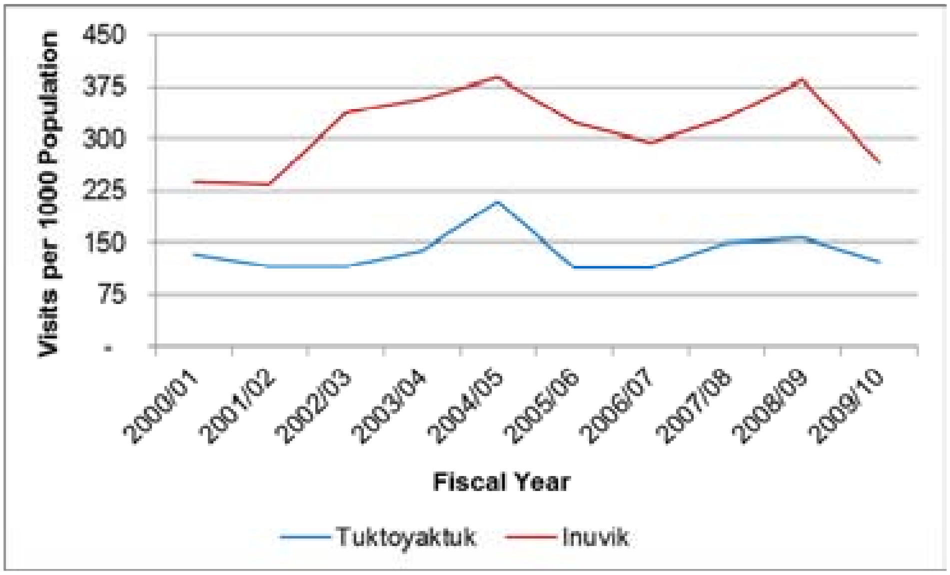


Source: GNWT HSS (2010e)

Figure 3.2.6-5
Cases of Accidents, Injuries and Poisonings Treated by Physicians, 2000 – 2010

[7] Note: Average rate is for both sexes, and all ages

The average number of cases of mental disorders per 1,000 individuals follows a similar trend in both Tuktoyaktuk and Inuvik as shown in Figure 3.2.6-6 (GNWT HSS 2010e).

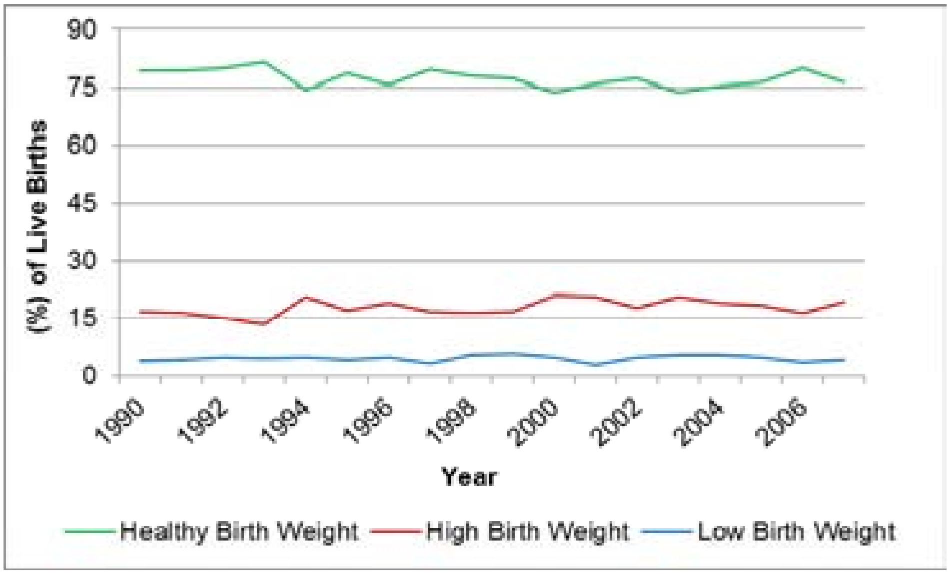


Source: GNWT HSS (2010e)

Figure 3.2.6-6
Cases of Mental Disorder Treated by Physicians, 2000 – 2010

3.2.6.3 Children's Health

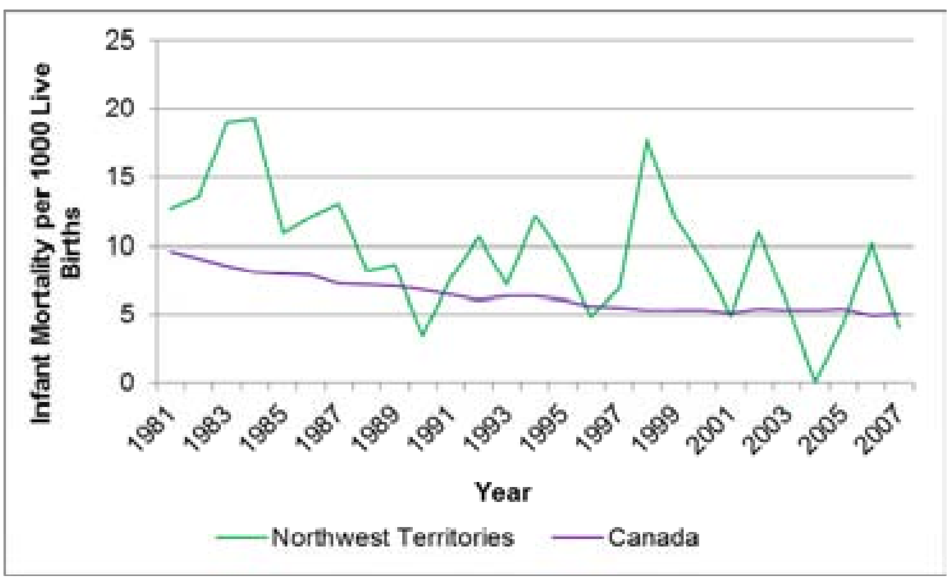
Children's health information was available at the territorial and federal level, but unavailable for the region or specific communities. Birth weight is a key determinant in child health. A low birth weight (<2,500g) indicates a risk for developmental delays and health problems. A high birth weight (>4,000g) indicates that the mother will most likely experience a difficult delivery. Figure 3.2.6-7 shows the incidences of low, high and healthy birth weights in the NWT as a percentage of live births (GNWT HSS 2005; GNWT Bureau of Statistics 2010m).



Source: GNWT HSS (2005); GNWT Bureau of Statistics (2010m)

Figure 3.2.6-7
Incidences of Low, High Birth Weights, and Healthy Births in NWT, 1990-2007

The infant mortality rate is a measure used to determine the status of child and maternal health. Figure 3.2.6-8 shows the infant mortality rate in the NWT and Canada from 1981 to 2007. The infant mortality rate is based on 1,000 live births. In Canada, the infant mortality rates steadily decreased from 1981 to 2007. In the NWT, infant mortality rates also decreased in general; however, the rates tend to fluctuate over the years (GNWT HSS 2005; GNWT Bureau of Statistics 2010m).



Source: GNWT HSS (2005); GNWT Bureau of Statistics (2010m)

Figure 3.2.6-8
Infant Mortality Rate in the NWT and Canada, 1981 – 2007

There is little information regarding the dental health of children in the NWT. A report by Thompson et al. (1998), states that girls tend to brush their teeth more often and consume fewer sweets between meals. Aboriginal students generally went for dental treatment when needed; however, they brushed their teeth less frequently than other students and often learned on their own without parental instruction (Thompson et al. 1998).

The Hamlet of Tuktoyaktuk has a dental health program for children. The program is called "Little Teeth are a Big Deal" and covers topics such as tooth and gum maintenance (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011). Due to the reluctance of the Inuvik health staff to participate in a phone interview, little is known regarding the dental health programs in Inuvik.

3.2.6.4 Nutrition

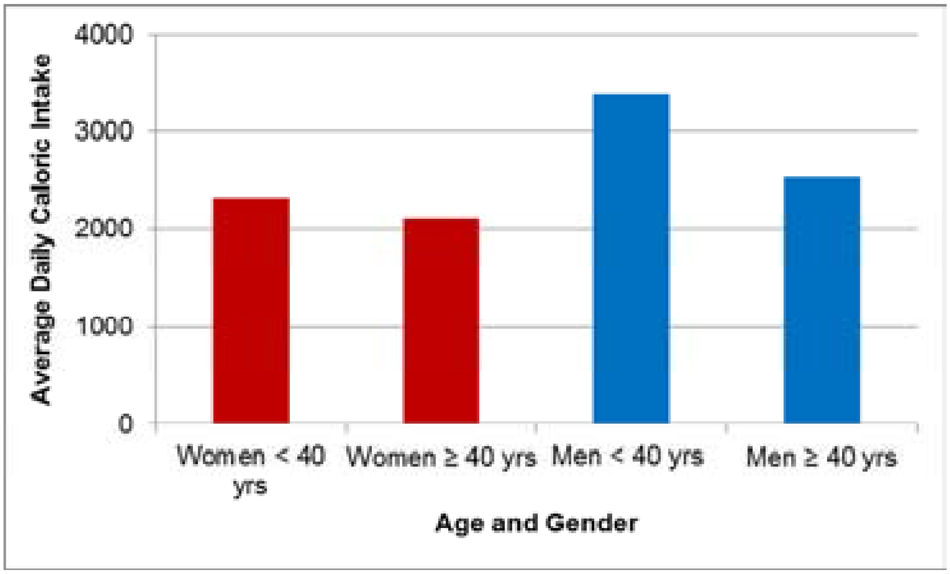
The Inuit Health Survey included a food security questionnaire. The results of the survey indicated that more than half (54%) of the households participating had enough food to eat or were considered food secure. Of the remaining households, 33% showed moderate food insecurity and 13% showed severe food insecurity (Egeland 2010).

Overall, approximately 40-60% of people living in small NWT communities rely on country food for at least 75% of their meat and fish (GNWT ENR NDa). For information regarding food sharing, refer to Section 3.2.7.2.

The Inuit Health Survey found participants preferred to eat nutrient-rich country foods; however, the high cost of obtaining country foods makes it difficult to do so. Of those that do consume country food, men tend to eat more than women, and older adults (>40 years) tend to eat more than younger adults (<40 years). Of the country foods consumed, fresh caribou meat and Arctic char were the two that were eaten most often and in the largest quantities (Egeland 2010).

The Inuit Health Survey identified that market foods such as chips, pop, sweet drinks (made from crystals), and chocolate bars/candy were consumed regularly by many adults. Almost 80% of adult participants reported drinking 2-4 cans (355 ml/can) of sweetened soda pop daily. As such, 25-33% of the total calories consumed by participants came from high sugar foods and drinks.

Men consumed more calories from protein and fat than women, and women consumed more calories from carbohydrates then men. Typically men consumed more calories than women, and younger adults consumed more calories than older adults. In 2004, the average caloric intake for the Inuvialuit was higher than the Canadian average. Figure 3.2.6-9 shows the average caloric intake for older and younger men and women (Egeland 2010).



Source: Egeland (2010)

Figure 3.2.6-9
Average Caloric Intake of Inuit People by Age and Gender, 2007-2008

The Inuit Health Survey reported that 74% of participants said they walked about 20 minutes a day, five days a week. Men walked for a longer period of time than women (Egeland 2010).

3.2.6.5 Country Foods

Consuming country foods is important to Inuvialuit identity, and is the culmination of a series of co-operative activities - harvesting, processing, distributing, and preparing - that require behaving in ways that emphasize Inuvialuit values of co-operation, sharing, and generosity (IRC 2007k).

Traditional food is relied upon by residents in Arctic communities for both physical and nutritional well-being. A study conducted by Lambden et al. (2007) indicated that people in Arctic communities felt that traditional food was healthier for them and contained large quantities of iron and had added benefits derived from food purity i.e. no chemicals, steroids and preservatives (Lambden et. al. 2007).

Access to traditional food is not only culturally and nutritionally important it also plays a fundamental role in food security in the north (Lambden et. al. 2007). A discussion regarding accessibility to country foods and food sharing networks is located in Section 3.2.7.2 of this report.

Although store-bought food is generally available in some variety, many Inuvialuit continue to eat country foods and to hunt and fish for a good part of their diet (IRC 2007k). According to the Inuvialuit Regional Corporation (2007j), Inuvialuit look forward to the changing seasons as their diet varies with the season. For example, geese and muskox are hunted in the spring and fall; whaling and fishing take place in the summer; caribou hunting occurs in the fall and winter (IRC 2007j).

There are several nutritional benefits of country foods. Based on a study of 43 Arctic communities, the Centre for Indigenous Peoples' Nutrition and Environment (NDa) found that the benefits of a country foods diet are:

- More lean meats and fish;
- Less calories – helpful for weight control;
- Less saturated fat – better for the heart;
- More iron – better for muscles and blood;
- More zinc – better for wound healing and fighting infection;
- More Vitamin A – better for vision and fighting disease;
- More calcium – better for strong bones and teeth; and
- Strengthened cultural capacity and well-being.

Table 3.2.6-2 provides a summary of the types of animals that are hunted or fished for country foods. The information is summarized from the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans (Community of Inuvik et al. 2008, Community of Tuktoyaktuk et al. 2008).

TABLE 3.2.6-2: SUMMARY OF COUNTRY FOODS

Mammals		Beluga Whale (*Delphinapterus leucas*) Qilalugaq
		Bowhead Whale[8] (*Balaena mysticetus*) Aqviq or Arvia
		Ringed Seal (*Phoca hispida*) Natchiq
		Caribou (*Rangifer tarandus*) Tuktu
		Lynx (*Lynx canadensis*) Niutuyiq
		Moose (*Alces alces*) Tuttuvak
		Muskrat (*Ondatra zibethicus*) Kivgaluk
		Snowshoe hare or Rabbit (*Lepus americanus*) Ukalliq
Birds	Ducks / Qaugait	King Eider (*Somateria spectabilis*) Quingalivik
		Common Eider (*Somateria mollissima*) Quingalik
		Mallards (*Anas platyrhynchos*) Kurugakpak
		Scoters (Black Duck) (*Melanitta* spp.) Taakruaq
		Wigeon (Baldpate Duck) (*Anas americana*) Ugiuhiuq
		Old Squaw (*Clangula hyemalis*) Ahaliq
		Pintail (*Anas acuta*) Kurugak

[8] Although described as a country food consumed in the region, bowhead whales have been rarely caught in the past several years.

TABLE 3.2.6-2: SUMMARY OF COUNTRY FOODS

	Geese / Tundra Swan	Canada Goose (*Branta canadensis*) Uluagullik
		Tundra swan (*Cygnus columbianus*) Qugruk
		Snow Goose (*Chen caerulescens*) Kanguq
		White-fronted Goose (*Anser albifrons frontalis*) Nirliq
		Brant (*Branta bernicla*) Niglignaq
	Ptarmigan (*Lagopus spp.)* Qaiq	Rock Ptarmigan (*Lagopus mutus*)
		Willow Ptarmigan (*Lagopus lagopus*)
	Other	Snowy Owl (*Nyctea scandiaca*)Ukpik
Fish		Arctic Charr (*Salvelinus alpinus*) Qalukpik
		Arctic Cisco (*Coregonus autumnalis*)
		Jackfish or Northern Pike (*Esox lucius*) Siulik
		Arctic Grayling (*Thymallus arcticus*) Hulukpaugaq
		Blue or Pacific Herring (*Clupea pallasi*)
		Lake Trout (*Salvelinus namaycush*) Iqaluakpak
		Broad Whitefish (*Coregonus nasus*) Anaakiq
		Burbot or Loche (*Lota lota*) Tittaaliq
		Lake Whitefish/ Crooked Backs (*Coregonus cluepeaformis*) Pikuktuq
		Coney or Inconnu (*Stenodus leucichthys*) Higaq
		Dolly Varden Charr (*Salvelinus malma*) Qalukpik
		Least Cisco or Big-eyed Herring (*Coregonus sardinella*)
Plants		Black bearberry (*Arctostaphylos alpine*) Paungat
		Dwarf Arctic Birch (*B. nana* subsp. *exilis*)
		Marsh marigold (*Caltha palustris* subsp. *arctica*)
		Crowberry (*Empetrum nigrum* subsp. *hermaphroditum*) Paungat
		Fireweed (*Epilobium angustifolium*)
		River beauty or willowherd (*E. latifolium*)
		Horsetail (*Equisetum arvense*)
		Lettergrass (*Eriophorum angustifolium* subsp. *subarcticum*)
		Licorice root, Eskimo potato (*Hedysarum alpinum* subsp. *americanum*) Masu
		Mare's tail (*H. vulgaris*)
		Seabeach sandwort (*Honckenya peploides*)
		Mountain sorrel (*Oxyria digyna*)
		Wooly Lousewort (*P. kanei* subsp. *kanei*)
		Lousewort (*P. langsdorffii* subsp. *arctica*)
		Lousewort (*P. s.* subsp. *interior*)

TABLE 3.2.6-2: SUMMARY OF COUNTRY FOODS

	Sweet Coltsfoot (*Petasites frigidus*)
	Sweet Coltsfoot (*P. hyperboreus*)
	Eskimo rhubarb (*Polygonum alaskanum*) Qaugaq
	Bistort (*P. bistorta* subsp. *plumosum*)
	Alpine bistort (*P. viviparum*)
	Buttercup (*R. pallasii*)
	Arctic raspberry (*Rubus arcticus* subsp. *stellatus*)
	Cloudberry (*R. chamaemorus*) Aqpik
	Arctic Dock (*R. arcticus*)
	Alaska willow (*Salix alaxensis*)
	Diamond-leaf willow (*S. pulchra*)
	Bulblet saxifrage (*S. cernua*)
	Bulblet saxifrage (*S. cernua*)
	Bog saxifrage (*S. hirculus*)
	Cordate leaved Saxifragi (*S. punctata* subsp. *nelsoniana*)
	Dandelion (*T. lacerum*)
	Blueberry (*Vaccinium uligonosum* subsp. *alpinum*) Asivit
	Blueberry (*V. u.* subsp. *microphyllum*) Asivit
	Lingonberry, Cranberry (*V. vitis-idaea* subsp. *minus*) Kimingnat

Source: Community of Inuvik et al. (2008) and Community of Tuktoyaktuk et al. (2008)

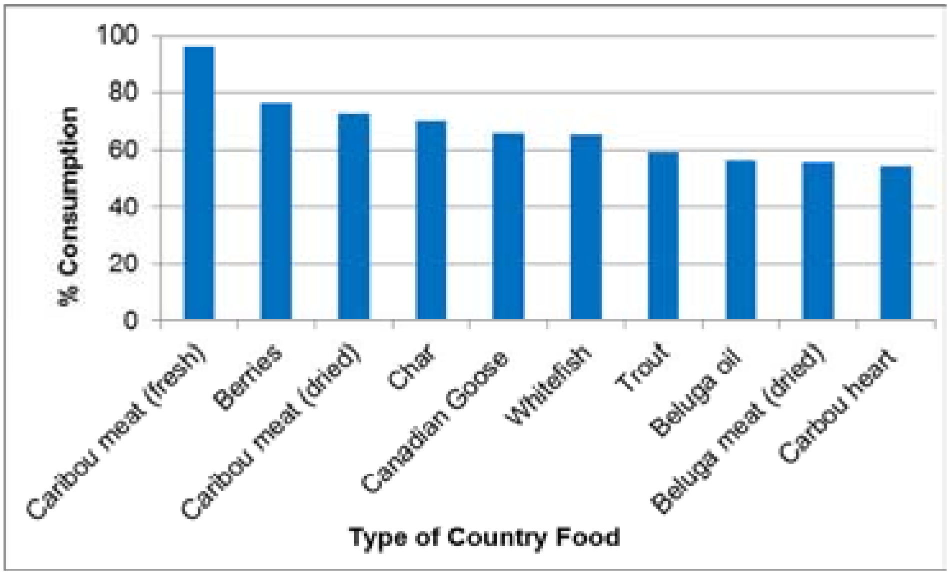
The abundance of these country foods is dependent on the species population, habitat availability, and ongoing tradition of hunting/ trapping/ fishing. A discussion regarding key species population and habitat is located in Section 3.1.7 to 3.1.10 and discussion of the current and historic levels of hunting/trapping/ fishing is located in Section 3.2.8 of this EIS.

Lambden et al. (2007) surveyed Yukon First Nations, Dene/Metis and Inuit women in 44 Arctic communities on recent changes in the quality or health of traditional plants or harvested wildlife. Between 10% and 38% of participants (depending on the community) reported noticing change in the quality of the traditional food species.

Specific changes were noted by 10% to 27% of participants. These changes included physical deformities such as "fish scales looking funny" and "caribou liver and lungs being stuck to their ribs"; decreased accessibility; contamination of traditional foods; reduced animal size; and change in taste and other sensory changes such as "the fish flesh is not as firm as it used to be" and "the fish don't taste the same" (Lambden et. al. 2007).

Intake of traditional foods by age and gender differs. Consistently, older adults consumed more traditional foods (gram/day) than younger adults, and men consumed more than women. Younger people consumed less than older people and children consumed much less traditional foods than either of the other groups (Kuhnlein and Receveur 2007).

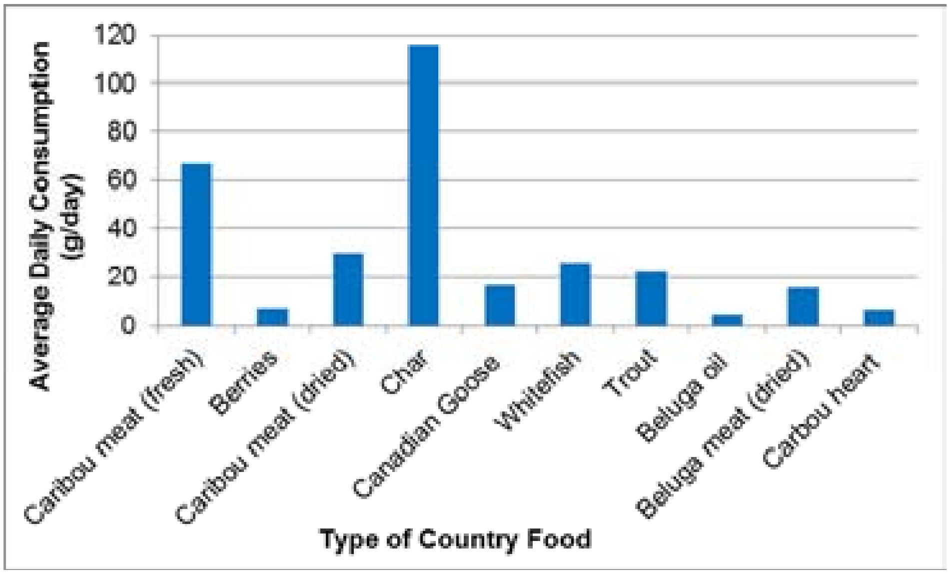
The Inuit Health Survey reported the most commonly consumed country food in the ISR (Figure 3.2.6-10). Fresh caribou meat was the most commonly consumed food, followed by berries and dried caribou meat. Caribou heart was the least commonly consumed country food (Egeland 2010).



Source: Egeland (2010)

Figure 3.2.6-10
Most Commonly Consumed Country Food in the ISR, 2007-2008

The Inuit Health Survey also documented the average daily intake of country food for each participant (Figure 3.2.6-11). Char was consumed in the greatest amounts (116.0 g/day) followed by fresh caribou meat (66.7 g/day) and dried caribou meat (30.2 g/day) (Egeland 2010).



Source: Egeland (2010)

Figure 3.2.6-11
Average Daily Consumption of Country Food in the ISR, 2007-2008

Market or store-bought food groups represent the main categories of grains, meats, fruits, vegetables, dairy, and meat alternatives. A variety of market foods are available in Inuvik and Tuktoyaktuk. In a survey of five Arctic communities in the Yukon and the NWT, the most frequently consumed market foods are tea, sugar, white bread, biscuits, lard, crystal-powdered drinks, instant coffee, evaporated milk, flaked corn cereal, soft drinks, butter and eggs (Kuhnlein and Receveur 2007). These market foods are major sources of energy, but are generally expensive due to shipping costs (Kuhnlein and Receveur 2007).

Kuhnlein and Receveur (2007) state that when traditional meats or fish were included in the diet, daily intakes of energy as protein and many micronutrients (including vitamin D, vitamin E, riboflavin, vitamin B-6, iron, copper, magnesium, manganese, phosphorus, potassium, and selenium) were significantly higher than when market foods were consumed. For children, daily diets containing traditional foods had significantly more iron, zinc, copper, magnesium, phosphorus, potassium, vitamin E, riboflavin, and vitamin B-6 than on days with no traditional foods.

3.2.6.6 Social Pathology or Dysfunction

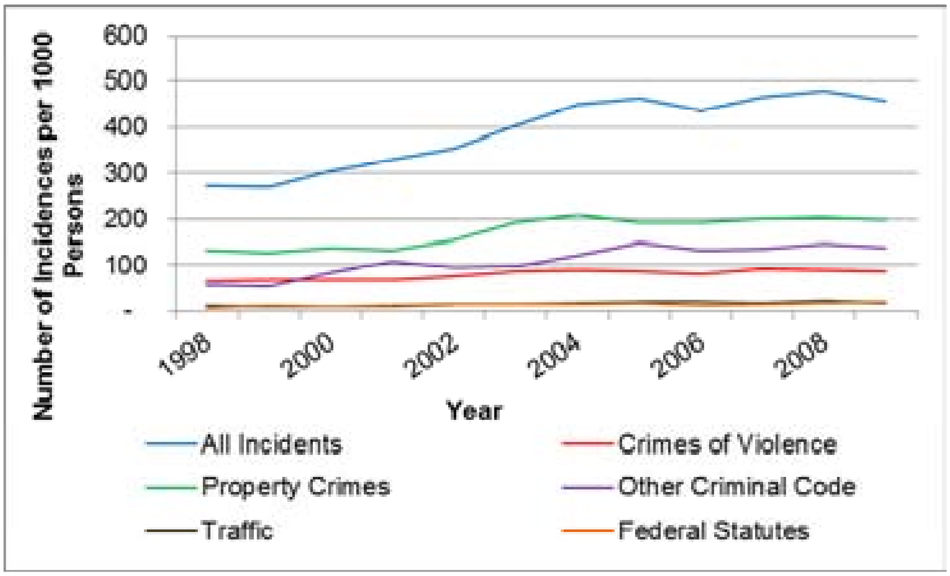
Family Violence

According to the Family Violence Survey conducted in the NWT in 2007, 87.5% of participants stated that they were either very worried or somewhat worried about family violence in their communities. The perception of family violence varied with gender, with 25.2% of men and 15.6% of women agreeing that physical violence is a private matter to be dealt with within the family. Of those surveyed, 46.6% agreed that children aged 12 years and younger were at the greatest risk from family violence. Approximately 33% of participants noted an increase in the rate of family violence from 2002 to 2007 in their communities while 44.4% stated the rates have remained the same (GNWT Bureau of Statistics 2008e).

Community based family violence statistics were unavailable.

Northwest Territories Crime Rates

In the NWT, the number of all criminal incidences has steadily increased from 1998 to 2009. Property crimes occurred most frequently, and traffic crimes and federal statutes occurred the least frequently, these trends can be observed in Figure 3.2.6-12.

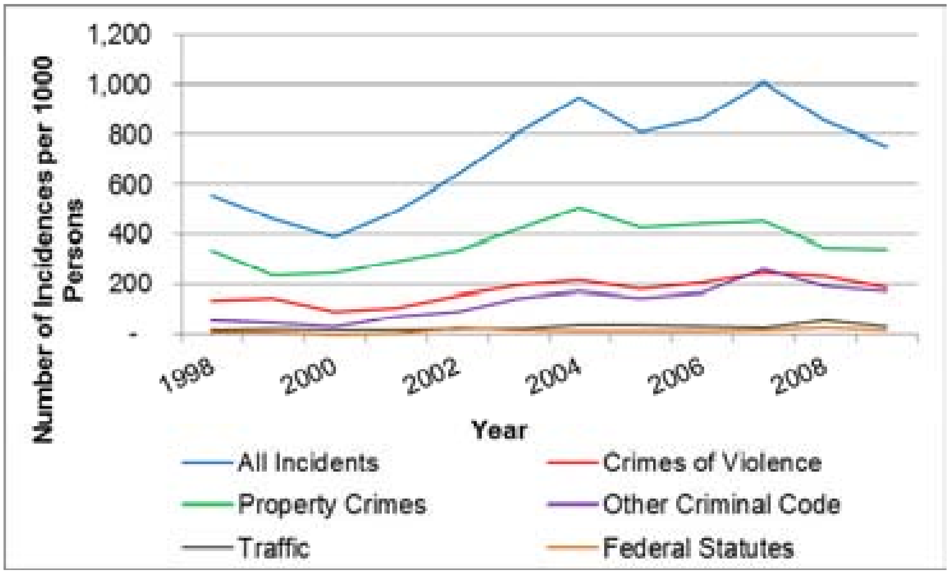


Source: GNWT Bureau of Statistics (2010p)

Figure 3.2.6-12
NWT Crimes, 1998-2009

Tuktoyaktuk Crime Rates

The Tuktoyaktuk RCMP detachment reports on crime statistics. Crime levels have generally increased since 1999, with noticeable increases in the numbers of crimes recorded between 2002 and 2004 followed by a decrease in 2005 and a subsequent increase between 2006 and 2007 (Figure 3.2.6-13).

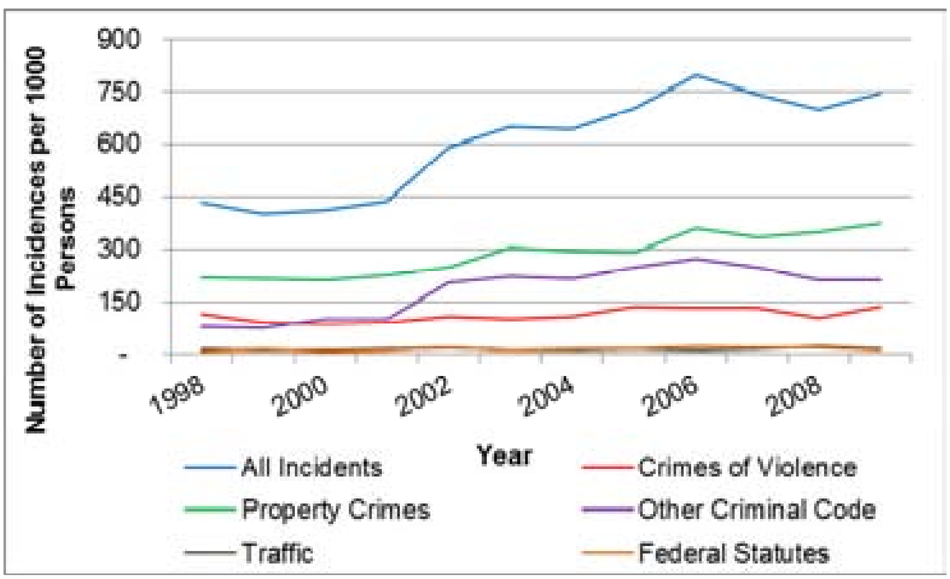


Source: GNWT Bureau of Statistics (2010p)

Figure 3.2.6-13
Tuktoyaktuk Crimes, 1999 – 2009

Inuvik Crime Rates

The Inuvik RCMP detachment reports on crime statistics. Crime levels have generally increased since 2000, with noticeable spikes in the number of crimes between 2002, 2003, and 2006 (Figure 3.2.6-14).



Source: GNWT Bureau of Statistics (2010p)

Figure 3.2.6-14
Inuvik Crimes, 1999-2009

Alcohol, Drug and Other Substance Abuse

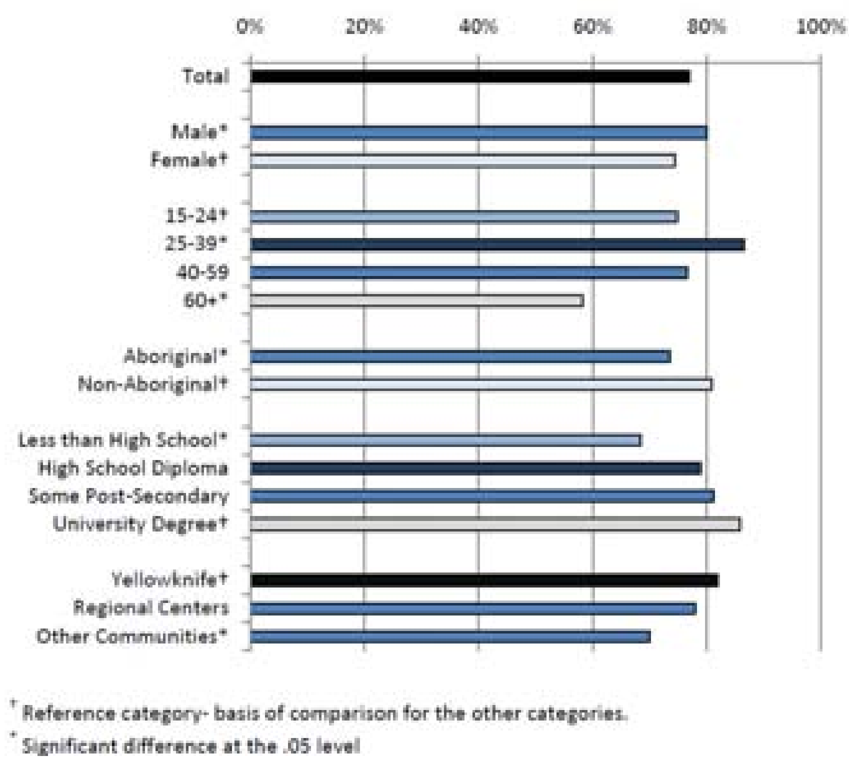
Data for alcohol and drug use is not available on a community level, but is available at the territorial level. The GNWT Department of Health and Social Services conducts an Addiction Survey every few years. Data collected in these surveys is published in the NWT Addiction Report and used to monitor trends in alcohol, tobacco, illicit drug use and gambling activities in the NWT (GNWT HSS 2010d).

Alcohol

The Addiction Survey measures five degrees of alcohol consumption: current drinkers, drinking frequency, usual consumption, frequency of heavy drinking and harmful/ hazardous drinking.

Current drinkers were individuals who indicated they had consumed a drink in the past 12 months. The term "drink" in this report refers to one bottle or can of beer, one glass of wine or a cooler, or one straight or mixed drink with one and a half ounces of hard liquor.

The proportion of current drinkers is organized by demographic characteristics and presented in Figure 3.2.6-15. Participants in the 25 to 39 year old age group were most likely to be current drinkers while those in the 60 and over age group were least likely. Furthermore, males were more likely to be current drinkers than females (GNWT HSS 2010d).

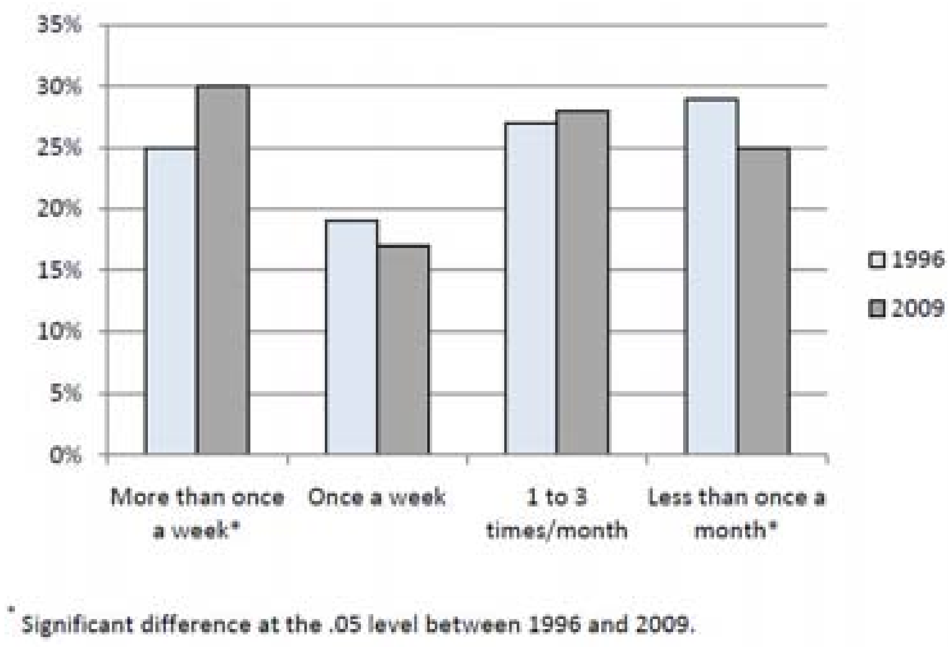


Source: GNWT HSS (2010d)

Figure 3.2.6-15
Proportion of Current Drinkers by Demographic Characteristics among Residents Aged 15+, NWT 2009

Current drinkers were surveyed for drinking frequency. Drinking frequency was determined by posing the following question during the Addiction Survey: during the past 12 months, how often did you drink alcoholic beverages? The answers were recorded in one of four categories: more than once a week, once a week, 1-3 times a month, and less than once a month.

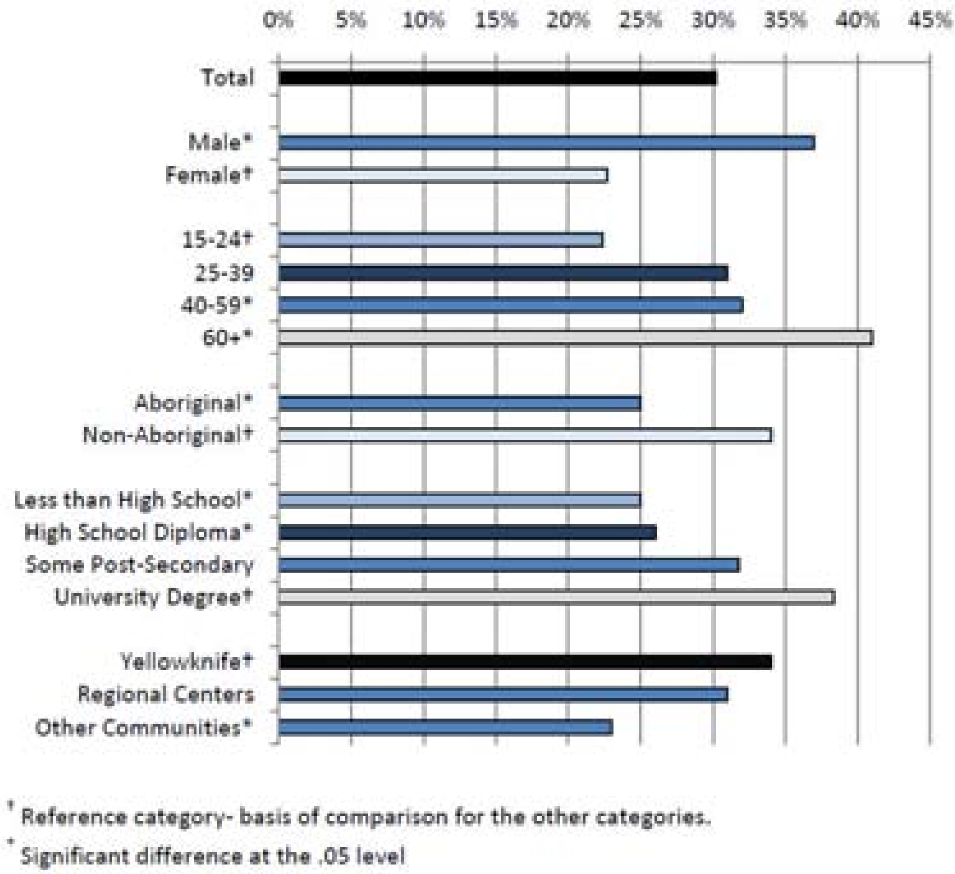
Figure 3.2.6-16 compares the drinking frequency results from 1996 to 2009. The frequency of current drinkers drinking more than once a week has increased from 25% in 1996 to 30% in 2009. While the frequency of those drinking less than once a month has decreased from 29% to 25% (GNWT HSS 2010d).



Source: GNWT HSS (2010d)

Figure 3.2.6-16
Trends in the Frequency of Drinking among Current Drinkers Aged 15+, NWT 1996 – 2009

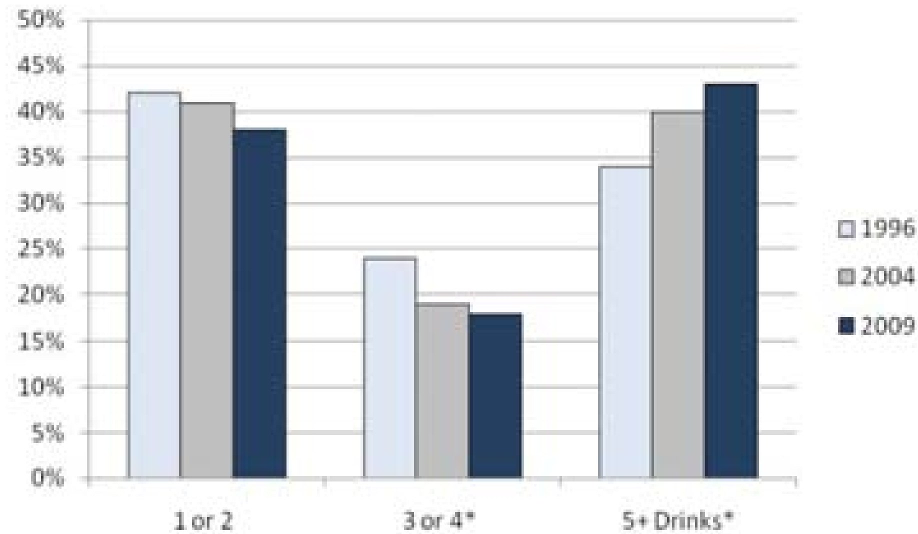
Figure 3.2.6-17 shows the demographic characteristics of current drinkers aged 15 and older who reported drinking more than once a week in 2009. Those in the age group 15 to 24 years of age were the least likely of all age groups to drink more than once a week. Males were more likely than females to drink more than once a week in 2009 (GNWT HSS 2010d).



Source: GNWT HSS (2010d)

Figure 3.2.6-17
Demographic Characteristics of Those Aged 15+ Drinking More Than Once a Week, NWT 2009

Usual consumption refers to the usual amount of drinks typically consumed by survey participants on a single occasion. Figure 3.2.6-18 compares the usual consumption in the NWT for 1996, 2004, and 2009. Since 1996 the percentage of current drinkers consuming one to two drinks or three to four drinks has decreased; however, the percentage of current drinkers consuming five or more drinks has increased (GNWT HSS 2010d).

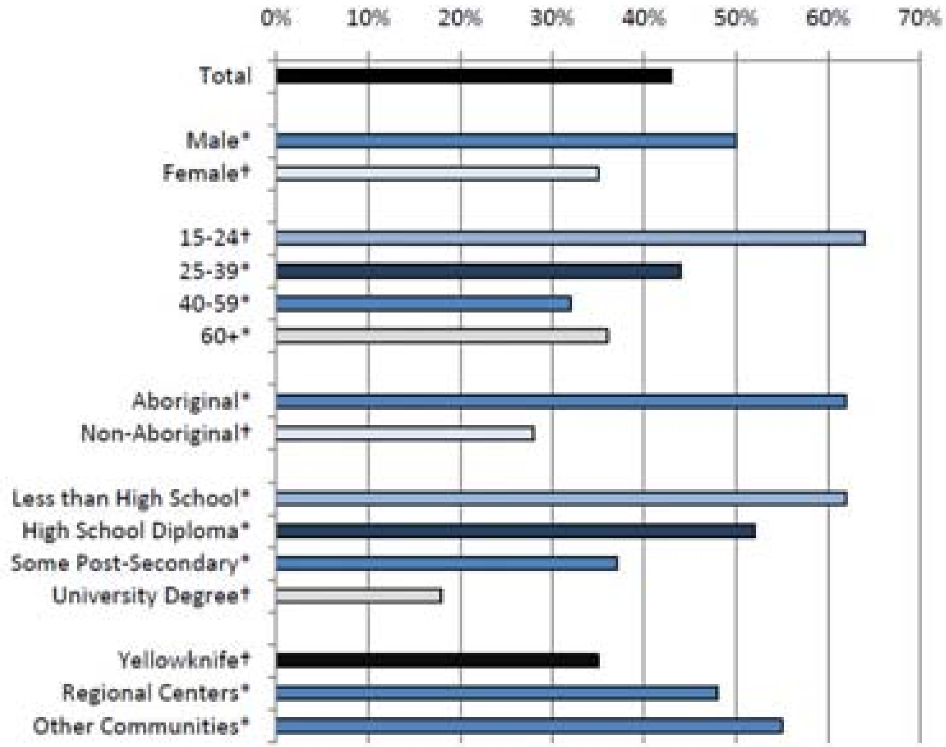


* Significant difference at the .05 level between 1996 and 2009.

Source: GNWT HSS (2010d)

Figure 3.2.6-18
Usual Number of Drinks Consumed on a Single Occasion by Current Drinkers Aged 15+, NWT 1996 – 2009

Figure 3.2.6-19 shows the demographic characteristics of current drinkers aged 15 and older who reported drinking five or more drinks on a single occasion. Those in the age group 15-24 years of age were more likely to consume five drinks or more on a single occasion than any other age group. Aboriginal people were nearly three times more likely than non-Aboriginal people to consume five or more drinks. Drinking five or more drinks was highest among those with an education level of less than a high school diploma (GNWT HSS 2010d).

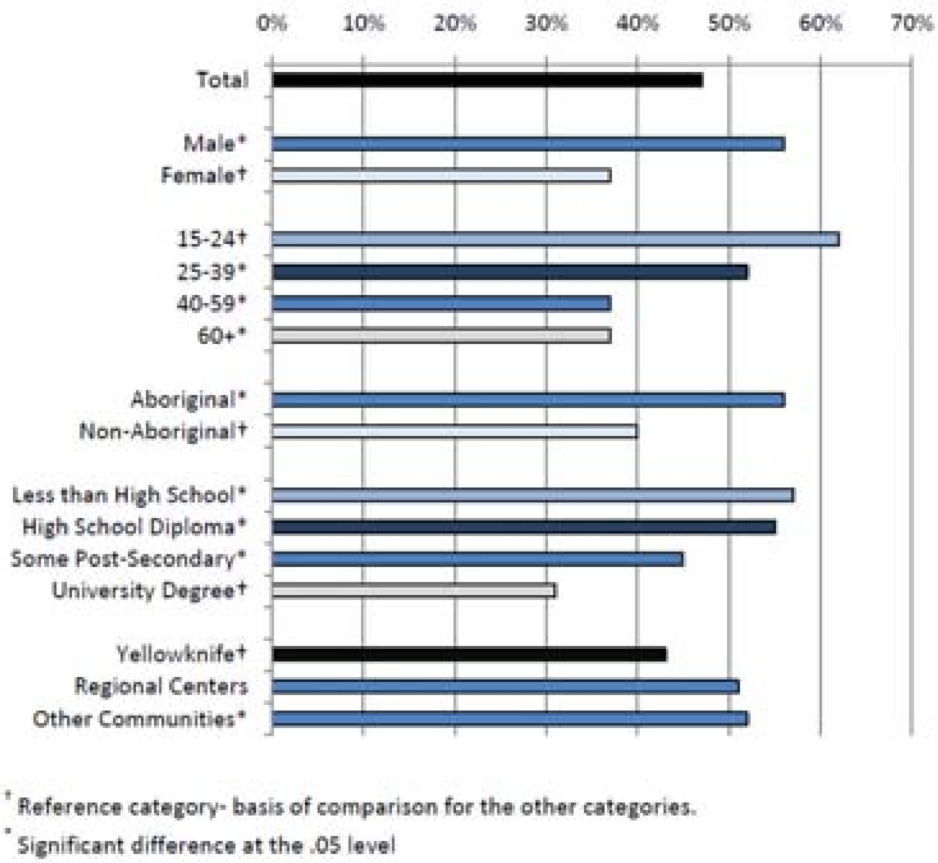


† Reference category- basis of comparison for the other categories.
* Significant difference at the .05 level
Source: GNWT HSS (2010d)

Figure 3.2.6-19
Demographic Characteristics of Current Drinkers Aged 15+ Consuming 5+ Drinks on a Single Occasion, NWT 2009

Heavy drinking increases the risk of alcohol-related problems. The Centre for Addiction and Mental Health (CAMH) and the Canadian Centre on Substance Abuse define heavy drinking as "a pattern of alcohol consumption that brings the blood alcohol concentration to 0.08% or more." This blood alcohol concentration usually corresponds to five drinks for males and four for females over the span of two hours.

Figure 3.2.6-20 shows the proportion of current drinkers aged 15 or more in the NWT that drink heavily at least once per month. Similar to Figure 3.2.6-19, the age group 15-24 was most likely to drink heavily once per month, males were more likely than females, Aboriginal people were more likely than non-Aboriginal people, and those with less than a high school diploma were more likely to drink heavily once per month (GNWT HSS 2010d).

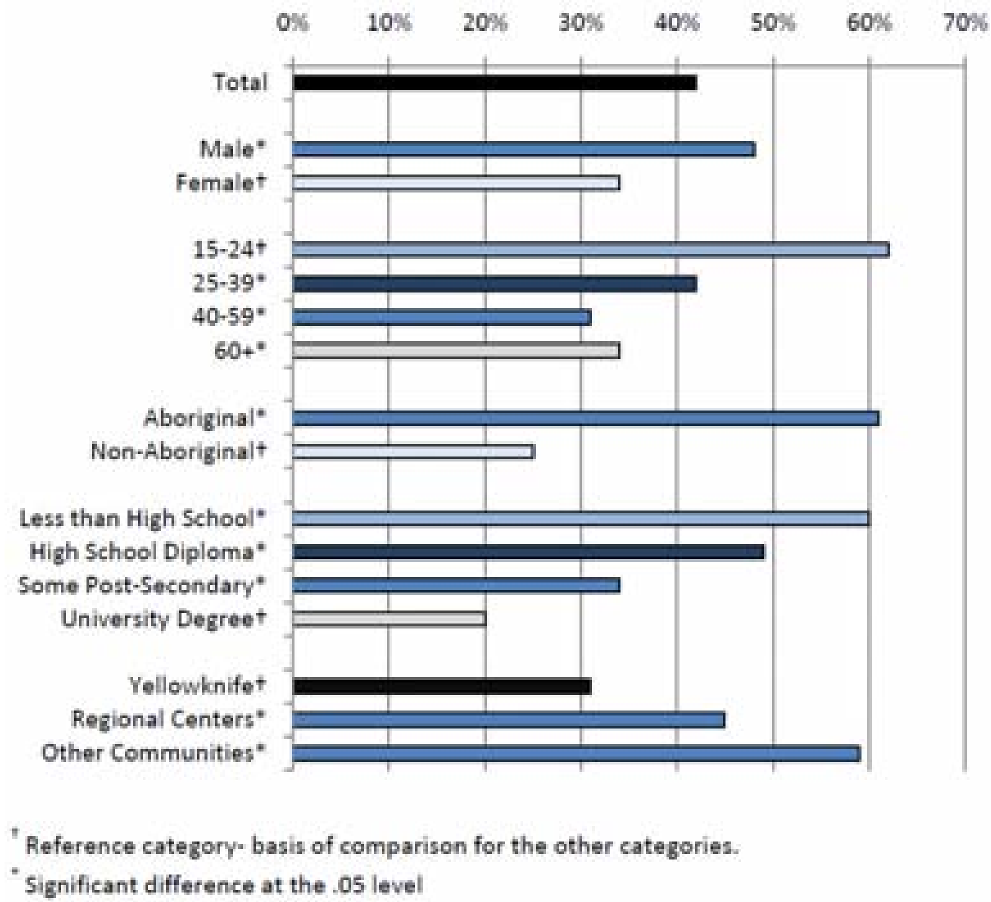


Source: GNWT HSS (2010d)

Figure 3.2.6-20
Demographic Characteristics of Current Drinkers
Aged 15+ Drinking Heavily at Least Once per Month, NWT 2009

An Alcohol Use Disorder Identification Test (AUDIT) has been developed to identify hazardous patterns of alcohol use and indicate alcohol dependency. AUDIT generates a score derived from a questionnaire composed of ten items. A score of eight or more indicates a harmful/hazardous use of alcohol.

Figure 3.2.6-21 shows the demographic characteristics of current drinkers in the NWT age 15 years and older that score eight or more on the AUDIT. A total of 42% of participants scored eight or more on AUDIT. Males, 15-24 year olds, Aboriginal people, those with lower levels of education, and residents outside of Yellowknife were all more likely to score eight or more on AUDIT and, therefore, were more likely to engage in harmful/hazardous drinking (GNWT HSS 2010d).

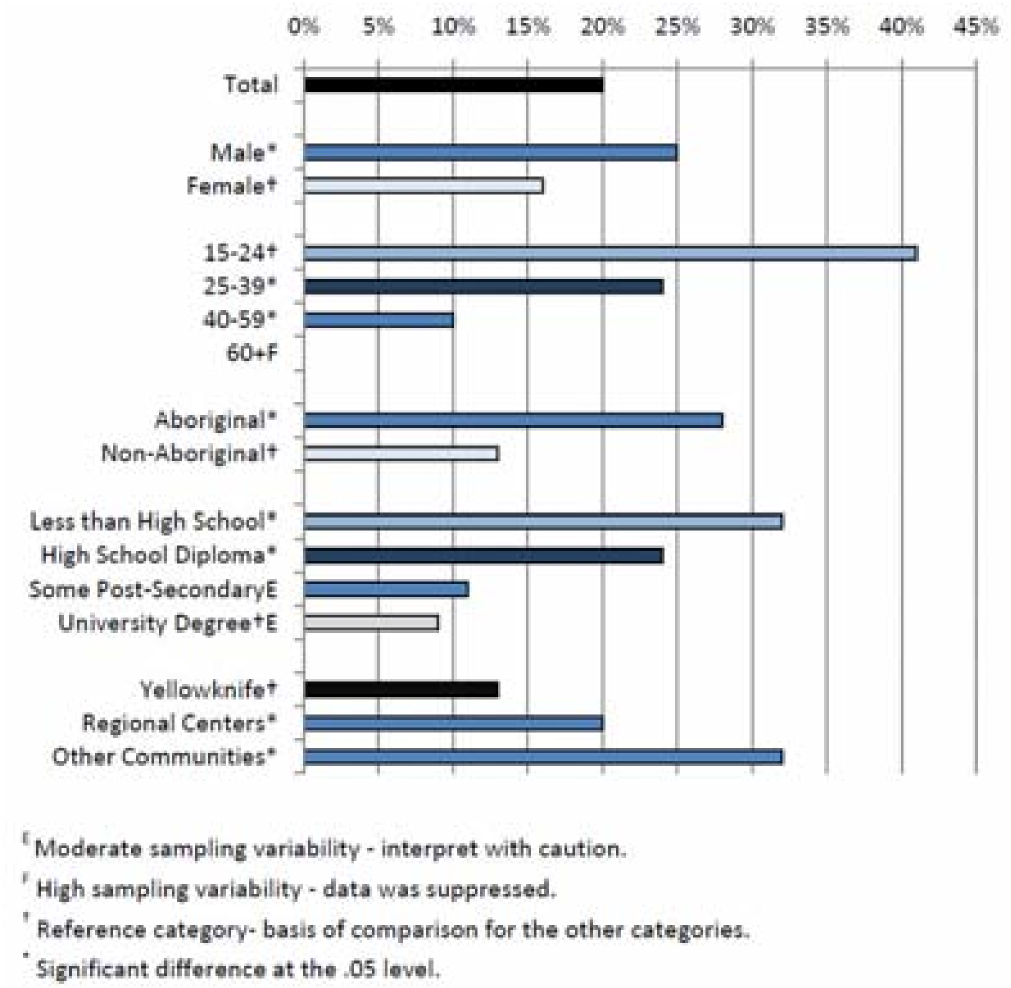


Source: GNWT HSS (2010d)

Figure 3.2.6-21
Demographic Characteristics of Current Drinkers Aged 15+ Scoring 8+ in AUDIT, NWT 2009

Cannabis

Participants of the NWT Addiction Survey 2009 were asked if they had used cannabis within 12 months prior to the survey. Between 1996 and 2009 the use of cannabis within the NWT population age 15 and older has remained stable at 20%. In 2009, males, 15-24 year olds, Aboriginal people, individuals with less than a high school diploma, and residents living outside of Yellowknife were all more likely to have used cannabis in the 12 months prior to the survey. These characteristics are shown in Figure 3.6.2-22 (GNWT HSS 2010d).

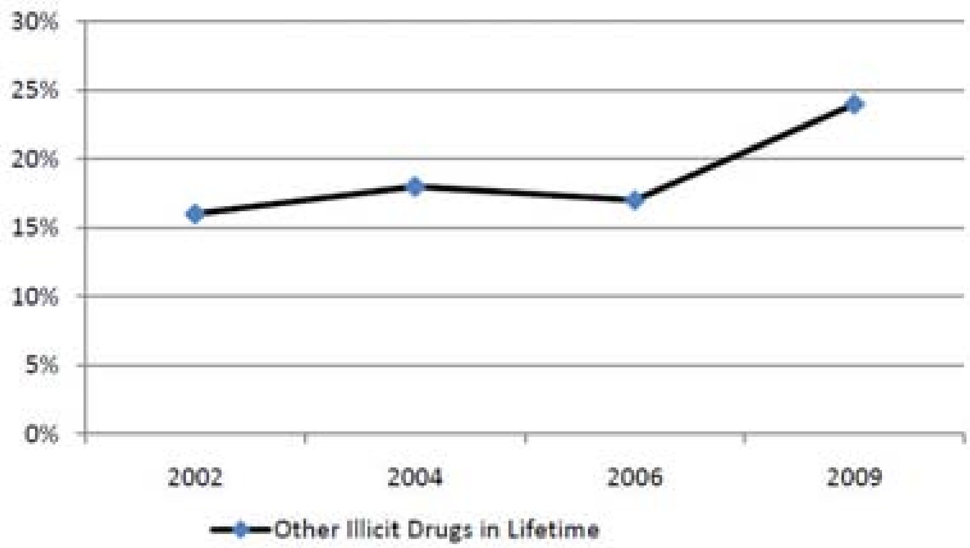


Source: GNWT HSS (2010d)

Figure 3.2.6-22
Proportion of Cannabis Use in the Past 12 Months by Demographic Characteristic among Residents Age 15+, NWT 2009

Other Illicit Drugs

Participants of the 2009 NWT Addiction Survey were asked if they had tried any of the following drugs in their lifetime: cocaine/crack, hallucinogens (magic mushrooms, PCP or LSD/acid), speed, ecstasy and heroin. Figure 3.2.6-23 compares the proportion of NWT residents age 15 and older from 2002 to 2009 who have used these drugs at any point in their lifetime. The trend is increasing over time. According to the 2009 NWT Addiction Report, the most common drugs used at least once in the NWT in 2009 were hallucinogens (20%) followed by cocaine/crack (11%), ecstasy (6%) and speed (3%) (GNWT HSS 2010d).



Source: GNWT HSS (2010d)

Figure 3.2.6-23
Cocaine/crack, Hallucinogens, Speed, Ecstasy and Heroin
"Ever Used in Lifetime" among Residents Age 15+, NWT 2009

3.2.6.7 Support Services and Programs

Both Inuvik and Tuktoyaktuk have access to Telehealth Services available from Stanton Territorial Hospital in Yellowknife. Services include consultation with a doctor in Inuvik or a specialist in Edmonton or Yellowknife, as well as education sessions for staff. Telehealth bridges geographical distances, improving the access to and delivery of health and social services, including health education (BDHSS 2010d).

Tuktoyaktuk

The Rosie Ovayouk Health Centre has eight staff including four nurses. Health Centre services include emergency treatment, school health programs, chronic disease clinic, immunization programs, wellness clinic, pre and post-natal care, health promotion and disease prevention initiatives, diagnostic, restorative, rehabilitative and palliative care services, and home care.

Regional providers work in partnership with health centre staff and/or travel to Tuktoyaktuk to provide additional services such as dental therapy, rehabilitation services, nutrition counselling, diabetes education and health promotion. Visiting health services also provide eye care and more complicated dental and orthodontic work. The Inuvik Regional Hospital also services the population of Tuktoyaktuk.

Social services and a counselling program are located in the Government Building. Three community social service workers provide the following services:

- Child protection, child and family services;
- Voluntary family support and adoptions;
- Family violence intervention;
- Community development;
- Mental health and addiction;
- Services for the aged or those with disabilities.

The Community Counselling Program is implemented by one counsellor and two community wellness workers, and provides crisis intervention, therapeutic counselling, education, and referrals to resources (BDHSS 2010a).

Inuvik

There are several regional health care facilities located in Inuvik. Facilities include: the Inuvik Regional Hospital, Public Health Services (Semmler Building), Billy Moore and Charlotte Vehus Homes (group homes for disabled adults), assisted living units, and a Family Counselling Centre.

The 51 bed hospital provides the following services:

- 24/7 emergency room;
- Operating room;
- Obstetrical care;
- Acute and long-term care;
- Pharmacy;
- Diagnostic imaging;
- Laboratory;
- Physician family clinics; and
- Visiting specialist clinics and medical referrals to southern facilities (BDHSSA 2010c).

Other services provided by the hospital for the region include rehabilitation, nutrition, mental health and addition and telehealth.

The Public Health Services unit is staffed by nine employees, including five nurses. They offer services including a school health program, a chronic disease clinic, immunization programs, wellness clinics, pre and post natal care, health promotion and disease prevention initiatives, and home care (BDHSS 2010c).

Social services programs are located at the Inuvik Regional Hospital and are implemented by seven employees, including five community social service workers. The following services are offered:

- Child protection;
- Child and family services (voluntary family support, foster care, adoptions);
- Services for aged and disabled;
- Family violence intervention;
- Community development;
- Mental health and addition services; and
- Home care support (BDHSS 2010cc).

3.2.7 Socio-cultural Patterns

This section describes socio-cultural patterns and social organizations in Tuktoyaktuk and Inuvik. Becoming familiar with traditional culture is critical to understanding socio-cultural patterns in the ISR. For more on social programs, see Sections 3.2.4.3 Education and 3.2.5.16 Recreation Services.

Indicator data showing adherence to traditional beliefs and values is currently not available for the study area communities. However, culture is reflected in activities that are shaped by beliefs and values, activities that make use of traditional knowledge, skills, and disciplines, and programs that support social and cultural development. As stated in an Alaskan Journal of Anthropology article entitled *Inuvialuit Rising: The Evolution of Inuvialuit Identity in the Modern Era*, the younger generations are working hard to reclaim Inuvialuit languages and cultural traditions and to forge a cohesive Inuvialuit identity in the modern world (Lyons 2009). To that end, the Inuvialuit Regional Corporation provides funding to support ongoing social and cultural development, and notes that traditional activities are actively pursued in both Inuvik and Tuktoyaktuk (IRC 2007d).

Activities reviewed in this section range from cultural and spiritual life, including language, family and community life, social relations, and social and cultural programs.

3.2.7.1 Cultural and Spiritual Life

Cultural and spiritual life is demonstrated through speaking traditional languages and partaking in cultural events and ceremonies. Several churches exist in both communities.

Tuktoyaktuk

The Hamlet hosts the Beluga Jamboree each year (BDHSS 2010e), and many residents head south to Inuvik for various festivals and cultural events (M. Gruben, Mayor, Tuktoyaktuk, pers. comm., January 7, 2011). The Kitti Hall Community Centre hosts drum dancing, cooking and other traditional activities.

Several churches have historically operated in the community, and one church operates regular services. The Glad Tidings Mission, a Pentecostal Church, has approximately 40 people attending services each week. The Anglican Church historically operated but no longer has a parish (Diocese of the Arctic 2010a). The Catholic Church is open only a few times a year.

The percentage of Tuktoyaktuk's population that speak an Aboriginal language has been slowly declining. In 1984, 35.8% of the Aboriginal population could speak an Aboriginal language, but this subsequently declined to 22.3% in 2009 (GNWT Bureau of Statistics 2009a). More recent data regarding use Aboriginal languages are not available.

Inuvik

Inuvik hosts several festivals throughout the year: Sunrise Festival (January), Muskrat Jamboree (spring), Midnight Madness (June), Great Northern Arts Festival (July), and the End of The Road Music Festival (August). The town is also home to a Choral and Theatrical Society and has traditional dancing and singing groups (BDHSS 2010f). A 2010 Christmas feast featured local music and dancing at one of many yearly events held at the Midnight Sun Complex (Inuvik Drum 2010).

Source: Inuvik Drum (2010)

Photo 3.2.7-1
The Delta Good Times Band and Ingamo Friendship Dancers at the Inuvik Christmas Feast

Inuvik is home to four churches and a mosque: Our Lady of Victory Church, First Bible Baptist Church, Lighthouse Community Church, Anglican Church of Ascension, and The Midnight Sun Mosque. Our Lady of Victory Church is an Inuvik landmark also known as Inuvik's Igloo Church. Built by volunteer labour, this church took two years to build from start to completion (Yukon Info ND). The Anglican Church of Ascension has a regular membership and offers services on Sunday at both the church and hospital chapel (Diocese of the Arctic 2010b). The First Bible Baptist Church has a Pastor and a primarily Aboriginal membership of approximately 35; it offers three services a week, two on Sunday and one on Wednesday evening. They also host a Friday evening addictions therapy session (S. Donley, Pastor, First Bible Baptist Church, January 31, 2011). The Lighthouse Community Church also offers a Sunday service. The Midnight Sun Mosque was shipped to Inuvik by barge in September 2010 to serve the growing Muslim population in the community. The mosque was built by a Manitoba-based Islamic charity, the Zubaidah Tallab Foundation (Canadian Broadcasting Corporation 2010).

The percentage of Inuvik's Aboriginal population that speaks an Aboriginal language is slowly declining. In 1984, 35.2% of the Aboriginal population could speak an Aboriginal language. This has since declined to 16.2% in 2009 (GNWT Bureau of Statistics 2009b). According to the 2010 Assessment of Services and Self-Government Survey by the Inuvik CC, almost half (46%) of the Elders spoke Inuvialuktun (IRC 2007e).

3.2.7.2 Family and Community Life

Little information is available regarding household social organization. Based on census data, the majority of households have three or fewer people. Compared to the Beaufort-Delta region and Inuvik, Tuktoyaktuk has the highest percentage of households with 4-5 persons and 6 or more persons (GNWT Bureau of Statistics 2009a, 2009b). The majority of houses in Tuktoyaktuk and Inuvik are rented compared to owned (GNWT Bureau of Statistics, 2010e). More detailed information is available in Section 3.2.2.

The communities are led by a Mayor and Council. Under the IFA, the region is operated by the IRC and several organizations and committees to assist in the management of the region, as shown below.

- Inuvialuit Regional Corporation – receives and manages IFA benefits and revenues.
- Inuvialuit Investment Corporation – oversees management of a diverse securities portfolio that was established with proceeds from the IFA.
- Inuvialuit Development Corporation – invests in over 20 Inuvialuit companies with complementary industries and visions.
- Inuvialuit Petroleum Corporation – established as a diversified petroleum company and is currently investing proceeds until hydrocarbon-related opportunities become available.
- Inuvialuit Land Corporation – holds title to the Inuvialuit lands received under the IFA. Lands consist of 90,649 km^2, including 13,000 km^2 with sub-surface rights.
- Inuvialuit Land Administration – responsible for managing and administering Inuvialuit-owned lands in the ISR, including reviewing applications for land and water permits.

- Inuvialuit Trust – manages financial distribution of benefits to Inuvialuit beneficiaries.
- Community Corporations (Inuvik and Tuktoyaktuk) – administers, supervises, governs, and regulates matters of local concerns to the members of the Corporation.
- Hunters and Trappers Committee – represents the collective Inuvialuit interest in wildlife and upholds harvest rights.
- Joint Secretariat – administers funding for Joint Implementing Bodies (as listed below) and provides administrative and technical support.
- Wildlife Management Advisory Council (NWT) – provides wildlife management advice pertaining to the Western Arctic region of the NWT, including the ISR.
- Fisheries Joint Management Committee – responsible for collecting harvest information and making recommendations on subsistence quotas for fish and harvestable quotas for marine mammals. Manages a student mentoring program.
- Environmental Impact Screening Committee – screens all development proposals within the ISR to determine if an environmental assessment is required (by the EIRB).
- Environmental Impact Review Board – responsible for carrying out environmental assessments of development projects.
- Inuvialuit Game Council – represents collective Inuvialuit interest in wildlife and renewable resources in the ISR.

The social and community life in Inuvik and Tuktoyaktuk are at times differentiated by whether the people are Aboriginal or non-Aboriginal, and whether the people live a more or less traditional lifestyle. Households with a traditional lifestyle are more typically involved in subsistence harvesting, with regular trips on the land and may or may not be part of the wage economy. Households with non-traditional or less-traditional lifestyles may or may not partake in subsistence harvesting and may be more involved in the wage economy.

The 2006 Census conducted by Statistics Canada, collected data for unpaid work. Work in this category includes housework, childcare, and senior care. The unpaid services can either be provided to the households of the worker or other households (Statistics Canada 2006a, 2006b).

In Section 3.2.4, Figure 3.2.4-16 shows the categories of unpaid work for both Tuktoyaktuk and Inuvik. Housework is the category of unpaid work with the highest participation from people aged 15 years and older. In 2006, in Tuktoyaktuk, 540 people (60% of the total population) and 2,345 people (64%) in Inuvik reported unpaid housework. Housework includes general housekeeping, yard work, and home maintenance (Statistics Canada 2006a, 2006b).

Other forms of unpaid work are subsistence harvesting or community volunteer work. Subsistence harvesting is a key cultural attribute and is conducted by many residents of Tuktoyaktuk and Inuvik, as is volunteerism.

Information regarding social roles may be derived from the NWT labour force statistics and interviews with community members. In 2006, the industries with the greatest female participation rate included public administration (23.4%), health care and social assistance (15.9%), and retail trade (10.5%). The industries with the greatest male participation rate included public administration (19.4%), transportation and warehousing (11.8%), and construction (10.9%). Based on these statistics, it may be suggested that women are likely to hold more local jobs with regular work hours, whereas men hold jobs of a more transient nature (e.g., construction projects) or that require shift work (e.g., transportation). Some interviewees have observed that women take on a primary role in the household with up to 90% of the responsibility (A. Kasook, Director, Transition House, pers. comm., January 27, 2011; P. Donley, Pastor, First Bible Baptist Church, pers. comm., January 31, 2011).

Table 3.2.7-1 shows that men are more likely to participate in hunting and trapping than women, whereas women are more centrally involved in berry picking. However, this does not preclude women from joining in on trips to the land. Mentorship programs through the HTC work to improve access to various harvesting activities (INAC 2004b).

TABLE 3.2.7-1: PERCENT OF PERSONS IN HARVESTING ACTIVITIES, BY SELECTED CHARACTERISTICS FOR THE NWT, 2002

	Trapped	Hunted or Fished	Gathered Berries	Gathered Plants
Persons 15 Years and Over	5.0	40.2	18.2	6.8
Males	7.6	51.4	12.8	5.7
Females	2.2	27.9	24.4	7.9
15-24 Years	4.0	34.6	12.9	3.9
25-39 Years	4.7	40.8	16.9	5.2
40-59 Years	5.1	46.1	22.1	7.3
60 Years and Over	8.3	31.6	23.8	16.6
Aboriginals	9.9	44.9	23.6	13.0
Males	15.4	58.3	16.6	10.7
Females	4.3	30.7	30.9	15.5
Non-Aboriginals	0.7	36.5	13.2	1.3
Males	1.1	46.2	9.4	1.7
Females	0.3	25.4	17.9	1.0

Source: GNWT HSS (2006a)

Very little information regarding sharing and mutual aid is publically available. The two areas reviewed pertained to food sharing and housing. According to the 2007-2008 Inuit Health Survey, food sharing networks are strong and the majority of households share their country food with others. When households were out of country food, more than 67% received supplementary country foods from family, friends, the community freezer, or hunter and trapper organizations. Of households that ran out of food, almost 60% bought more store food, 30% went hunting or fishing, and over 25% went without (IRC 2010). It was noted that, given the cost and effort associated with harvesting, it can be difficult to ask to share in someone else's harvest without offering some kind of compensation (A. Kasook, Director, Transition House, pers. comm., January 27, 2011). There is also a food bank in Inuvik, run primarily by volunteers, that is open on Wednesday evenings (Inuvik Photos 2010).

The challenges of sharing housing, especially public housing, were discussed by those interviewed. For example, if family members open their homes to others in transition, they risk losing their own housing or if an Elder is legally sharing a unit with family, then passes away, a grandchild may be forced to move (P. Donley, Pastor, First Bible Baptist Church, pers. comm., January 31, 2011). In Tuktoyaktuk, it was noted that homelessness has become more common over the past 10 years (A. Kasook, Director, Transition House, pers. comm., January 27, 2011).

3.2.7.3 Traditional Activity Participation

According to the Inuvialuit Communications Society (ICS 2009), young people are encouraged to participate and are mentored in various traditional activities including producing clothing, harvesting and cooking country foods, drum dancing, participating in northern games, sharing through oral tradition, and using traditional languages. Funding from the IRC supports youth mentoring programs related to hunting, fishing, trapping and other cultural activities. The Inuvialuit Cultural Resource Centre Director was unable to elaborate further on traditional activities and expand upon specific ways that traditional activity participation ranges by age and gender due to a conflict of interest related to the review process (C. Cockney, Director, Inuvialuit Cultural Resource Centre, pers. comm., February 3, 2011).

Clothing – In the past, winter clothing was made entirely from animal furs and hides. Today, fabric parkas, trimmed with fur for protection from wind and snow, are popular. Muskrat fur coats may also occasionally be seen. Mukluks (boots) made of caribou skin, sealskin, rabbit skin, or muskox wool provide water and wind protection for the feet. Fur mitts, often attached to the parka by strings, help keep hands warm. In the summer, both men and women wear an atikluk - the outer shell of a parka - which is not only cooling in hot weather but also offers protection from northern mosquitoes. Moccasin dancing slippers made of moose hide, sewn with sinew, and featuring colourful beadwork and appliqué, are used for Old Time Dances (IRC 2007b).

Foods – Although store-bought food is readily available in great variety, many Inuvialuit continue to hunt, fish, and eat more nutritious and less costly country foods for a large portion of their diet. Consuming country foods is important to Inuvialuit identity, and the culmination of a series of cooperative activities - harvesting, processing, distributing, and preparing - that require behaving in ways that emphasize Inuvialuit values of cooperation, sharing, and generosity. Traditional country foods include caribou, muskox, arctic hare, muskrat, seal, duck, goose, beluga and bowhead whale, fish (whitefish, herring, inconnu, arctic char, and trout), and berries (akpiks, blueberries, crowberries, currants, and cranberries) (IRC 2007k).

Source: ICS (2009)

Photo 3.2.7-2
Summer Fish Harvest

Drum Dancing – From early times, the Inuvialuit have used songs and chants to recount legends, stories, and traditions. In this way, Inuvialuit history has been handed down through the generations. Not long ago, drum dancing was being practiced less and less in the culture. However, a few Elders did not forget and together with groups of determined young people, they began to work on its revival. Today, the tradition continues. Drum dancing has experienced a resurgence and is flourishing in the communities of Aklavik, Inuvik, Paulatuk, Tuktoyaktuk and Ulukhaktok (Holman). In the last few years, drum dance groups have performed at home and around the world, including Japan, Mexico, and the Canadian Pavilion at Expo 2000 in Hanover, Germany (IRC2007j).

Northern Games – Traditional northern games originate from the time when the Inuvialuit were semi-nomadic. Played for both fun and survival, these games developed strength, endurance, and resistance to pain. The people were tested and prepared for the hard life on the land. Traditional games, such as the blanket toss, were also played when groups from different areas visited and celebrated their culture together. Today, the Arctic Winter Games and the annual Northern Games keep the traditions of celebration, gathering, and sharing alive (IRC 2007j).

Oral Tradition – Until recently, there was no written form of Inuvialuktun. History, knowledge and traditions were passed by Elders from generation to generation as stories, legends, and songs. Today, Elders are being interviewed in several oral history projects including the Inuvialuit Oral Histories Project, the Kitigaaryuit Oral Traditions Research Project 1996, and the Yellow Beetle Oral History and Archaeology Project (IRC 2007j).

Photo 3.2.7-3
Elders share oral traditions with school children. Source: IRC (2007b)

Language – The Inuvialuit belong to three linguistic groups. Collectively the three dialects they speak are known as the Inuvialuktun language:

Ummarmiut meaning "people of the evergreens and willows" is spoken in the tree-lined inland communities of Aklavik and Inuvik.

Siglit (its meaning is debated) is spoken in the coastal communities of Tuktoyaktuk, Paulatuk and Sachs Harbour.

Kangiryuarmiut meaning "people of the large bay" is spoken in the community of Ulukhaktok (Holman) on Victoria Island (IRC 2007j).

Language rates are declining, as noted above in Section 3.2.7.1. However, many initiatives are underway to increase exposure to traditional languages. Young people are exposed to traditional languages through books such as Inuvialuktun Nursery Rhymes (ICS 2008), and by prioritizing the training and hiring of traditional language-speaking childcare workers in various community social programs. To encourage daily use of Inuvialuktun, the Inuvialuit Cultural Resource Centre also funds fluent-speaker positions in each Child Development Centre (IRC 2007c). The use of Inuvialuktun is encouraged in the Inuvik Community Corporate office where traditional names are used for staff signage and meeting minutes, and flashcards with numbers, common expressions, days, and colours are posted in the office (IRC 2010).

3.2.7.4 Social Relations

Information regarding the social relations between residents and non-residents, men and women, younger and older generations, and Aboriginal and non-Aboriginal people is not publicly available. A variety of sources, including personal communications, were used to identify a sense of the relationships. However, it should be noted, that many people asked to discuss this topic were reluctant to provide an opinion or to be put on record. As such, the names of people that contributed potentially sensitive data have been removed from the citation. Unless self-identified, it was not specifically noted whether participants were Aboriginal or non-Aboriginal. Furthermore, it should be noted that information reflected in this section is personal opinion and is subjective in nature.

It was noted by many that relations between Aboriginal and non-Aboriginal, and residents and non-residents have improved significantly over the past 20 years. Those interviewed had different ways of characterizing relationships. With regard to Aboriginal and non-Aboriginal social relations, a school administrator in Inuvik observed that there is healthy interaction overall, while another person described interactions between Aboriginal and non-Aboriginal as cordial and working, but not generally more intimate than that (pers. comm., January 31, 2011). It was also noted that non-residents are often brought in for management positions with more security and this can cause tension (pers. comm., January 31, 2011). A health professional in that situation admitted to feeling like a minority, and that some outsiders tend to try to maintain a professional distance, while others do not (pers.comm., January 17, 2011).

Elders are generally respected in the community, and are actively encouraged to share traditional knowledge through various IRC programs (IRC 2007b). Issues related to poverty and addiction can inadvertently result in emotional abuse, an issue that is being addressed through various health programs (GNWT Seniors' Society 2009).

Detailed information was not provided for social relations between men and women, other than to note that unemployment, addiction, and mental health are a few of the issues that strain relationships (A. Kasook, Director, Transition House, pers. comm., January 27, 2011).

3.2.7.5 Social and Cultural Support Systems and Programs

Social and cultural development issues are considered a community priority, as evidenced by the variety of support systems and programs available regionally and locally. As summarized in an Inuvik Roundtable discussion, "We need to safeguard traditional occupations and find a balance. Creating knowledge, not just jobs… It starts with the family – the importance of culture, having self-esteem" (GNWT Premier's Office 2010). The Inuvialuit are supported by federal, territorial, regional and local programs.

The IRC supports the skills development of cultural elements such as clothing, foods, drum dancing, language, oral traditions, and northern games, as discussed in Section 3.2.7.3.

Inuvialuktun is classified as an endangered language because it is spoken by fewer than 50% of the population, many of whom are Elders. As a result, in May 1998, the Inuvialuit Cultural Resource Centre (ICRC) opened as a regional centre in Tuktoyaktuk with a mandate to preserve the Inuvialuktun language with the assistance of Elders, provide support and a language curriculum for Inuvialuktun teachers, and promote the on-going development of the Inuvialuktun language (IRC 2007a).

In April 2000, ICRC was relocated from Tuktoyaktuk to Inuvik to better serve the region with easier access to the governments and other Inuvialuit communities. Funding for ICRC comes from INAC, GNWT Education, Culture and Employment, Parks Canada and the

Beaufort-Delta Divisional Board of Education. Recent projects undertaken with this funding include:

- Indigenous Language Conference;
- Summer Language and Cultural Camps;
- Community Language Programs;
- Elder Database Development with translations and recordings;
- Language Teacher Training and Language Program Development;
- Production of classroom materials for language teachers; and
- Development of an Inuvialuit Culture and History Program (Grades 1 to 6) and a teaching kit with books, videos and traditional tools.

It was reported in the December 2010 IRC Board Summary Newsletter that the ICRC is producing a video series of Inuvialuit activities:

- *Drum Dance Instructional;*
- *Beluga Whale Hunting with Billy Day;*
- *Our Children's Legacy;* and
- *A Path for Our Children* (IRC 2010).

Other recent ICRC publications include the new *Siglit Dictionaries, Reindeer Days Remembered*, and *Tuktoyaktuk Place Names* and *Inuvialuit Nautchiangit: Relationships Between People and Plants*. The latter is a collection of traditional knowledge on the use of plants from more than 40 Inuvialuit Elders in the ISR who were interviewed and filmed by the project's ethnobotanist over a period of four years (Parks Canada 2009b).

The IRC (2010) identified that due to budget cuts, there was less funding available from the Canadian Heritage (Aboriginal Language Initiative) and the Beaufort-Delta Education Council budgets.

The Inuvialuit Communications Society also produces print and video content from Canada's western arctic, reflecting the lives and traditions of the Inuvialuit people. The magazine *Tusaayaksat* is published four times a year and distributed to Inuvialuit beneficiaries. ICS also produces a series of television programming (ICS 2010). Two example publications include the *Inuvialuktun Nursery Rhymes* (ICS 2008) and *The Inuvialuit Year* (Photo 3.2.7-4; ICS 2010).

Source: ICS (2008, 2009)

Photo 3.2.7-4
Inuvialuit Communication Society Publications

3.2.8 Harvesting

The traditional culture of the Inuvialuit is unique due to the adaptations to everyday challenges posed by living in the harsh and remote northern environment. Traditionally the people have lived off the land and relied on a variety of wildlife, fish and plant species for sustenance. The ability to survive in such an environment has shaped Inuvialuit behaviour and activities, creating a focus on harvesting game, fish and fowl for food because the supply of available plant foods was too limited and seasonal to sustain life. Despite the continued importance of harvesting to the Inuvialuit culture, these activities have diminished in recent years. More information can be found in Section 3.2.8.3 Participation in Harvesting Activities for Household Food Supply, of this report (GNWT Bureau of Statistics 2009a and 2009b).

Traditional activities, such as hunting, fishing and trapping, sustain the Inuvialuit values and identity. The Inuvialuit use local resources to provide traditional foods and their hunting, fishing and trapping activities convey a tradition-based and fundamental relationship between the Inuvialuit and their environment. Species that the Inuvialuit have traditionally relied upon for sustenance include beluga whale, seal, caribou, furbearing animals, fish and birds. The most important food sources to the Inuvialuit are caribou and whale (IOL et al. 2004).

3.2.8.1 Contribution of Harvesting to the Economy

Many of the harvesting activities that occur in the NWT contribute to the local economy. Caribou harvests generate an estimated $17 million annually (GNWT ENR 2010b). Regional data or data specific to wildlife species are not available.

To determine the economic contribution of country food to local communities, based on the cost to purchase store or country foods instead of harvesting country foods, a monetary value was assigned to harvested wildlife. The monetary value of harvested wildlife is calculated based on the cost of replacing harvested wildlife, birds and fish with market beef, chicken and fish. An Inuvik food price index was used as the baseline and the 2000 base prices used for each category of food as follows:

- $10.50/kg for boneless beef blade roast
- $11.00/kg for boneless chicken
- $10.00/kg for haddock fillets (IOL et al. 2004)

The food prices previously described are now outdated. Several attempts were made to contact the local grocery stores for current prices with no response so updated prices were calculated based on the annual inflation rate from 2000 to 2010. Specific inflation rates for Inuvik and Tuktoyaktuk are not available so inflation rates for Yellowknife were used. Table 3.2.8-1 shows the inflation rates for each fiscal year ending December 31 for 2000 to 2010, and the calculated (adjusted) food prices per year for each comparable food product (GNWT Bureau of Statistics 2010j). The inflation rates in Yellowknife may not accurately reflect the inflation rates in Inuvik or Tuktoyaktuk, and other factors may affect product costs at local stores.

TABLE 3.2.8-1: INFLATION RATES FOR YELLOWKNIFE AND ADJUSTED FOOD COST

Comparable Food Product	Cost to Purchase in Store in 2000	Inflation Rate (%) Per Year										
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
		1.7	1.6	3.0	2.3	1.5	2.3	1.4	2.9	4.0	0.6	1.7
Beef	$10.50/kg	10.68	10.85	11.17	11.43	11.60	11.87	12.04	12.39	12.88	12.96	13.18
Chicken	$11.00/kg	11.19	11.37	11.71	11.98	12.16	12.44	12.61	12.98	13.49	13.58	13.81
Haddock	$10.00/kg	10.17	10.33	10.64	10.89	11.05	11.30	11.46	11.80	12.27	12.34	12.55

Source: GNWT Bureau of Statistics (2010j); IOL et al. (2004).

The current number of harvesters in Tuktoyaktuk and Inuvik is not readily available, nor is the quantity of wildlife harvested. According to IOL et al. (2004), the quantity (in kilograms) of wildlife harvested, per type, in 1997 throughout the ISR was:

- mammals – 163,868 kg
- birds – 22,693 kg
- fish – 62,751 kg

Based on the calculated (adjusted) costs to purchase comparable foods in the local stores, the overall contribution of harvesting to the economy in the ISR is estimated as:

- $2,160,000 for mammals;
- $313,000 for birds; and
- $788,000 for fish.

As shown in Table 3.2.8-2, the percentage of households consuming country foods in 2008 is higher in Tuktoyaktuk than in Inuvik but is declining (GNWT Bureau of Statistics 2010k and 2010l).

TABLE 3.2.8-2: PERCENTAGE OF HOUSEHOLDS CONSUMING COUNTRY FOODS

Location	Percentage of Households Consuming Country Foods (%)			
	1993	1998	2002	2008
NWT	29	30	33	28
Beaufort-Delta Region	51	51	45	-
Tuktoyaktuk	71	71	-	63
Inuvik	30	31	29	25

Source: IOL et al. (2004); GNWT Bureau of Statistics (2010k, 2010l)

Trapping is another contributor to the NWT economy. The traditional fur economy is promoted through the Genuine Mackenzie Valley Furs (GMVF) Program, by the GNWT in partnership with the NWT Harvesters. The GNWT ITI compiled the annual harvest totals based on fur auction records for 2007-2008 in GNWT, as shown in Table 3.2.8-3. Specific data for the Beaufort-Delta region, Tuktoyaktuk, and Inuvik are not available.

TABLE 3.2.8-3: GNWT ANNUAL HARVEST TOTALS, 2007-2008

Annual Harvest Total (2007-2008)				Annual Sold Total (2007-2008)	
Species		Harvest	Number Sold	Sold ($)	Prime Fur Bonus ($)
Bear	Black	7	12	945.00	200
	Grizzly	3	2	1,750.00	100
	Polar	1	1	2,300.00	50
Beaver		1,399	1,277	24,914.00	7,580
Coyote		3	2	60.00	20
Fisher		27	32	2,004.00	330
Fox	Cross	110	115	4,090.23	1,020
	Red	136	145	3,642.00	930
	Silver	13	12	327.00	105
	White (Arctic)	193	346	7,180.75	2,445
Lynx		723	725	171,499.58	17,300

TABLE 3.2.8-3: GNWT ANNUAL HARVEST TOTALS, 2007-2008					
Annual Harvest Total (2007-2008)				Annual Sold Total (2007-2008)	
Species		Harvest	Number Sold	Sold ($)	Prime Fur Bonus ($)
Marten		11,282	11,093	1,019,223.97	211,522
Mink		704	675	10,817.00	1,030
Moose Hide		4	4	3,350.00	0
Muskrat		10,736	4,768	13,885.96	623
Otter		22	40	1,475.00	50
Seal	Ringed	309	42	2,489.00	725
Squirrel		645	678	1,202.90	255
Weasel		814	268	1,821.30	214
Wolf	Boreal	51	44	5,946.00	250
	Arctic	3	3	850.00	0
	Tundra	3	7	1,768.00	200
Wolverine		78	76	19,747.00	2,750
Total		27,269	20, 367	$1,301,288.69	$247,699

Source: IOL et al. (2004); GNWT Bureau of Statistics (2010k, 2010l)

Marten were harvested and sold the most compared to other species in 2007-2008, in terms of number sold and overall sales value. Marten generated the highest Prime Fur Bonus (PFB), which occurs when the fur sells for a price greater than or equal to the guaranteed advance (GNWT ITI 2007). The guaranteed advance is an advance payment to trappers who ship their furs through the GMVF program. These advances are reconciled when the fur has been sold (GNWT ITI ND).

3.2.8.2 Resource Accessibility, Quality and Level of Harvest

Importance and Management of Resource

Wildlife and land resources are of primary importance to the Inuvialuit, and are used for cultural, traditional, and subsistence purposes. The importance of these resources can be determined from the number of people involved in traditional activities and from the number of households with people who prefer to consume country foods.

In the majority (86%) of households in the ISR, people prefer to eat more country food than is actually available (Egeland 2010). A factor that is currently affecting availability of country foods is a decline in species population, such as caribou. Country foods are also considered inaccessible to some people in the region due to lack of active hunters in the household, lack of transportation such as snowmachine or boat, and high cost of supplies and fuel to go fishing and hunting (Egeland 2010).

Changes in lifestyle can also make acquiring country foods a challenge. As residents are increasingly tied to the wage economy, they hunt or fish on weekends in areas nearer to their places of residence. Harvesting time limited to weekends means they have less time to travel to find game, fish or wildfowl (Community of Tuktoyaktuk et al. 2008).

Modes of transportation have also changed in favour of faster means of transportation. In winter, hunters use snowmachines, and in summer, boats and four-wheel drive or all-terrain vehicles (Community of Tuktoyaktuk et al. 2008). Purchase of these vehicles adds to the overall costs of harvesting country foods.

The Community Conservation Plans for both Tuktoyaktuk and Inuvik were prepared in accordance with principles laid out in the IFA to aid Inuvialuit communities with land management in order to preserve the option of living off the land for present and future generations (Community of Tuktoyaktuk et al. 2008).

The IFA sets up several resource management bodies, including:

- Wildlife Management Advisory Council (NWT and North Slope). Responsible for advising government ministers and Inuvialuit agencies on all wildlife-related matters.
- Fisheries Joint Management Committee (FJMC). Responsible for managing marine mammals harvesting and marine and freshwater fisheries.
- Inuvialuit Game Council (IGC). Manages and regulates the collective Inuvialuit interest in wildlife and advises the government.
- Hunters and Trappers Committees (HTC). Allocates resources and promotes Inuvialuit involvement in conservation, research, management, enforcement and utilization.
- Inuvialuit Land Administration (ILA). Manages and administers access to Inuvialuit private lands. The ILA also screens development proposals on Inuvialuit private lands.
- Environmental Impact Screening Committee (EISC). Screens all development proposals on Crown lands within the ISR for potentially negative environmental impacts.
- Environmental Impact Review Board (EIRB). Reviews project proposals which may have significant environmental impacts. The EIRB has the authority to conduct detailed public reviews and make recommendations to the federal government regarding proposed developments (Community of Tuktoyaktuk et al. 2008).

Harvesting Areas and Amount Harvested

This section describes the harvesting areas and amount harvested for key species. The data presented in the following section are primarily derived from the Inuvialuit Harvest Study 1988-1997 (Joint Secretariat 2003). This study has not been updated since it was originally published; in the Inuvialuit Settlement Region, comprehensive harvest studies are no longer being conducted (G. More, Land and Water Manager, GNWT ENR, pers. comm., October 26, 2010). Additional harvest information is provided, where available.

Caribou

The Inuvialuit have exclusive harvesting rights to caribou within the Inuvialuit Settlement Region. Inuvialuit communities rely on the Cape Bathurst and Bluenose-West herds of barren-ground caribou which occupy the northern portion of the Northwest Territories and western Nunavut (Community of Inuvik et al. 2008; Community of Tuktoyaktuk et al. 2008).

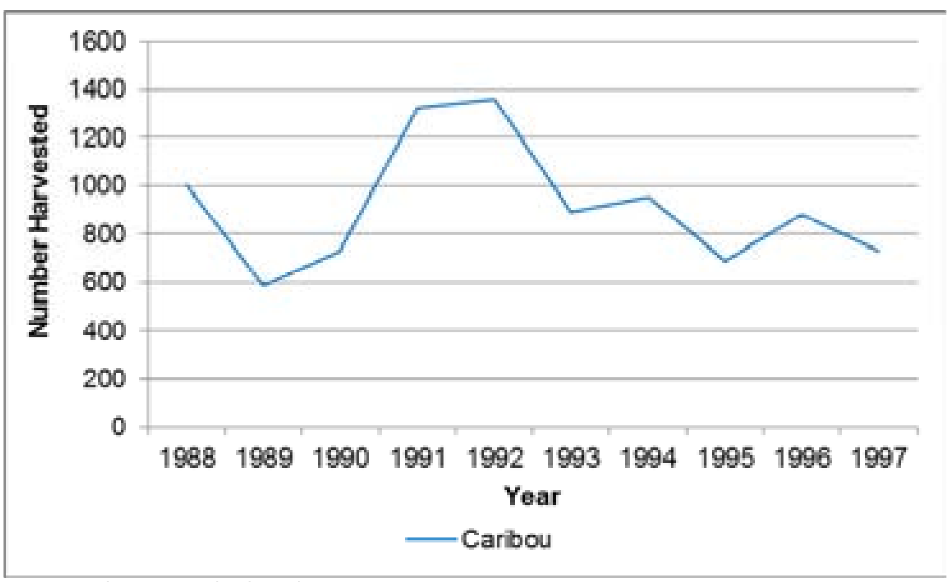
Due to a decline in barren-ground caribou population, hunting has been closed to all hunters, including Inuvialuit beneficiaries, from July 1, 2006 to the present in Area I/BC/07 (which includes the area of the proposed Highway). In Area I/BC/08, located to the north and east of Tuktoyaktuk, hunting for the Tuktoyaktuk Peninsula Herd is still permitted by Inuvialuit hunters between June 16 and March 31. This area is closed for hunting from April 1 to June 15 to allow the Cape Bathurst caribou herd to migrate back to their calving grounds along the coast.

Figure 3.2.8-1 shows the seasonal caribou harvesting areas.

Tuktoyaktuk

Between 1988 and 1997, the annual caribou harvest near Tuktoyaktuk fluctuated from a high of 1,398 caribou harvested in 1992 to a low of 586 caribou in 1989 (Figure 3.2.8-2). With the exception of the 1991 and 1992 harvest years, annual caribou harvests have remained below 1,000 caribou per year in the Tuktoyaktuk region (Joint Secretariat 2003).

The declining population, hunting bans and hunting season restrictions have affected the location and likely the number of caribou harvested in the Tuktoyaktuk area. However, current caribou harvesting data for this community are not available.



Source: Joint Secretariat (2003)

Figure 3.2.8-2
Estimated Annual Caribou Harvest, Tuktoyaktuk, 1988-1997

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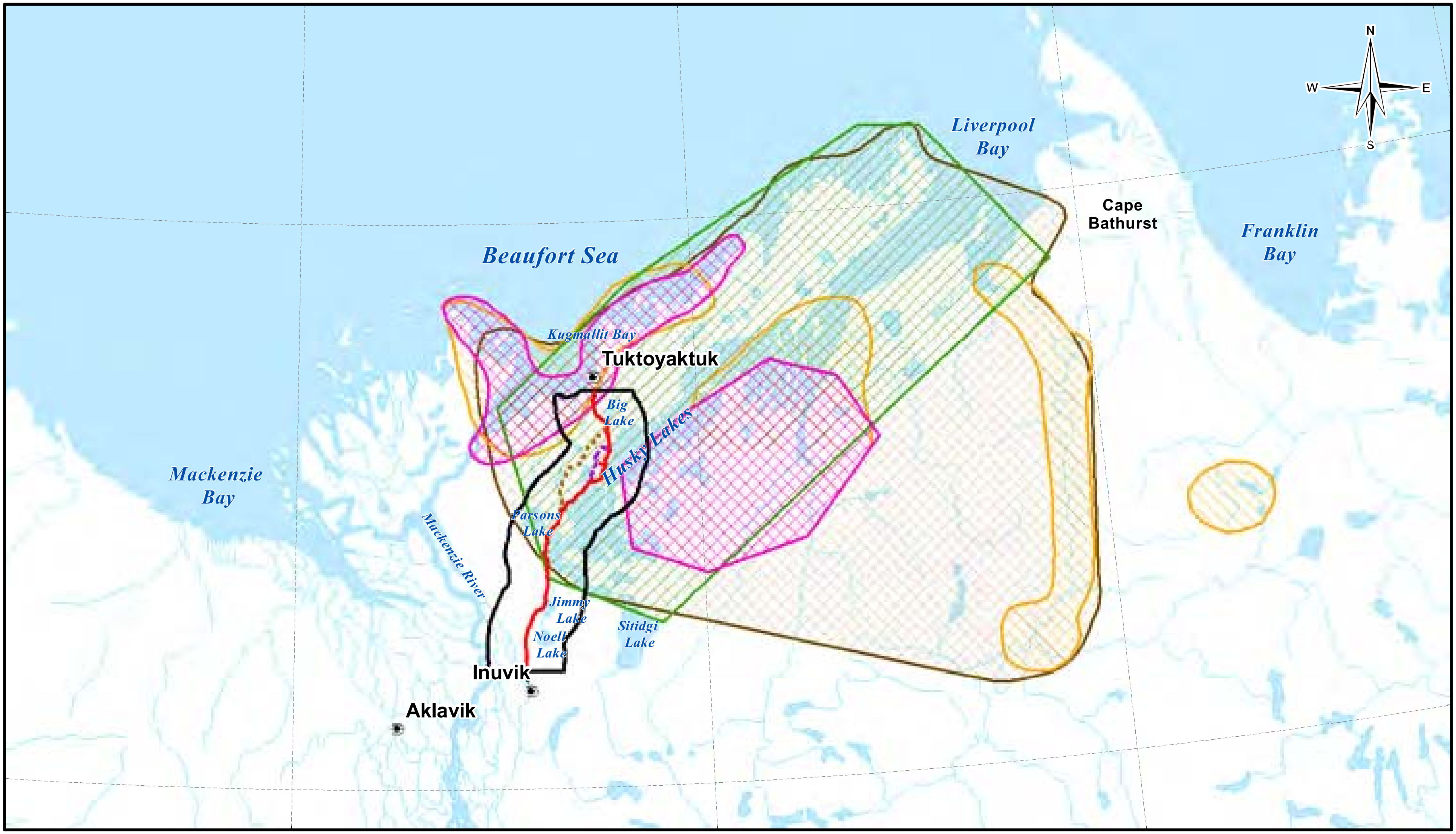


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 302C-Spring Caribou Harvest Area
- 306C-Summer Caribou Harvest Area
- 309C-Fall Caribou Harvest Area
- 315C-Winter Caribou Harvesting Area
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas
Caribou Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map008_Trad_CaribouHarv.mxd

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Caribou Harvesting Areas Spring, Summer, Fall, Winter

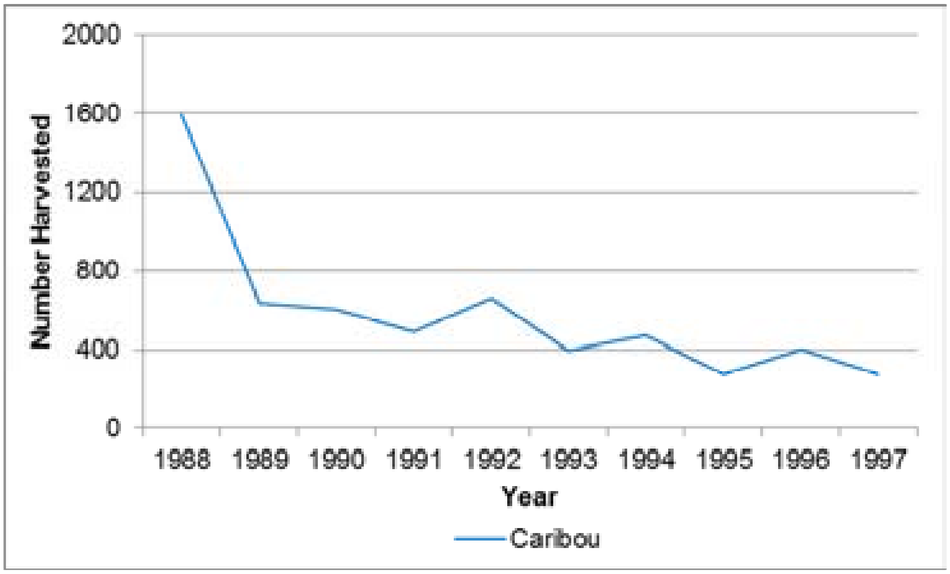
PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-1

Inuvik

In the Inuvik area, between 1988 and 1997, the Inuvialuit annual caribou harvest fell from 1,589 to 275 animals per year (Figure 3.2.8-3). The sharpest decline followed the 1988 hunting season; 1,589 caribou were harvested in 1988, compared with 635 in 1989. Since 1989, the number of caribou harvested has continued to decline to as few as 275 in 1997. The declining population, hunting bans and hunting season restrictions have affected the location and likely the number of caribou harvested in the Inuvik area. However, current caribou harvesting data for this community are not available.



Source: Joint Secretariat (2003)

Figure 3.2.8-3
Estimated Annual Caribou Harvest, Inuvik, 1988-1997

<u>Big-Game</u>

Other big-game harvested include moose, grizzly bear and, to a lesser extent, black bear. Moose are an important alternate food source when caribou are not available, and are also used for clothing and tools (Community of Inuvik et al. 2008). Figure 3.2.8-4 shows the spring moose harvesting areas. Traditionally, grizzlies are hunted for their fur (Community of Tuktoyaktuk et al. 2008).

GNWT ENR records indicate the grizzly bear harvests recorded in the Inuvialuit Harvest Study (Joint Secretariat 2003) were biased low. More recent data indicate that between July 2005 and June 2010, 48 grizzly bears were harvested using Tuktoyaktuk tags (GNWT ENR 2010h). Despite the increase from the earlier data, the harvest between 2005 and 2010 was less than the quota for the two hunting areas (GNWT ENR 2010h).

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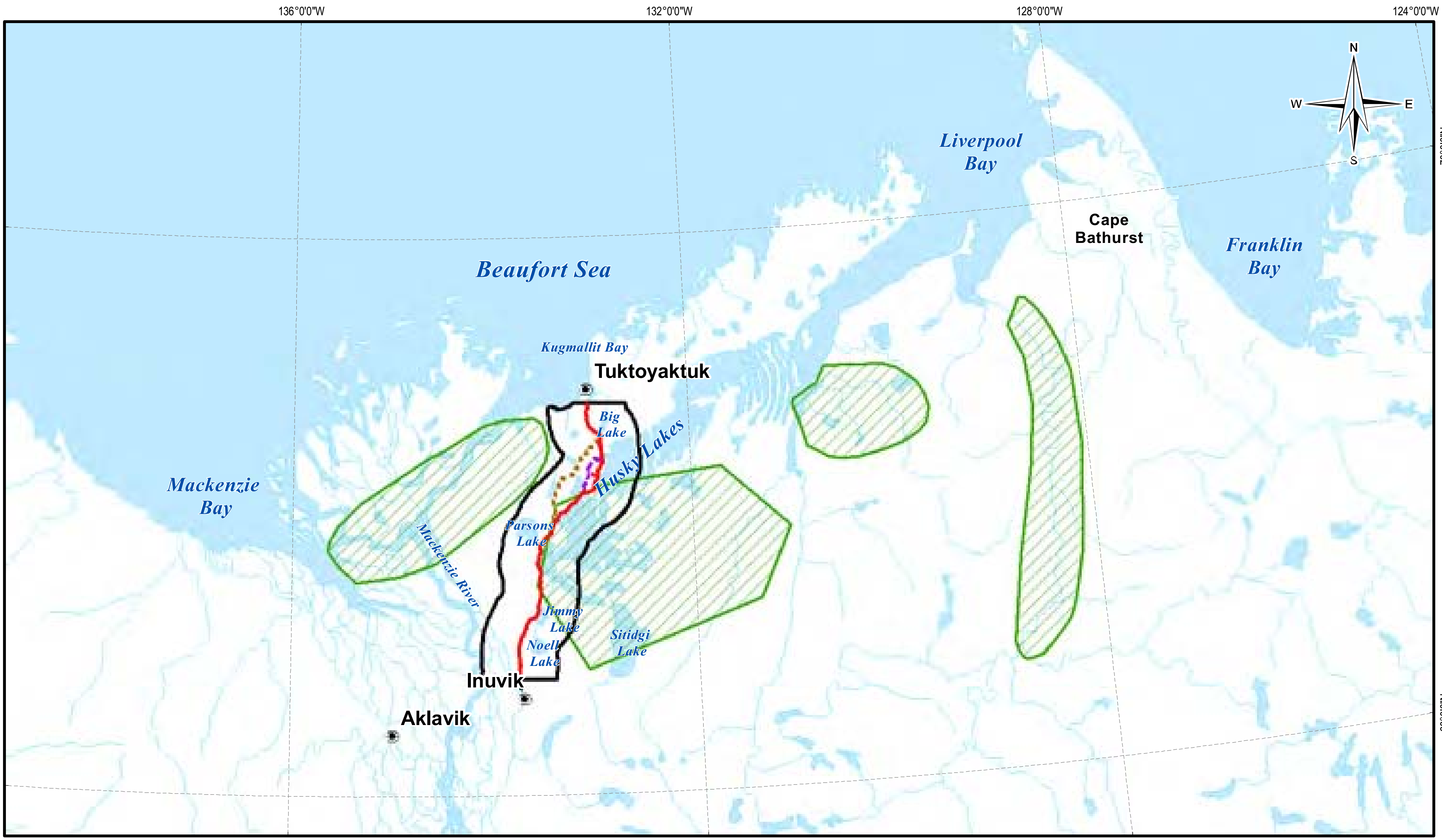


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 303B-Spring Moose Harvesting Area
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas

Moose Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.

V23201322_EIS_Map011_Trad_MooseHarv.mxd

Town of Inuvik | Northwest Territories | KIGGIAK - EBA

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Moose Harvesting Areas Spring

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

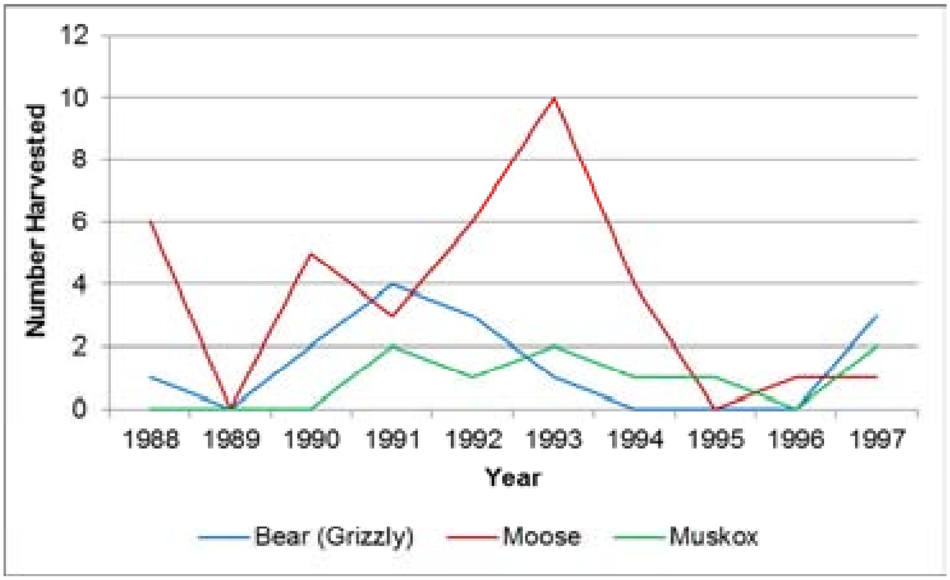
OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-4

Tuktoyaktuk

The numbers of grizzly bear, moose and muskox harvested in the Tuktoyaktuk area have fluctuated over time for (Figure 3.2.8-5), from six or fewer of each species per year to a high of 10 moose in 1993.

Muskoxen are typically harvested between April 1 and May 31 within the Tuktoyaktuk Planning Area (Community of Tuktoyaktuk et al. 2000).



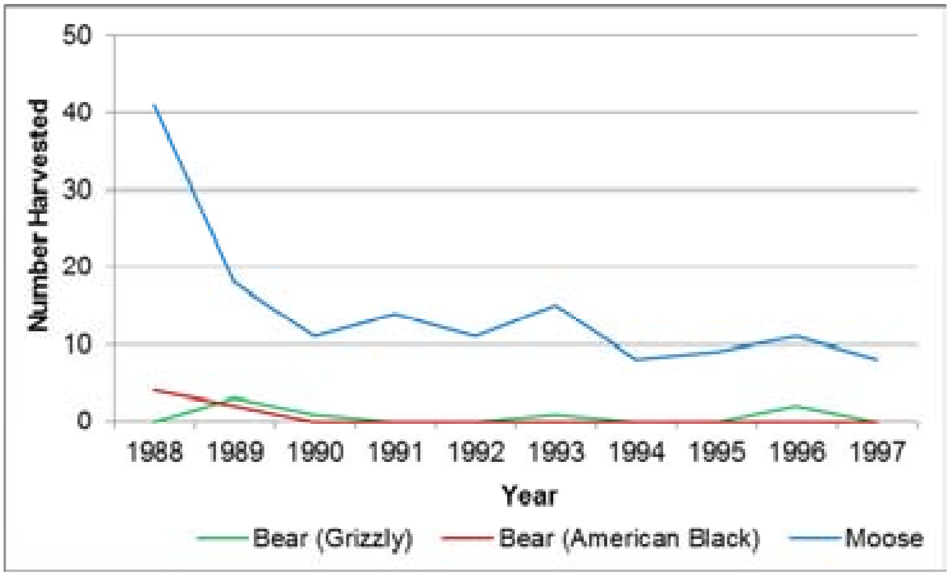
Source: Joint Secretariat (2003)

Figure 3.2.8-5
Estimated Annual Big-game Harvest, Per Species, Tuktoyaktuk, 1988-1997

More recent big-game harvest estimates for the ISR region were not available.

Inuvik

Moose hunting typically occurs between February 1 to March 31 and August 1 to 31 each year in the Inuvik Planning Area (Community of Inuvik et al. 2000). As indicated in Figure 3.2.8-6, between 1988 and 1997 the Inuvialuit annual moose harvest near Inuvik declined from 41 in 1988 to 8 in 1997. The sharpest decline followed the 1988 hunting season of 41 moose to 18 moose the following year. Between 1989 and 1997 the moose harvest near Inuvik fluctuated from 8 to 15 animals.



Source: Joint Secretariat (2003)

Figure 3.2.8-6
Estimated Annual Big-game Harvest, Per Species, Inuvik, 1988-1997

As indicated in Figure 3.2.8-6, based on the Inuvialuit Harvest Study (Joint Secretariat 2003) the Inuvialuit from Inuvik harvested seven grizzly bears between 1988 and 1997, including four that were harvested in 1989. No grizzly bears were harvested in the Inuvik area during the years 1988, 1991, 1992, 1994, 1995, or 1997. However, GNWT ENR records indicate the grizzly bear harvests recorded in the study were biased low. More recent data indicate that between July 2005 and June 2010, one grizzly bear was harvested (GNWT ENR 2010h).

Near Inuvik, it is estimated that less than five black bears were harvested during 1988 and 1989 (Figure 3.2.8-6).

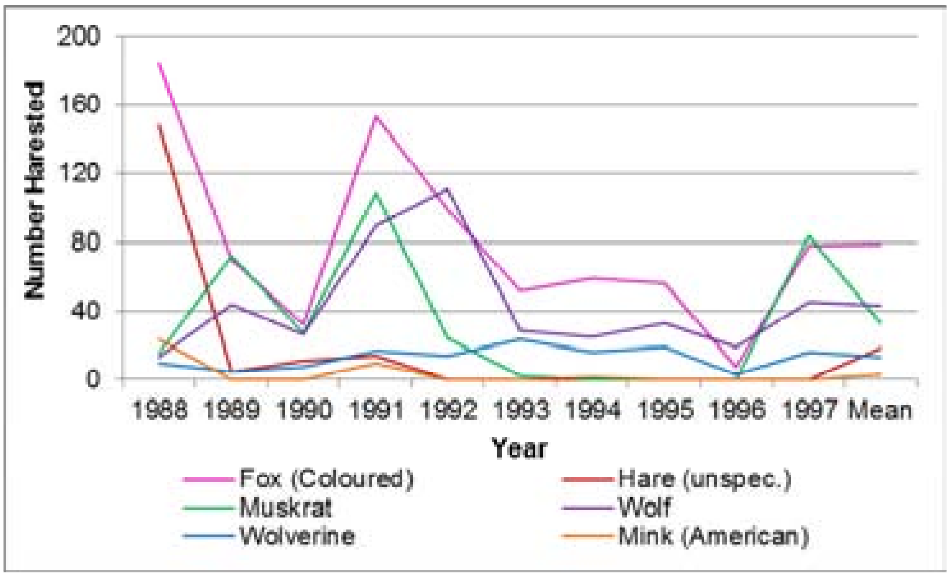
<u>Furbearers and Small Mammals</u>

Active trapping by the Inuvialuit near Inuvik has also been in decline. High-value, furbearing species trapped in the region include fox, American mink, hare, wolf (also classified as big-game), marten, wolverine and muskrat. Hare are also considered an important food source (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Tuktoyaktuk

Active trapping by the Inuvialuit near Tuktoyaktuk has fluctuated over the period from 1988 to 1997 (Figure 3.2.8-7). In the Tuktoyaktuk Planning Area, furbearers are typically harvested between January 1 to April 15 and November 1 to December 15 of each year (Community of Tuktoyaktuk et al. 2000). Muskrat are harvested between March 5 and May 31 each year (Community of Tuktoyaktuk et al. 2000).

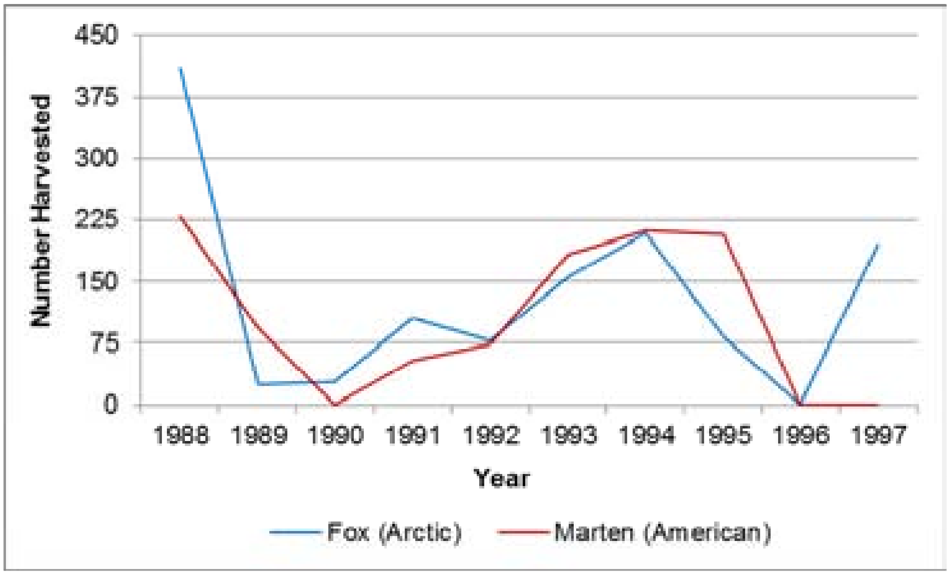
As indicated in Figure 3.2.8-7, mink and hare harvest rates have decreased between 1988 and 1997. Other species have generally fluctuated over this time period (Figures 3.2.8-7 and 3.2.8-8 (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-7
Estimated Annual Furbearers/ Small Mammals Harvest, Per Species, Tuktoyaktuk, 1988-1997

The number of Arctic fox and marten harvested near Tuktoyaktuk fell substantially between 1988 and 1990 and then rose steadily again until 1996 (Figure 3.2.8-8).

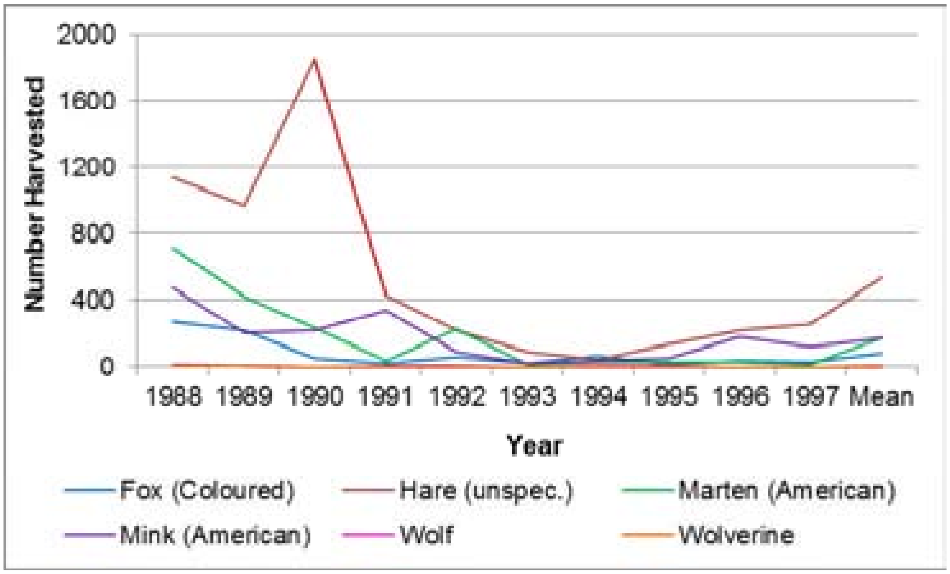


Source: Joint Secretariat (2003)

Figure 3.2.8-8
Estimated Annual Furbearers/ Small Mammals Harvest, Per Species, Tuktoyaktuk, 1988-1997

Inuvik

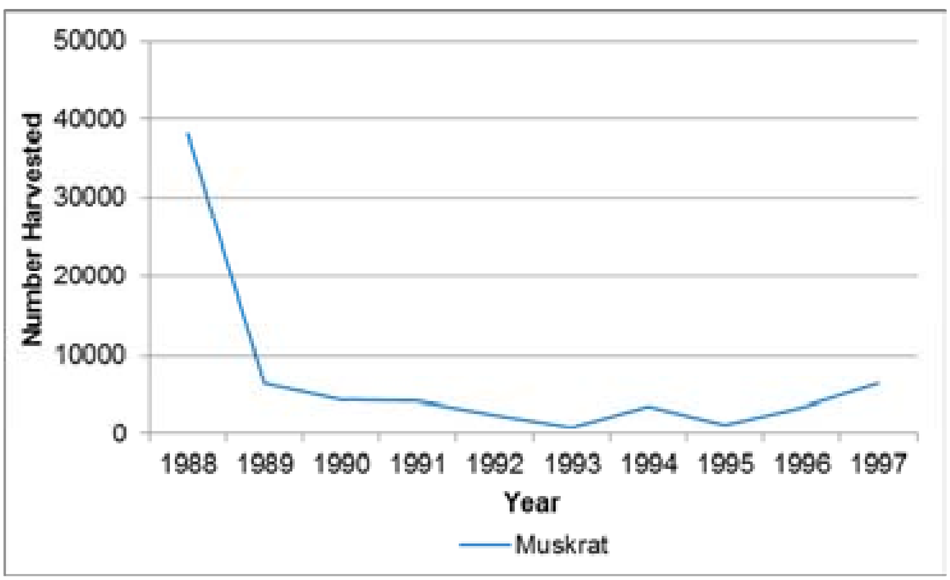
In the Inuvik area, furbearers are typically harvested between January 1 to May 15 and November 1 to December 31 of each year (Community of Inuvik et al. 2000). Muskrat are harvested from March 5 to June 15 each year (Community of Inuvik et al. 2000). As shown in Figures 3.2.8-9 and 3.2.8-10, harvest rates have decreased between 1988 and 1997. An exception is the hare harvest in 1990, which increased sharply in 1990. Wolf and wolverine were the least harvested each year (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-9
Estimated Annual Furbearers / Small Mammals Harvest, Per Species, Inuvik, 1988-1997

Muskrat harvesting has declined between 1988 and 1997, and the sharpest decline was from 1988 (38,136 animals) to 1989 (6,305 animals) (Figure 3.2.8-10). Between 1989 and 1997 the muskrat harvest fluctuated from a low 698 in 1993 to 6,314 in 1997. Figure 3.2.8-11 shows the winter harvesting areas for wolverine.



Source: Joint Secretariat (2003)

Figure 3.2.8-10
Estimated Annual Muskrat Harvest, Inuvik, 1988-1997

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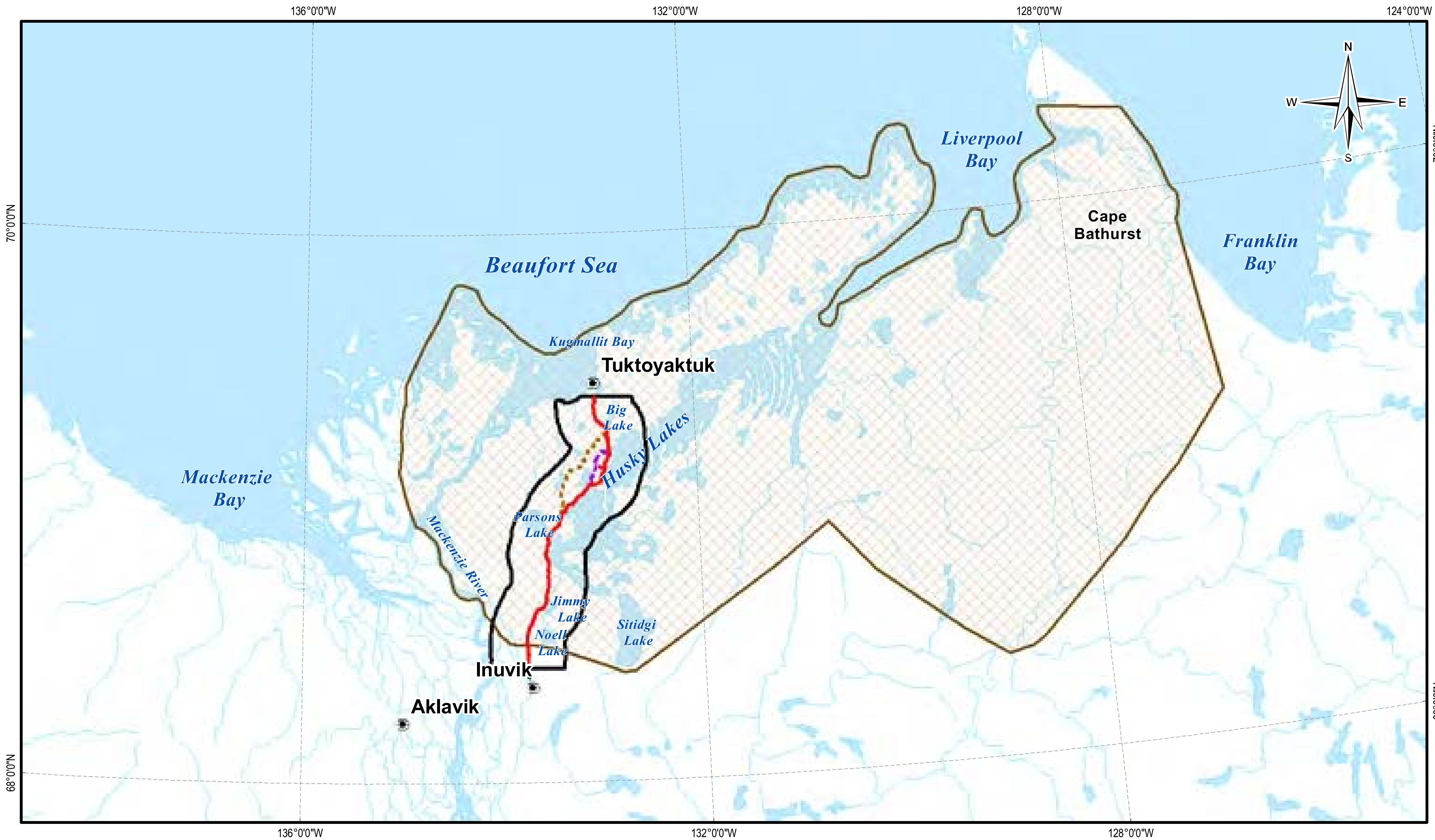


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 314C-Winter Wolverine Harvesting Area
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas
Wolverine Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map012_Trad_WolverineHarv.mxd

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Wolverine Harvesting Areas Winter

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

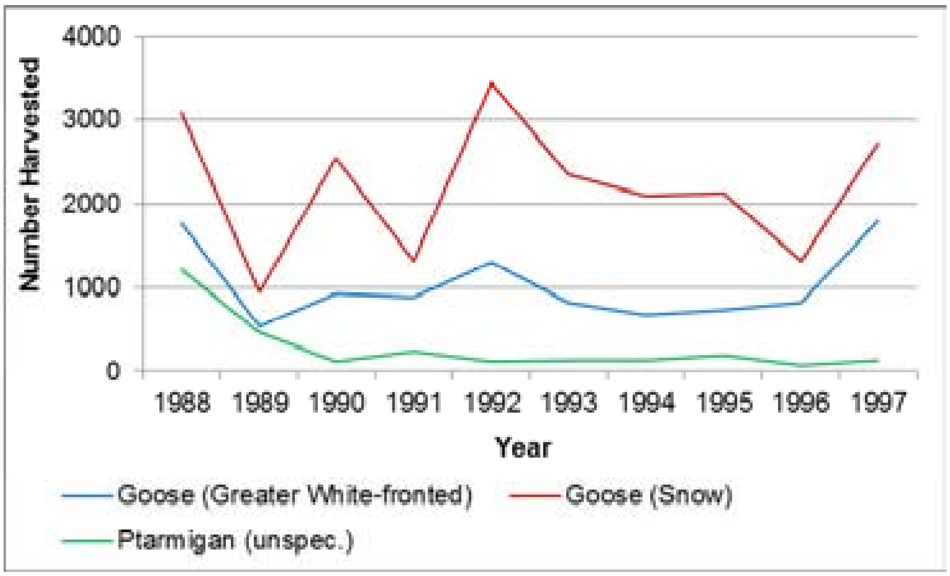
Figure 3.2.8-11

Waterfowl

Waterfowl are an important food source for the Inuvialuit during the spring and fall and the down from these birds is traditionally used in pillows and quilts (Community of Inuvik et al. 2008). Figure 3.2.8-13 shows the spring, summer and fall goose harvesting areas.

Tuktoyaktuk

Birds are harvested in the Tuktoyaktuk Planning Area from May 1 to June 30 and August 1 to September 30 each year (Community of Tuktoyaktuk et al. 2000). As shown in Figure 3.2.8-12, the annual harvest rates of the greater white-fronted goose, snow goose and ptarmigan near Tuktoyaktuk have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-12
Estimated Annual Bird Harvest (Goose and Ptarmigan), Tuktoyaktuk, 1988-1997

As shown in Figure 3.2.8-14, the annual harvest rates of eider and mallard ducks near Tuktoyaktuk have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003). According to the available records, no mallards were harvested near Tuktoyaktuk between 1993 and 1997.

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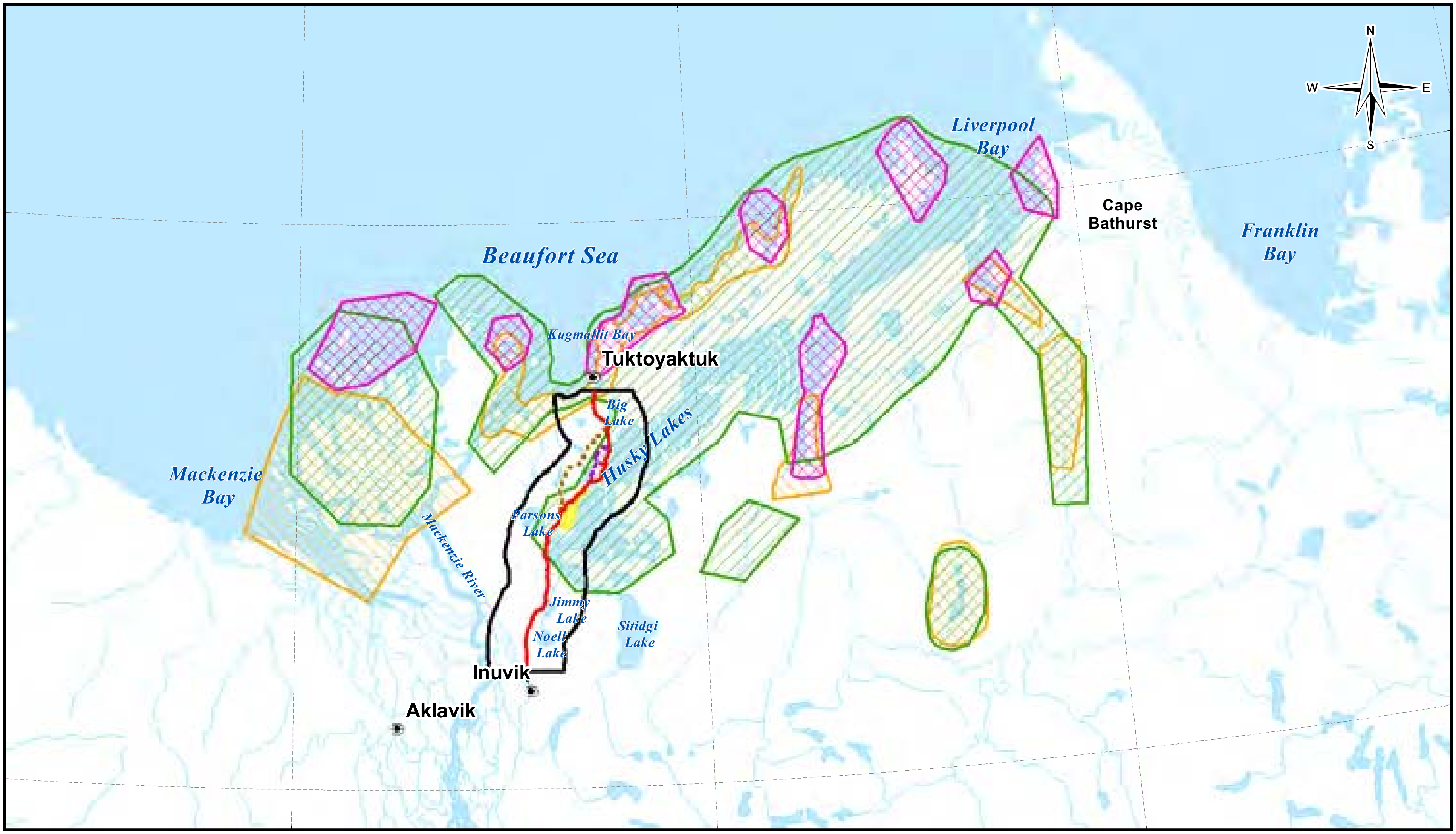


LEGEND

- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- Regional Study Area (15 km buffer)
- 304C-Spring Goose Harvesting Area
- 308C-Summer Goose Harvesting Area
- 312C-Fall Goose Harvesting Area
- Area Where Geese Congregate
- Watercourse
- Waterbody

NOTES
Base data source: National Atlas
Goose Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008
Area of Geese Congregation: Community Consultation, October 2009

ISSUED FOR USE

Scale: 1:2,250,000
20 10 0 20 40 60 80
Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map010_Trad_GooseHarv.mxd

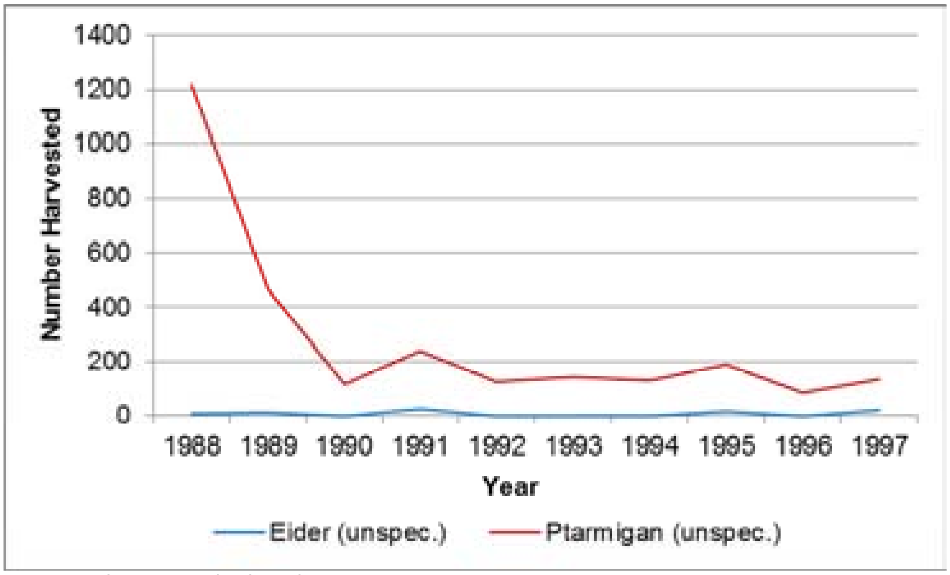
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Goose Harvesting Areas Spring, Summer, Fall

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-13

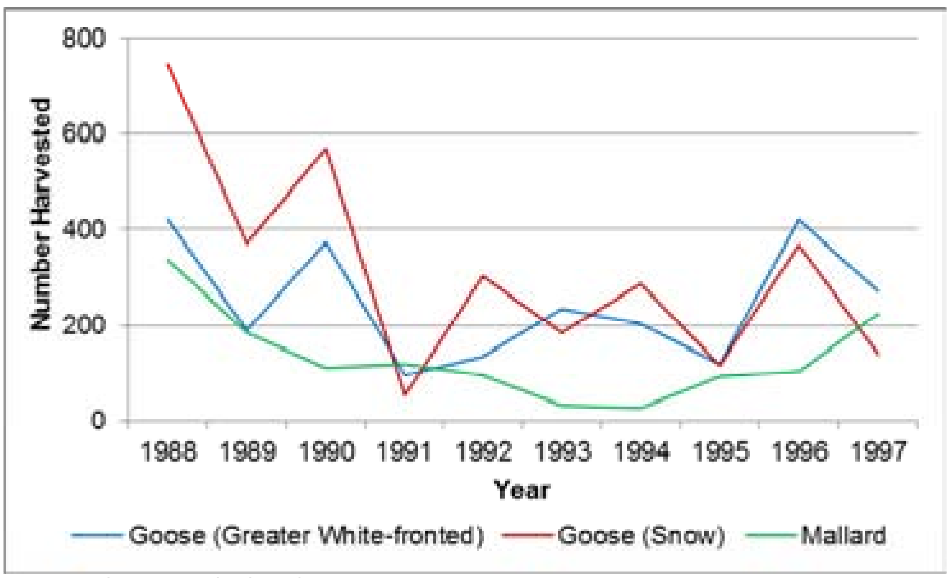


Source: Joint Secretariat (2003)

Figure 3.2.8-14
Estimated Annual Bird Harvest (Eider and Mallard), Tuktoyaktuk, 1988-1997

Inuvik

As shown in Figure 3.2.8-15, the annual harvest rate of the greater white-fronted goose, snow goose and mallard near Inuvik have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003). Overall, harvest numbers declined between 1988 and 1995 but increased in 1996 and 1997. The harvesting seasons for birds in the Inuvik Planning Area are May 1 to June 30 and September 1 to 30 (Community of Inuvik et al. 2000).



Source: Joint Secretariat (2003)

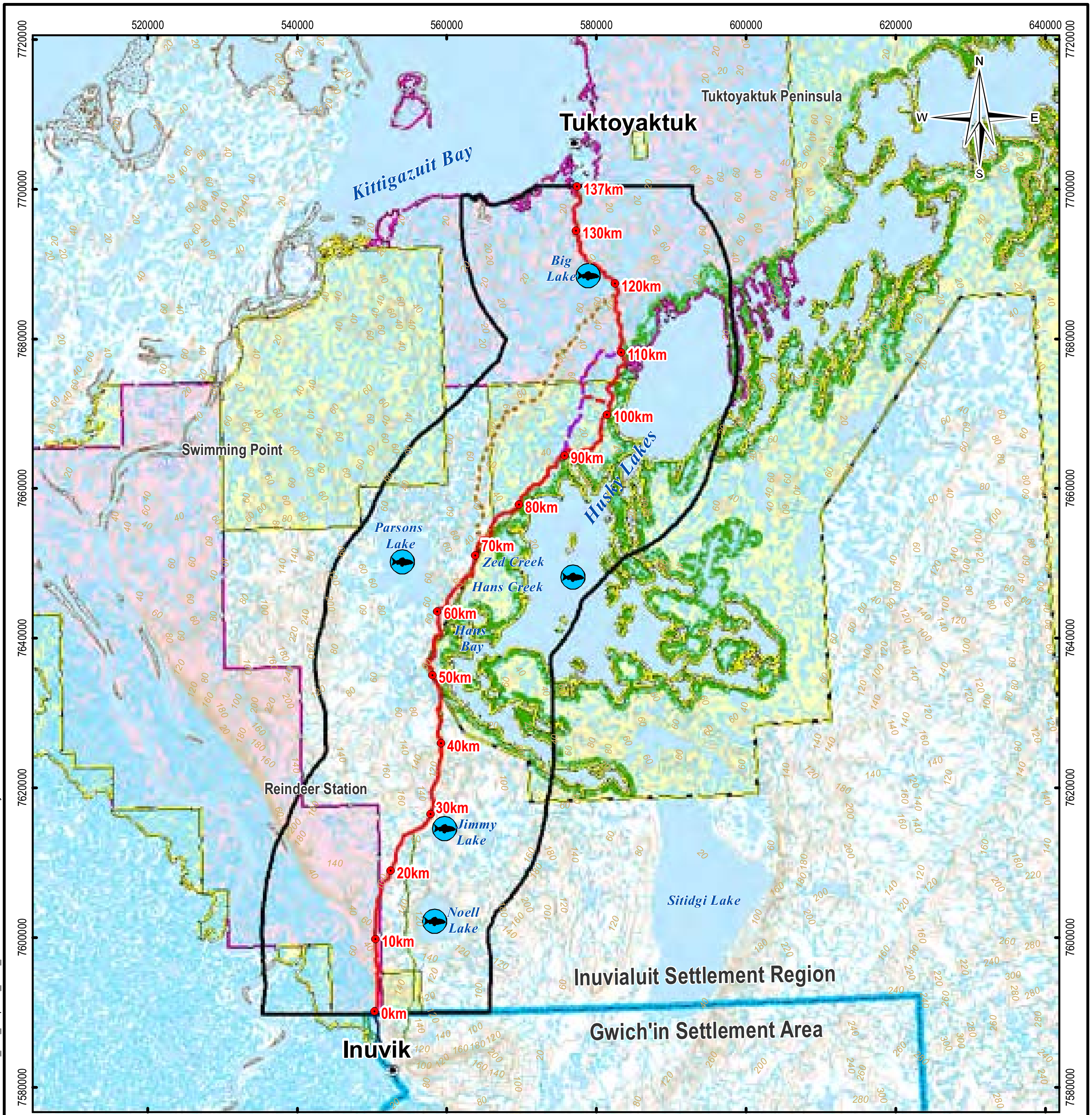
Figure 3.2.8-15
Estimated Annual Bird Harvest (Goose and Mallard), Inuvik, 1988-1997

Fish

Fish are an important food source for the Inuvialuit. The main fish-bearing lakes along the proposed Highway alignment are shown in Figure 3.2.8-16 while fish harvesting areas are shown in Figure 3.2.8-17. Fish-bearing lakes were identified by Rescan (1999a) and IOL et al. (2004), while the fish harvesting areas are identified in the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008).

Tuktoyaktuk

Fish species harvested near Tuktoyaktuk between 1988 and 1997 included inconnu, northern pike, lake trout, burbot, lake whitefish, broad whitefish and cisco. In general, the number of cisco harvested near Tuktoyaktuk declined significantly over the reported timeframe. Inconnu harvesting increased sharply in 1991, and declined again in 1992. Between 1988 and 1990, there was a considerable increase in the number of unspecified whitefish harvested from 1988; this may be attributed to the absence of data reported for broad and lake whitefish during that period. As shown in Figures 3.2.8-18 and 3.2.8-19, all other species showed minor fluctuations in the number harvested.



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LEGEND

- Fish Bearing / Ilkaasuat
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish Bearing Lakes Along the Proposed Alignment

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map007_Fish_FishLake.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-16

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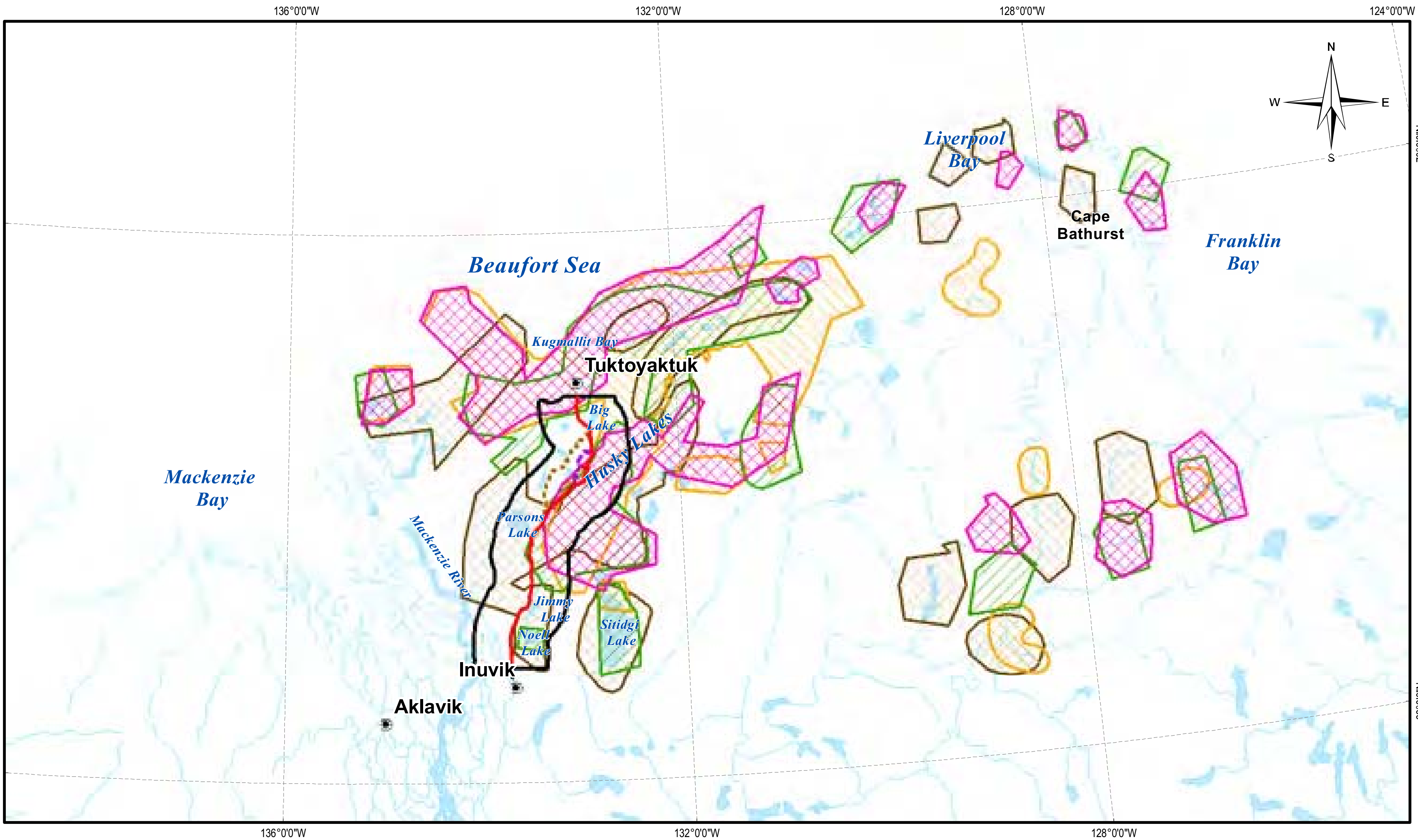


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 307C-Summer Fishing Harvesting Area
- 305C-Spring Fishing Harvesting Area
- 310C-Fall Fishing Harvesting Area
- 316C-Winter Fishing Harvesting Area
- Watercourse
- Waterbody

NOTES
Base data source: National Atlas
Fishing Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000
20 10 0 20 40 60 80
Kilometres

PROJECTION: UTM Zone 8
DATUM: NAD83
FILE NO.: V23201322_EIS_Map009_Trad_FishHarv.mxd

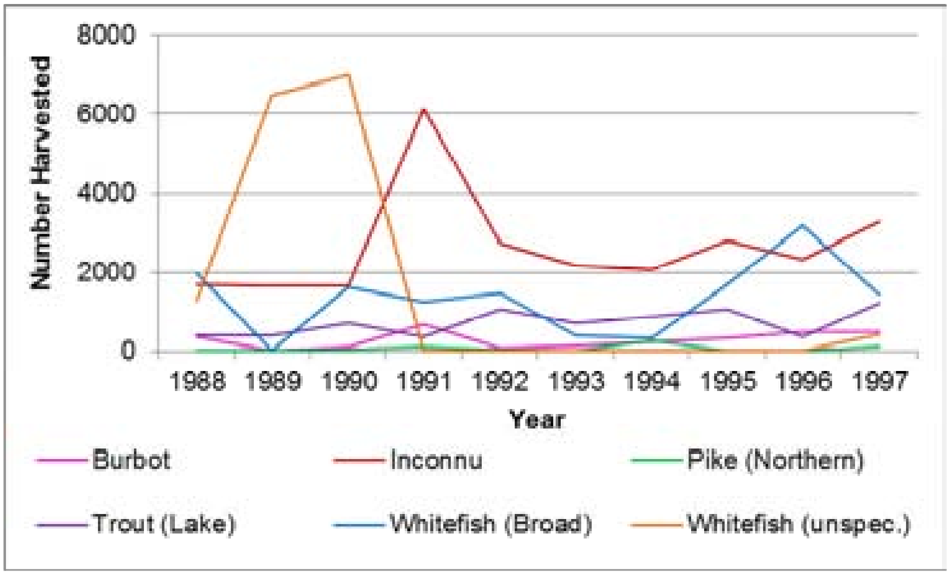
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish Harvesting Areas Spring, Summer, Fall, Winter

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

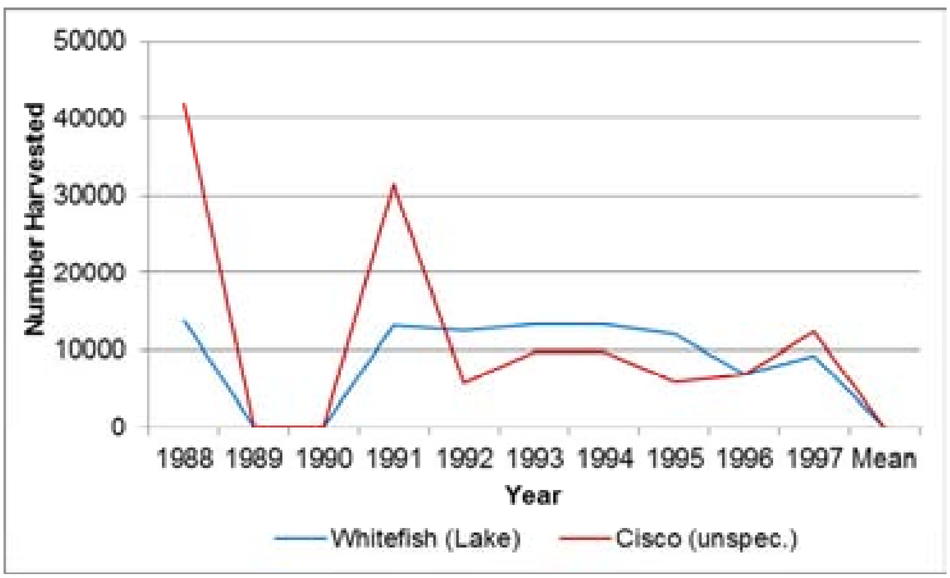
OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-17



Source: Joint Secretariat (2003)

Figure 3.2.8-18
Estimated Annual Fish Harvest, Per Species, Tuktoyaktuk, 1988-1997

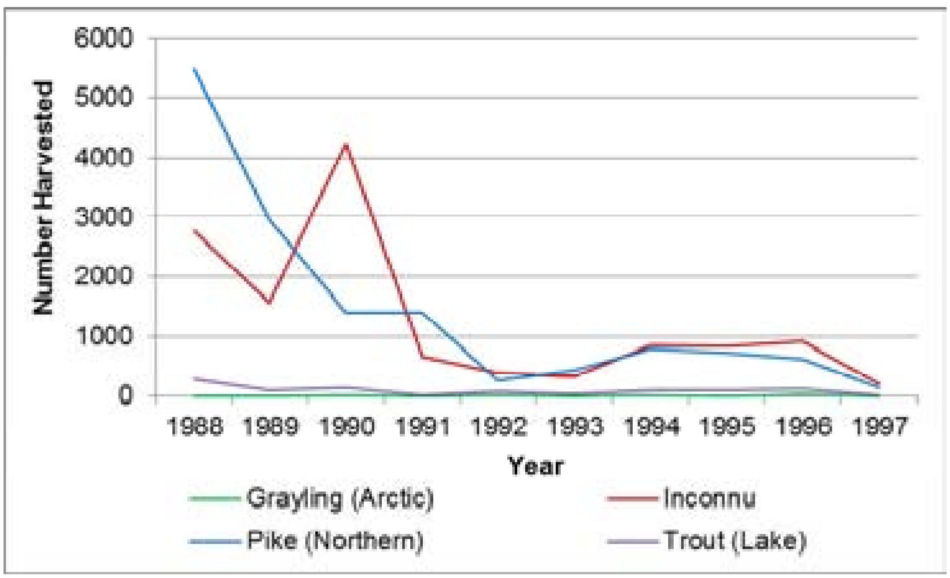


Source: Joint Secretariat (2003)

Figure 3.2.8-19
Estimated Annual Fish Harvest, Per Species, Tuktoyaktuk, 1988-1997

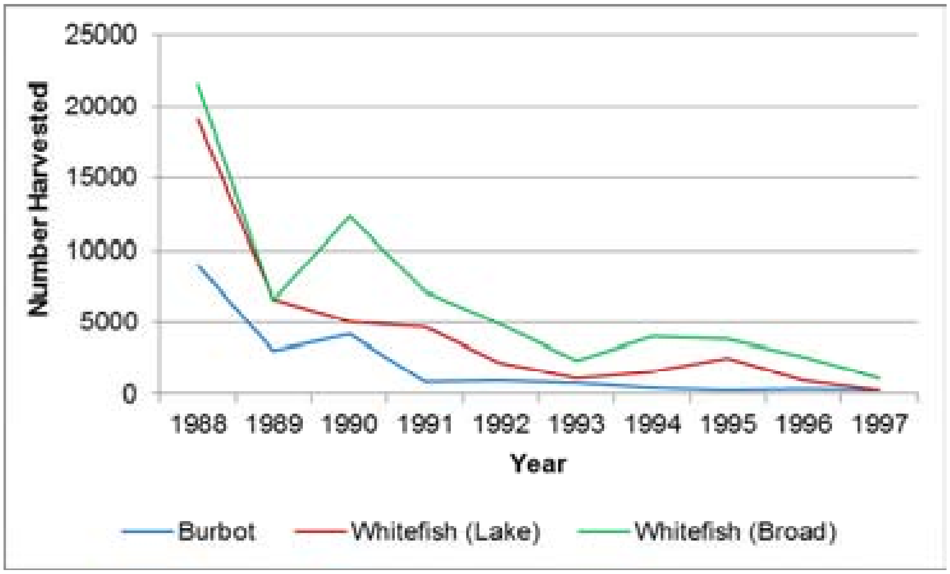
Inuvik

Fish species harvested near Inuvik between 1988 and 1997 included Arctic grayling, inconnu, northern pike, lake trout, burbot, lake whitefish and broad whitefish. In general, the harvest of all fish species near Inuvik declined over the reported time period. As shown in Figures 3.2.8-20 and 3.2.8-21, the greatest reductions in fish harvest occurred in broad whitefish, from 21,557 in 1988 to 1,149 in 1997; lake whitefish, from 19,094 in 1988 to 261 in 1997; and burbot, from 8,772 in 1988 to 216 in 1997. The 1990 harvest year had a considerable increase in the harvest of broad whitefish, burbot, and inconnu from the previous year (1989) before further declines were recorded from 1991 onward (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-20
Estimated Annual Fish Harvest, Per Species, Inuvik, 1988-1997



Source: Joint Secretariat (2003)

Figure 3.2.8-21
Estimated Annual Fish Harvest, Per Species, Inuvik, 1988-1997

Berries

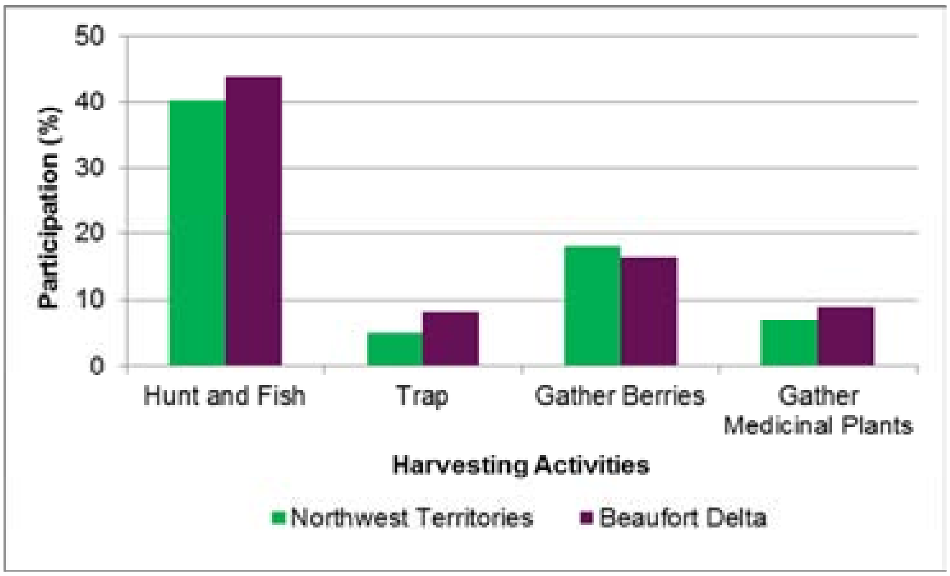
Berry (asiat) picking is an important summer activity (IOL et al. 2004; Kiggiak-EBA 2008). Key berry species include blueberry (*Vaccinium uliginosum* ssp. *alpinum* and ssp. *Microphylum*), or asivit, and salmonberry or cloudberry (*Rubus chamaemorus*), or aqpik. During the October 2009 consultation sessions held for the proposed Inuvik to Tuktoyaktuk Highway, a number of participants in both communities identified berry picking as an important summer family activity. The participants also indicated that the proposed Highway will help families to access new berry picking areas along the route that they cannot reach now. Several participants in the October 2009 consultation sessions at Tuktoyaktuk indicated that during the summer of 2009, some families drove on the completed section of the Tuktoyaktuk to Source 177 Access Road to pick berries along the right of way.

3.2.8.3 Participation in Harvesting Activities for Household Food Supply

The Inuit Health Survey 2007-2008 (Egeland 2010) shows that there is an active hunter in more than half of the households in the ISR. In particular, 70% of households with children have an active hunter. The majority of households in the ISR obtained their country foods directly from hunting themselves or from other family members. Country food is also obtained from friends, the community freezer, purchased at the store, or received from the hunters and trappers committee (Egeland 2010).

In 2002 the GNWT conducted an employment and harvesting survey to gather information about individuals involved in the NWT and Beaufort-Delta region in harvesting activities such as hunting, trapping, fishing, gathering berries, and gatherings plants for medicinal purposes. Information was also collected regarding the consumption of harvested meat and fish (GNWT Bureau of Statistics 2002).

The survey shows that of the people aged 15 years and older in the Beaufort-Delta region and the NWT, hunting and fishing had the greatest percentage of participation (Figure 3.2.8-22). Gathering berries was the only harvesting activity where the NWT's average participation exceeded that of the Beaufort-Delta (GNWT Bureau of Statistics 2002).



Source: GNWT Bureau of Statistics (2002)

Figure 3.2.8-22
Percent of Persons 15 Years of Age & Older Involved in Harvesting Activities, 2002

The survey participant responses were categorized according to gender, age range, and ethnicity (Table 3.2.8-4). Table 3.2.8-4 indicates that the majority of hunting, trapping and fishing activities was conducted by males, while the majority of gathering activities (berries and plants) were conducted by females.

Participation by age group seemed relatively dependent on the type of activity. Most trappers were 40 years and older, while hunters and fishers were active in all age groups. Berry gathering was primarily conducted by those aged 40 years and older, while plant gathering was primarily done by those aged 60 years and older.

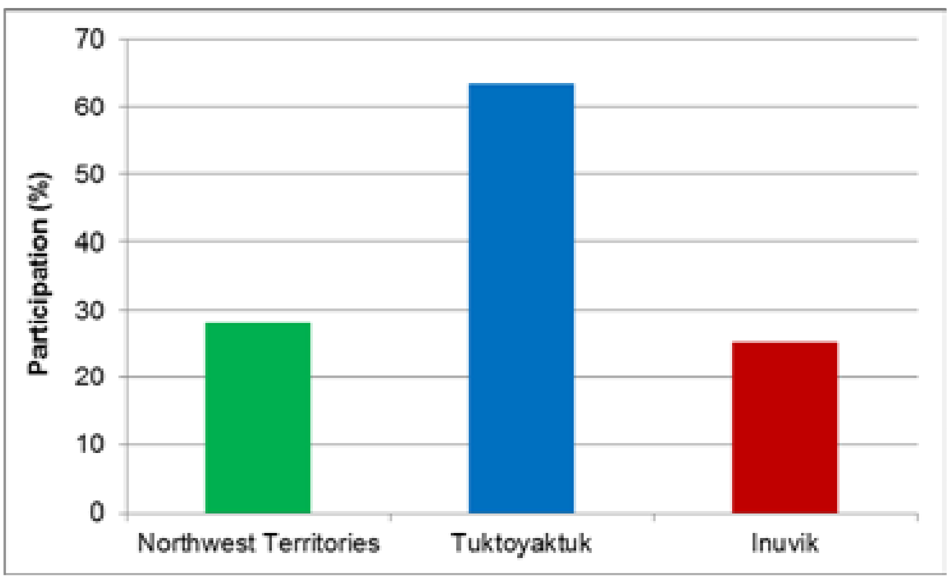
Aboriginal participation in harvesting activities exceeded that of non-Aboriginals (GNWT Bureau of Statistics 2002).

TABLE 3.2.8-4: PERCENT OF PERSONS INVOLVED IN HARVESTING ACTIVITIES, BY SELECTED CHARACTERISTICS FOR THE NWT, 2002

	Trapped	Hunted or Fished	Gathered Berries	Gathered Plants
Persons 15 Yrs. & Older	5.0	40.2	18.2	6.8
Males	7.6	51.4	12.8	5.7
Females	2.2	27.9	24.4	7.9
15-24 Years	4.0	34.6	12.9	3.9
25-39 Years	4.7	40.8	16.9	5.2
40-59 Years	5.1	46.1	22.1	7.3
60 Years & Over	8.3	31.6	23.8	16.6
Aboriginal	9.9	44.9	23.6	13.0
Males	15.4	58.3	16.6	10.7
Females	4.3	30.7	30.9	15.5
Non-Aboriginal	0.7	36.5	13.2	1.3
Males	1.1	46.2	9.4	1.7
Females	0.3	25.4	17.9	1.0

Source: GNWT Bureau of Statistics (2002)

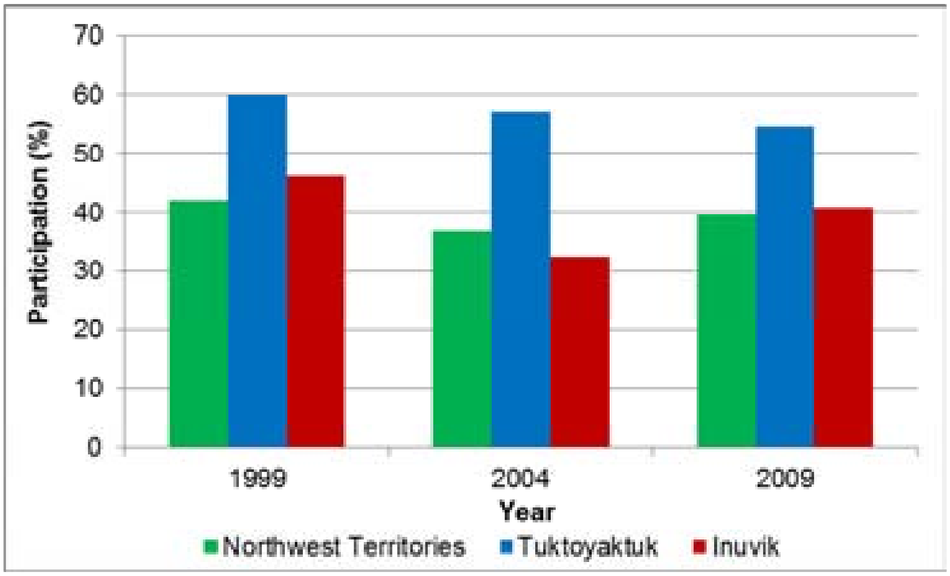
Figure 3.2.8-23 shows the percent of households that obtained half or more of meat and fish consumed by hunting and fishing in 2008. Tuktoyaktuk has the greatest percent participation.



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-23
Percent of Households that Obtained Half or More of Meat and Fish Consumed by Hunting and Fishing, 2008

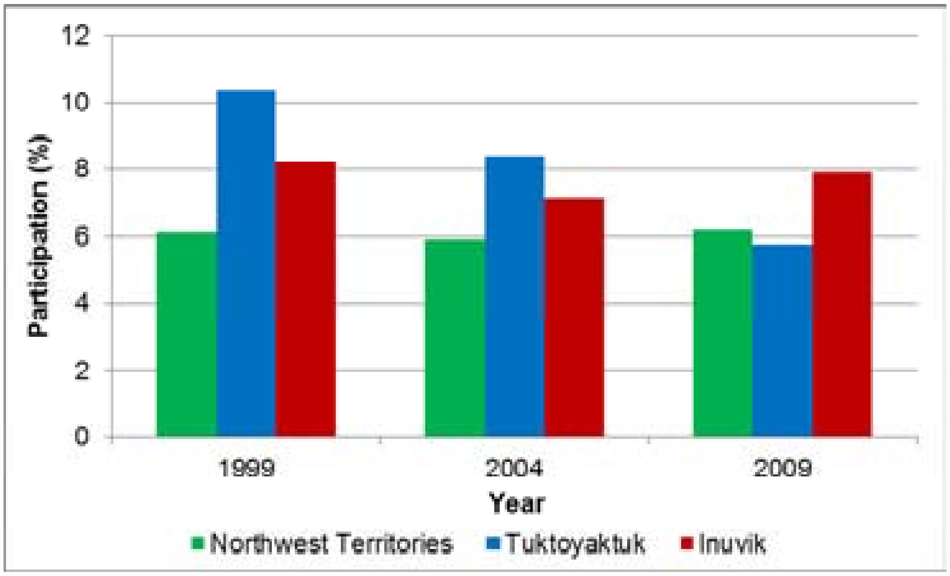
From 1999 to 2009 the percent of the population in Tuktoyaktuk, Inuvik and the NWT participating in hunting and fishing activities has decreased (Figure 3.2.8-24).



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-24
Persons 15 and Over Who Hunted or Fished in Previous Years, 1999-2009

Figure 3.2.8-25 shows the percent participation of persons 15 years of age and older who trapped between 1999 and 2009. There are no consistent trends that occur between Tuktoyaktuk, Inuvik, and the NWT.



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-25
Persons 15 and Over Who Trapped in Previous Years, 1999-2009

3.2.8.4 Encroachments and Restrictions of Harvesting Activities

Encroachments

Although there are few, if any, encroachments on current harvesting activities in the region, the recent approval of the Mackenzie Gas Project may change that. If constructed, the Mackenzie Gas facilities and pipelines would encroach upon harvesting areas within the Inuvialuit Settlement Region. Potential infrastructure includes the Parsons Lake Production Facilities and the Storm Hills Pigging Facility (NEB 2010). Project lead Imperial Oil Resources Ventures Limited has until the end of 2013 to indicate whether the Mackenzie Gas Project will be constructed in the near term.

Restrictions

Harvesting restrictions are a management tool implemented by co-management boards and the GNWT. As of 2010, harvesting restrictions are in place for certain wildlife species in the NWT including barren-ground caribou and grizzly bears.

Due to a decline in the barren-ground caribou population, barren-ground caribou hunting was closed to all hunters, including Inuvialuit beneficiaries, from July 1, 2006 to present in Area I/BC/07 (which includes the area of the proposed Highway). In Area I/BC/08, located to the north and east of Tuktoyaktuk, hunting for the Tuktoyaktuk Peninsula Herd is still permitted between June 16 and March 31. However, this area is closed for hunting from April 1 to June 15 to allow the Cape Bathurst caribou herd to migrate back to their calving grounds along the coast.

The Inuvialuit have exclusive harvesting rights to grizzly bear within the Inuvialuit Settlement Region. In 1987 the Tuktoyaktuk HTC expressed concern about over-harvesting of grizzly bears (Community of Tuktoyaktuk et al. 2000). The organization suggested that a quota be established, and the process of implementing a quota began (IDRC ND).

3.2.8.5 Harvesting Rights

The *Inuvialuit Final Agreement* provides the Inuvialuit with preferential harvesting rights to wildlife in the Western Arctic Region, subject to general laws such as public safety and conservation. Inuvialuit harvesting rights include:

- The preferential right to harvest all species of wildlife, except migratory non-game birds and migratory insectivorous birds, for subsistence usage throughout the Western Arctic Region;
- The exclusive right to harvest furbearers, including black and grizzly bears, throughout the ISR;
- The exclusive right to harvest polar bear and muskox throughout the ISR; and
- The exclusive right to harvest game on Inuvialuit lands and if, agreed upon, other areas (IRC 1987).

Fish are not considered “game” they are not included under the IFA exclusive harvest rights for Inuvialuit (Inuvialuit Regional Corporation 1987).

As well, the *Gwich'in Comprehensive Land Claim Agreement* (1992) provides the Gwich'in with certain harvesting rights to wildlife in the Western Arctic Region. In particular, according to Section 27.2.3, the Gwich'in have the right to harvest those species of wildlife which they have traditionally harvested within those areas of the Western Arctic Region which have been traditionally used by the Gwich'in to harvest wildlife.

3.2.8.6 Trapping, Outfitting and Related Area Use

Outfitting and trapping activities and related use areas are discussed in Section 3.2.9.2 of this report.

3.2.9 Land Use

The Tuktoyaktuk Peninsula, the Mackenzie Delta, and the Husky Lakes area have been occupied for several thousand years by the Inuvialuit, with recent in-migration by settlers from Europe and other countries of origin. There are several areas with traditional land use significance, and areas that are specially managed. Due to the rich natural resources in the area, industrial, transportation, and recreational land uses are prevalent and/or proposed for the future. The Inuvialuit continue to harvest and use many of the available natural resources, such as wildlife, waterfowl, fish, and berries.

Information regarding land uses along the proposed alignment of the Inuvik to Tuktoyaktuk Highway has been drawn from a number of sources. In October 2009 and January 2010, consultations and discussions were held with Elders, hunters and trappers, and community residents for this Project, as described in Section 1.6.2. In addition, information gathered during the consultation process for the Tuktoyaktuk to Source 177 Access Road Project Description Screening Report (Kiggiak-EBA 2008) was reviewed and incorporated. Further traditional knowledge information was collected from the Proposed Inuvik to Tuktoyaktuk Road Environmental/ Socioeconomic Baseline Report (Rescan 1999a). Other key sources of information include the Tuktoyaktuk Community Conservation Plan (TCCP) (Community of Tuktoyaktuk et al. 2008) and the Inuvik Inuvialuit Community Conservation Plan (IICCP) (Community of Inuvik et al. 2008).

Information from the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008) and the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008) are summarized in the following sections. Specific references from these reports are designated with a site number and land management category (e.g. 722C) as per the community conservation plan designation.

Representatives from each community organization, including the Tuktoyaktuk Hunters and Trappers Committee (HTC), Inuvik HTC, Tuktoyaktuk and Inuvik Community Corporations, Elders, and other community representatives coordinated development of the original TCCP and IICCP in 1993. In 2000 and 2008, updated editions were prepared by the Tuktoyaktuk HTC, Inuvik Inuvialuit HTC, the newly established Community Conservation Plan Working Group, the Wildlife Management Advisory Council (NWT), and staff from the Joint Secretariat.

3.2.9.1 Historic/Traditional Land Use

Tuktoyaktuk Peninsula

Tuktoyaktuk is located on a peninsula extending into Kugmallit Bay, east of the Mackenzie River Delta, on the Beaufort Sea coast. The name in Inuvialuktun means "resembling a caribou". It was formerly called Port Brabant, and the present name is commonly abbreviated to "Tuk". Tuktoyaktuk is located 122 km (76 mi.) by air or 177 km (110 mi.) by river northeast of Inuvik. In 1934, the Hudson's Bay Company chose this site as an alternative to Herschel Island and as the most suitable harbour in the region for shipping freight shipped down the Mackenzie River for distribution to Arctic coastal communities (Community of Tuktoyaktuk et al. 2008).

For generations, the Inuvialuit have inhabited the coastline from the United States (Alaska)-Canada border to Cape Bathurst. The primary land use patterns of the Inuvialuit in the Tuktoyaktuk region have centered on the Tuktoyaktuk-Kitigaaryuit area. Prior to 1890, the Inuvialuit had minimal contact with Europeans or others and lived a traditional harvesting lifestyle. This changed with the arrival of the American and European whaling ships at Herschel Island in 1890.

The influence of whalers and the spread of various diseases dramatically affected the local population and disrupted previous traditional subsistence patterns. The large settlement at Kitigaaryuit was abandoned just after the turn of the century. The previous local groupings of Inuvialuit became blurred as intermingling of the local Inuvialuit population occurred with whalers and Alaskan Inupiat who had come into the region with the whalers. With the collapse of the whaling economy around 1910, the region suffered a major economic downturn. Many of the whalers remained in the region and established trading and fur posts.

The expansion of trapping areas in the 1920s was attributed to high fur prices and an increase in boat ownership. During the 1950s, the decline of fur prices and the beginning of DEW Line construction at Tuktoyaktuk caused a shift in land use from the surrounding areas into the community, resulting in a temporary contraction of the areas used for hunting and trapping. However, with the introduction of the snowmachine, the Inuvialuit have again moved into these areas (Community of Tuktoyaktuk et al. 2008).

Exploration for petroleum began in the late 1950s, and by the 1970s and 1980s, increased industrial activity created major economic changes in the region. The continued decline in the fur market and the availability of employment with industry shifted large numbers of people into a wage based economy. The decline of oil and gas exploration activity in the early 1990s created a high level of regional unemployment. This continued until the early 2000s with the return of petroleum exploration, and ended again by 2010. Guided sports hunting in the winter and other forms of tourism during the summer have provided employment for a few people. The potential for tourism in the region remains strong due to the location of Tuktoyaktuk on the Beaufort Sea coast and its proximity to Inuvik and access to the south (Community of Tuktoyaktuk et al. 2008).

The majority (75%) of households continue to supplement their wage earnings by deriving a portion of their food from hunting and fishing. Wage employment generally limits the time available to travel to weekends and holidays. This increases the residents' dependence on hunting/fishing areas that are located close to the community, within 100 km (Community of Tuktoyaktuk et al. 2008).A profile of Tuktoyaktuk's population, demographics and community services is provided in Section 3.2.1.

Inuvik

Inuvik is located on the East Channel of the Mackenzie River Delta. It lies at the treeline and is located 97 km south of the Mackenzie Bay on the Beaufort Sea. The name "Inuvik" means "living place".

The Inuvik town site was first surveyed in 1955 and a permanent settlement was established in 1958 when, due to yearly flooding and erosion, the federal government moved its regional offices from Aklavik to the present site of Inuvik. It was originally intended that all government services and employees, as well as the local population would be relocated from Aklavik to the new Town of Inuvik. However, many of the Inuvialuit and Gwich'in residents decided to remain in Aklavik and the settlement continues to exist today. The Mackenzie Hotel, Recreation Hall, Polaris Theatre, RCMP Building and several small houses (known as "512s" due to their 512 sq. ft size) were some of the first buildings to be built in Inuvik, but many of the residents remained living in tents by the river until public housing was completed (Community of Inuvik et al. 2000).

Most of the Inuvialuit that moved to Inuvik were from the Mackenzie Delta region, but many had family ties with other settlements around the delta and even Alaska. John Keevik was the last elected Inuvialuit Chief for the Mackenzie Delta in approximately 1953, well before any land claim was proposed (Community of Inuvik et al. 2000).

The Canadian Armed Forces moved to Inuvik and left in 1986, when satellite communication replaced the need for a staffed base (Community of Inuvik et al. 2000). During the 1960s, people remember turning on their radios for the first time to listen to Wally Firth and Nellie Cournoyea for messages and announcements (Community of Inuvik et al. 2000).

Like Tuktoyaktuk, Inuvik also benefited from oil and gas exploration and despite the boom-bust cycle of activity referred to earlier, the community remains the local headquarters for industry companies exploring in the region, both onshore and offshore.

Inuvik is the regional government centre and transportation and recreation hub for the Mackenzie Delta region. The airport, government services, recreational programs and hospitality industry attract residents from neighbouring communities and tourists. A profile of Inuvik's population, demographics and community services is provided in Section 3.2.1.

The Inuvialuit traditionally hunted and fished in the region where Inuvik is now situated. Historically, trapping muskrat, fox and other furbearers created employment and prosperity in the area but has declined significantly as a result of lower fur prices. Most Inuvialuit do not trap as regularly or as extensively as in the past but some still trap occasionally on weekends and in the spring for muskrats on the Delta. Subsistence harvesting of animals and plants remains important to the Inuvialuit community (Community of Inuvik et al. 2000).

3.2.9.2 Current Land Uses

Existing land uses are identified in Figure 3.2.9-1 and are described below.

Traditional Use/ Special Harvesting Areas

There are several areas in the vicinity of the proposed Primary 2009 Route that are used for traditional or harvesting purposes or have special interest or values between Inuvik and Tuktoyaktuk.

Gungi – also spelled 'gunny', roughly translated means "bottom of the bay." During the consultations held in Tuktoyaktuk on November 21, 2008 for the proposed access road to Source 177 (Kiggiak-EBA 2008), many residents indicated that the area to the south of Tuktoyaktuk, including the Gungi area at the south end of Tuktoyaktuk Harbour and further south towards Big Lake (Ilkaasuat), is used regularly during the summer months for picnicking and berry picking. The residents indicated that a road would allow them to carry on these activities more easily in the future.

Husky Lakes Area – is considered by the residents of Tuktoyaktuk and Inuvik to be very important for year-round hunting, trapping, fishing, and recreation and for seasonal berry picking. The lakes provide spawning habitat for herring and lake trout. The Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2000) reported that fish harvesting has been typically concentrated in the upper parts of Husky Lakes around Saunatuk, Zieman Cabin and Stanley Cabin. Community of Tuktoyaktuk et al. (2000) also suggests that harvesting use has been more limited to the west of Husky Lakes (including the vicinity of the Inuvik to Tuktoyaktuk Highway alignment). Information for the harvest locations of key species is found in Section 3.2.8.

Fishing Areas – Big Lake (Ilkaasuat or "fishing area") was identified as a popular fishing area for lake trout and pike. Residents stated that a road would allow easier access to this fishing area (Kiggiak-EBA 2008; Rescan 1999a). In 1999, residents from Tuktoyaktuk suggested that people do not fish along the proposed route, but they do fish further to the east, so the Highway would not affect their fishing areas. Inuvik residents identified Husky Lakes as important fishing areas, and were concerned that traffic and industrial activity associated with the Highway may negatively affect the lakes. They suggested that the Highway be moved further away from the lakes. This request was accommodated in the alternative routing options. Fish lakes include Jimmy Lake, Noell Lake, and Parsons Lake. Further information about the fish harvesting area located near the proposed Highway is found in Section 3.2.8.

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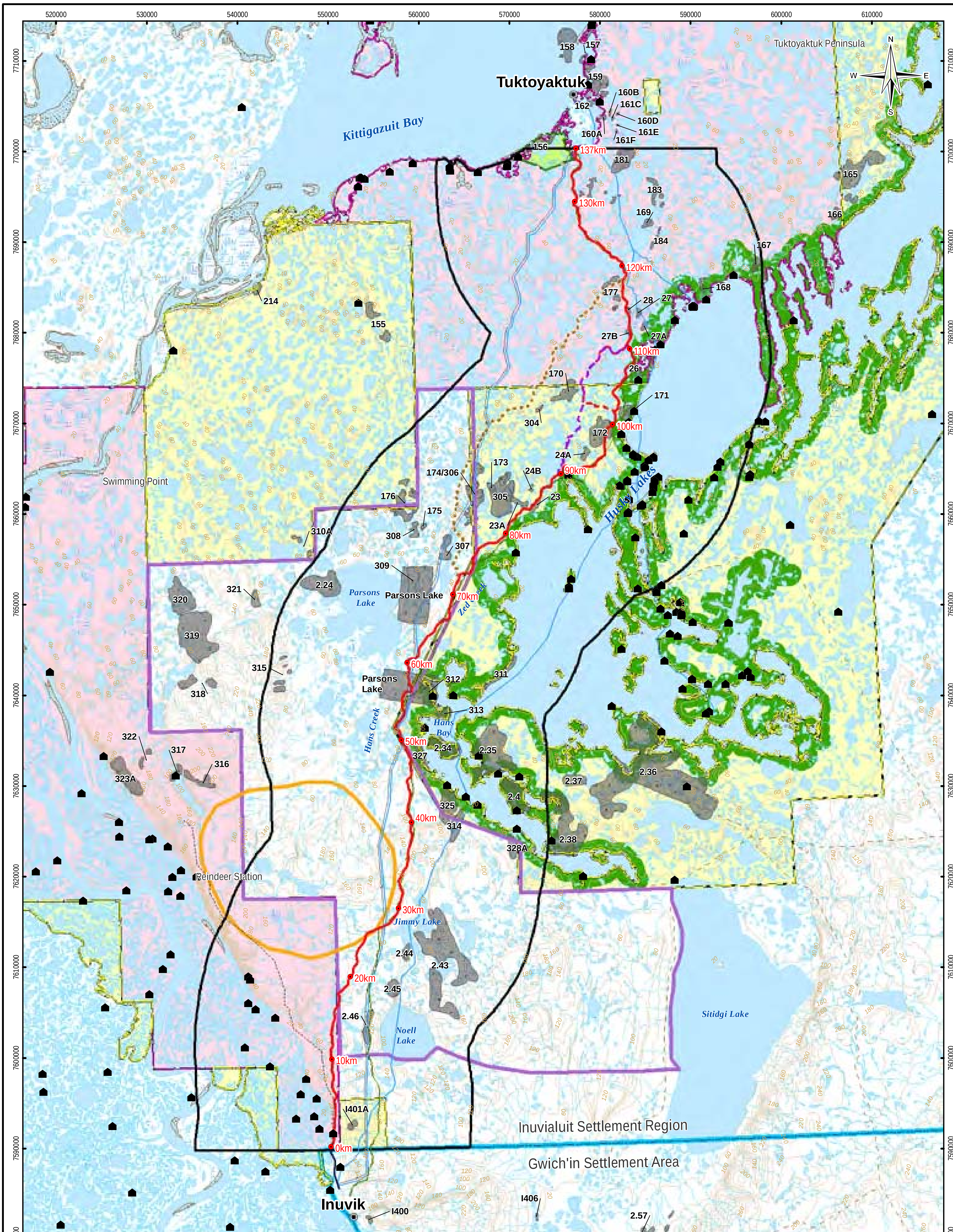

LEGEND

- Residential Leases
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Approximate Winter Reindeer Range
- Approximate Allotment B
- Borrow Sources
- Husky Lakes 1000m Setback
- Former Powerline
- Ikhil Gas Pipeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, Powerline, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Existing Land Uses

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
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PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.2.9-1

Hunting and Trapping Areas – during consultations, Tuktoyaktuk residents stated that there is limited hunting from Inuvik to Husky Lakes, but that hunting usually occurs around Parsons Lake. It was further stated that the proposed Highway would be good for hunters and trappers. According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), only wolves and wolverines are harvested in the area of the proposed Highway.

Specific areas related to current wildlife, waterfowl and fish harvesting are identified in the Harvesting Section (Section 3.2.8).

Traditional and Historical Cultural Areas - according to the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008), traditional and historical cultural areas are identified in areas east of Husky Lakes (Map 15), not in the vicinity of the proposed Highway.

According to the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008), traditional Inuvialuit camps and cultural sites have been identified but are not available to the public on maps.

Traditional Trails

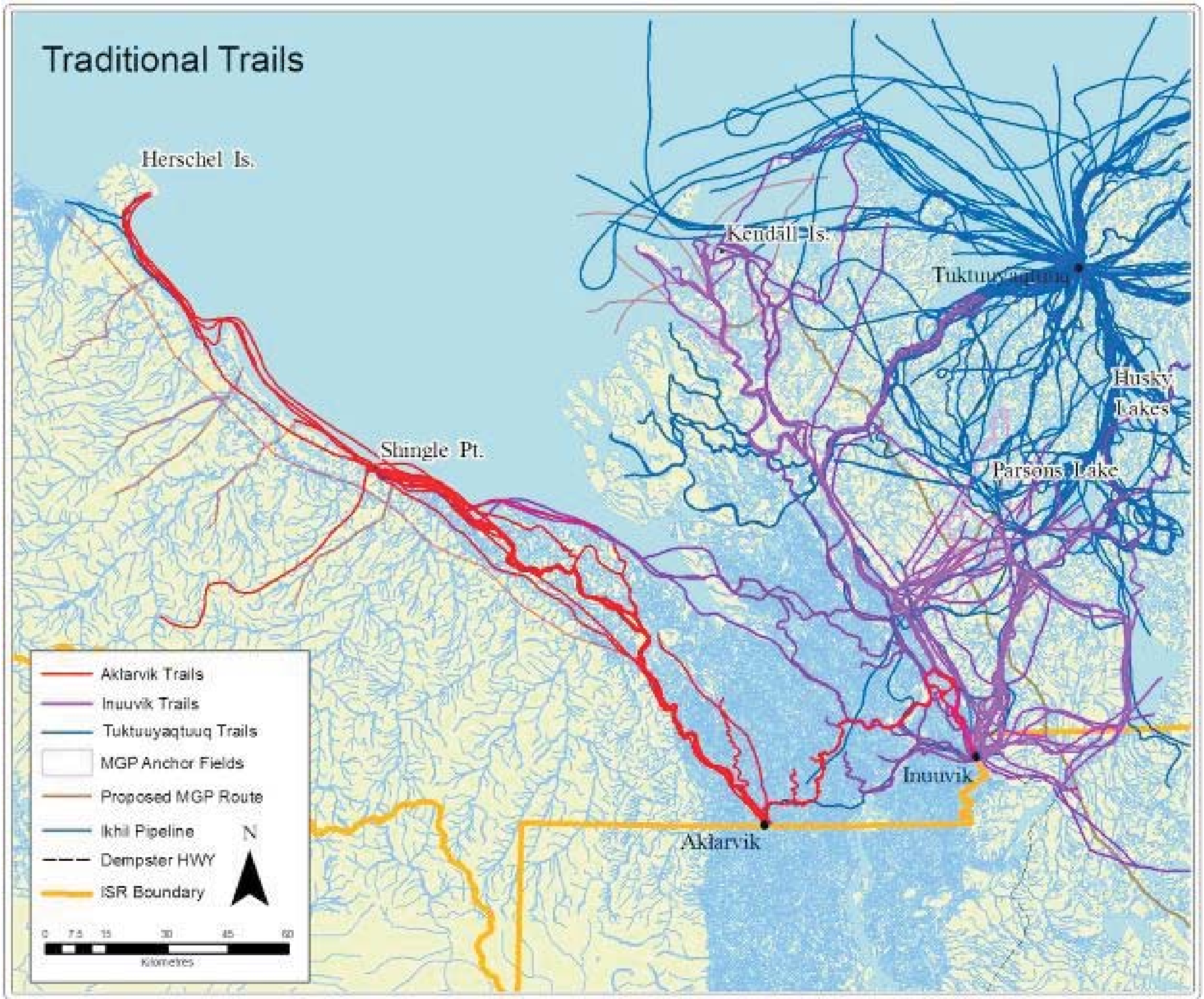
Since the introduction of snowmachines, winter access trails are developed each winter as needed that allow residents of Tuktoyaktuk and Inuvik to pursue recreational, hunting, trapping and other activities on the Tuktoyaktuk Peninsula and in the Mackenzie Delta, including in the general area of the proposed Highway. Several routes that are established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figures 3.2.9-1 and 3.2.9-2). The October 2009 consultations sessions confirmed that many families have and continue to use the traditional winter routes to the Husky Lakes.

Seasonal and Permanent Camp Areas

According to ILA records, there are currently 118 registered leases located throughout the Husky Lakes area with the heaviest concentrations of cabins present in the narrows northwest of Five Hundred Lakes and to a lesser extent around Whale Point and Portage Point at the southern limit of Husky Lakes (Figure 3.2.9-1).

According to the Tuktoyaktuk CCP (Community of Tuktoyaktuk et al. 2008), there are approximately 25 recreational, educational and trapping cabins located throughout the area. Locations of residential leases are identified in Figure 3.2.9-1; locations of cabins are identified in Figure 3.2.9-3 (ICC et al. 2006).

Specific types of cabin use, such as individual, recreational and commercial use is not available.



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NOTES

1. Source: Figure 20. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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Town of Inuvik

Northwest Territories

KIGGIAK - EBA

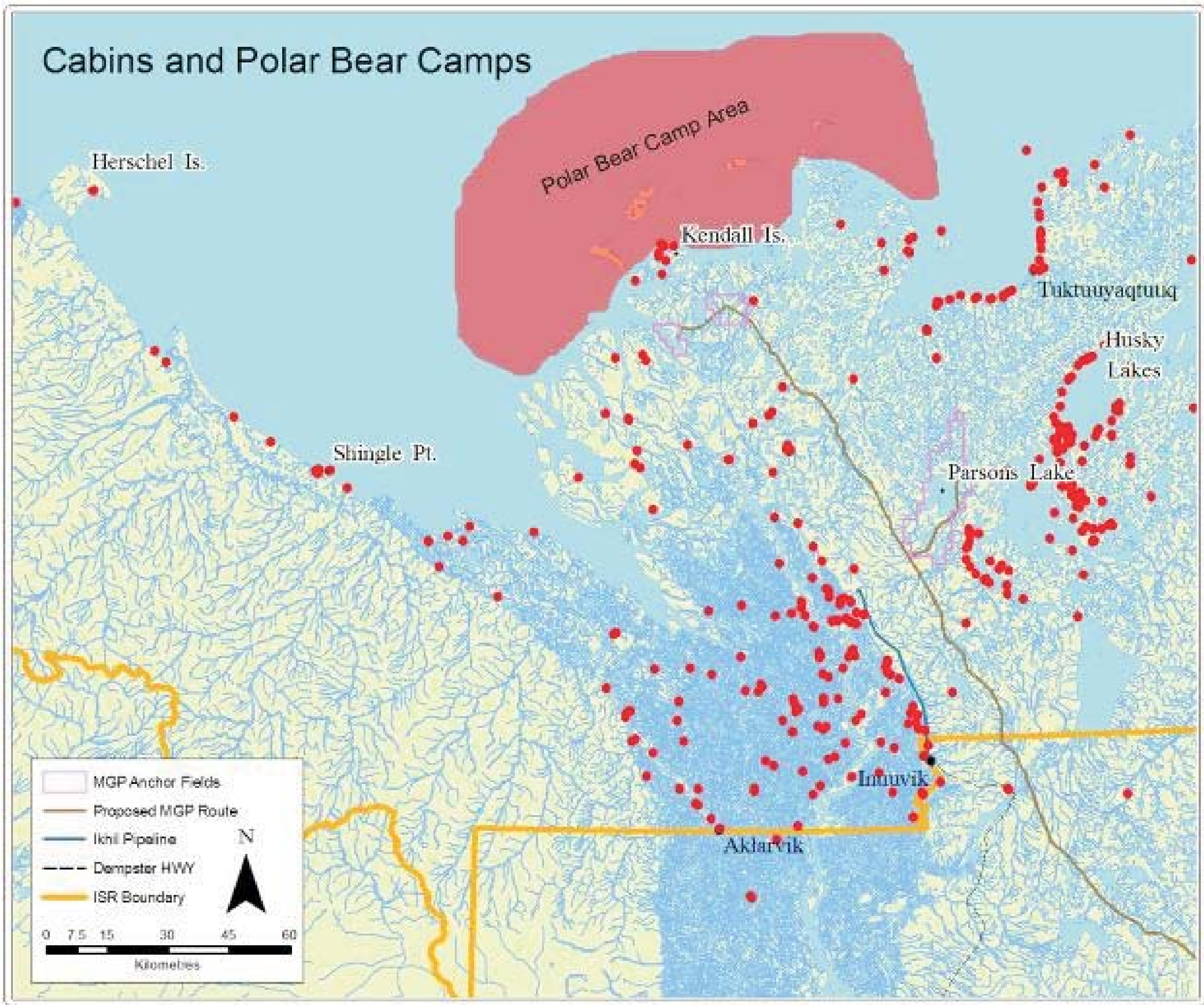
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Traditional Trails

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	March 15, 2011

Figure 3.2.9-2



NOTES

1. Source: Figure 9. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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Northwest Territories

KIGGIAK - EBA

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Cabins and Polar Bear Camps

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	March 15, 2011

Figure 3.2.9-3

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Parks and Recreation Areas / Protected Areas

Pingo Canadian Landmark (728E) - The area around Tuktoyaktuk has the greatest concentration of pingos. In particular, the Ibyuk Pingo is 50 m (164 ft) tall, and is approximately 1,000 years old. The Landmark is located approximately 4 km (2.4 mi) southwest of Tuktoyaktuk, covering a total of 16.4 km^2 (6.3 mi^2).

This area is protected under the *Canada National Parks Act* and *Western Arctic (Inuvialuit) Claims Settlement Act*. The proposed Highway is not located in this area (Community of Tuktoyaktuk et al. 2008).

Transportation Corridors

Tuktoyaktuk to Source 177 Access Road - A 19 km access road from Tuktoyaktuk to a nearby granular source was completed in 2010. The road follows the same general route as originally selected for the northernmost 19 km of the proposed all-weather Highway between Inuvik and Tuktoyaktuk. The alignment is located entirely on Inuvialuit Private Lands.

Winter Road - Every year a winter road is constructed between Inuvik and Tuktoyaktuk. This transportation link allows residents and businesses to transport people and goods between communities. According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the winter road allows Tuktoyaktuk residents to access cheaper goods in Inuvik and to conduct banking in Inuvik.

According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the winter road is not used for harvesting as people typically use their snowmachines for harvesting.

Winter Access Trails - As noted above, snowmachine trails are developed each winter as needed for recreational, hunting, trapping and other activities in the region including the general area of the proposed Highway. Several routes that become established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figure 3.2.9-1).

The consultations sessions held in October 2009 confirmed that many families have and continue to use the traditional winter routes to the Husky Lakes. The consultations also identified a second, more overland route, which generally followed the alignment of the former Northern Canada Power Commission (NCPC) power line right-of-way (ROW) that extended from Inuvik to Tuktoyaktuk (Figure 3.2.9-1).

Summer Access Trails - According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the Husky Lakes is not accessed much during summer months.

Granular Resources

Information regarding the material resources available in the Regional Study Area is located in Section 2.6. Before any removal of sand or gravel from Inuvialuit lands, a license must be obtained from the Inuvialuit Land Administration. The IFA contains various conditions on rights, fees and royalties payable (INAC 1997).

Industrial Zones

There are no areas designated specifically for industrial development within the non-municipal areas of the ISR. According to the Mackenzie Delta-Beaufort Sea Regional Land Use Planning Commission, the land classification system was developed to "contribute to conservation of important resource areas without necessarily formal legal designation… their intent is not to foreclose economic development in the region… rather, classifying the lands defines the conditions under which conservation and utilization can be assured" (MD-BSRLUPC 1991). Therefore, there are no specific industrial zones; rather, land uses may be proposed within areas that allow for that type of land use (e.g., Management Categories A to E).

The Town of Inuvik has zones for light industrial and heavy industrial development (Town of Inuvik 2008).

3.2.9.3 Land Use Designations

Land Management Categories

According to the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans, the proposed Highway alignment passes through several special management areas. In general, the Highway is located in the areas with Management Categories "B", "C" and "E" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "B" means that the "lands and waters where there are cultural or renewable resources of some significance and sensitivity but where terms and conditions associated with permits and leases shall assure the conservation of these resources" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "E" means that the "lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Figure 3.2.9-4 shows the all-site designations in the Inuvik Planning Area in relation to the proposed Highway. The all-site designations for the Tuktoyaktuk Planning Area are similar to the Inuvik Planning Area, in the Project RSA.

Areas of High Conservation Value/ Ecological Sensitivity or Importance

The special management areas that the proposed Highway is located in, or in the vicinity of, are described below, and are shown on Figure 3.2.9-5.

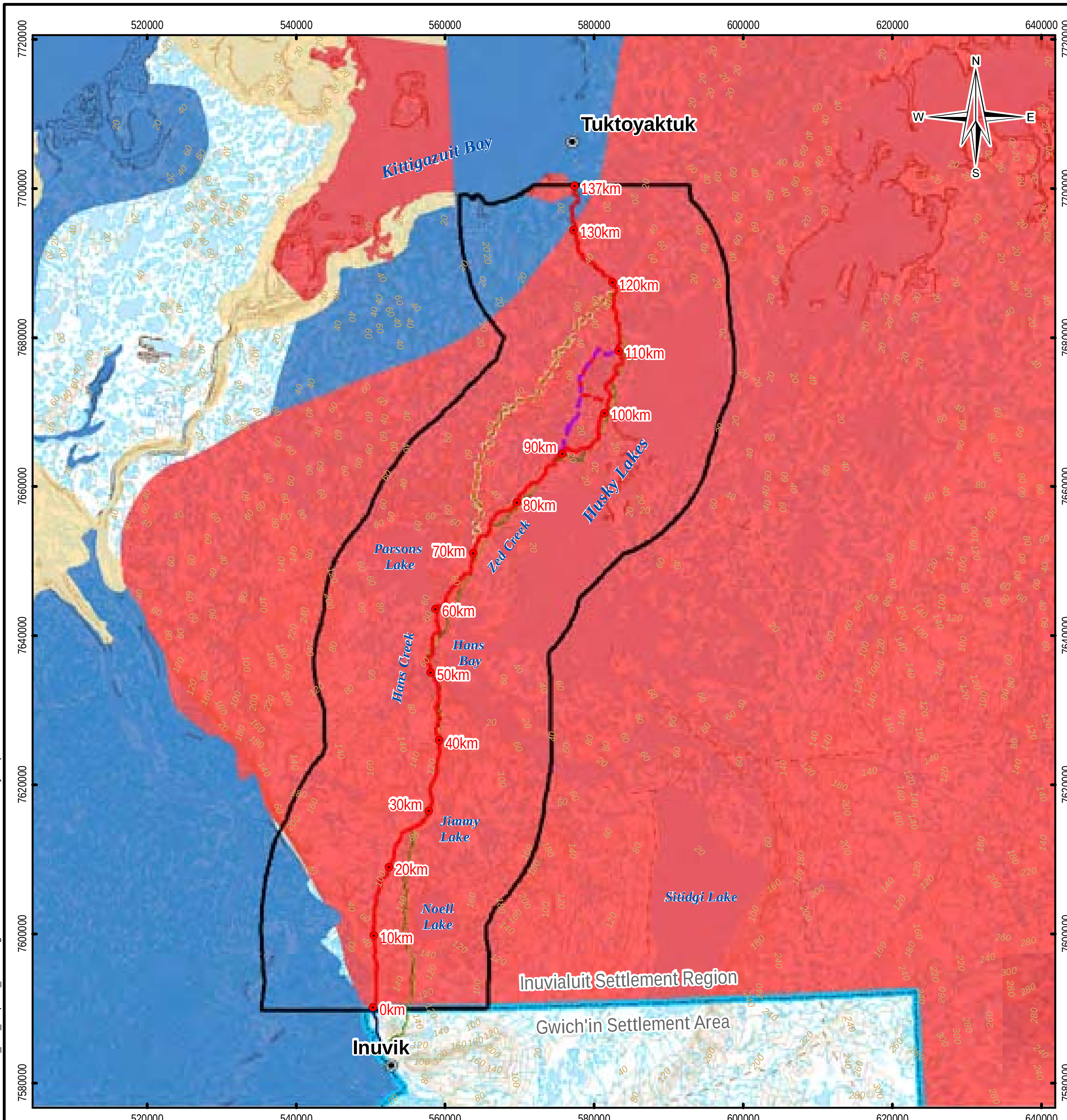
Critical Grizzly Bear Denning Areas (322C) - Grizzly bears make their dens over an expansive area between October and May each year. The proposed Highway is located within this area.

Caribou Hills (702B) - The Caribou Hills management area is in the middle of the Mackenzie Delta, with a unique transition zone between alluvial taiga and low tundra habitats. It has a unique successional plant life and is an important subsistence berry picking and harvesting area. A portion of the proposed Highway is located within the Caribou Hills area.

Fish Lakes and Rivers (704C) - The northern portion of the proposed Highway is located within Fish Lakes and Rivers management area which includes the rivers and lakes along the shoreline west of Tuktoyaktuk, inland to their headwaters, as well as Parsons and Yaya Lakes. These lakes and rivers are important fish habitat and important historical and current subsistence harvest areas used by the residents of Tuktoyaktuk and Inuvik. The proposed Highway is located within this area.

Husky Lakes (705E) - The Husky Lakes management area is adjacent to a portion of the proposed route of the Inuvik to Tuktoyaktuk Highway. The Husky Lakes and the area surrounding the lakes provide important historical and current subsistence fishing, trapping, hunting and berry picking areas. There are approximately 25 recreational, educational and trapping cabins located throughout the area. The Lakes are an important spawning area for Pacific herring, lake trout and beluga (Community of Tuktoyaktuk et al. 2008).

The Husky Lakes area is considered by the residents of Tuktoyaktuk and Inuvik to be very important for year-round hunting, trapping, fishing, and recreational use and for seasonal berry picking. The lakes provide spawning habitat for herring and lake trout. The TCCP (Community of Tuktoyaktuk et al. 2008) reported that fish harvesting has been typically concentrated in the upper parts of Husky Lakes around Saunatuk, Zieman Cabin and Stanley Cabin. Community of Tuktoyaktuk et al. (2000) also suggests that harvesting has been more limited to the west of Husky Lakes (including the vicinity of the Highway alignment).



LEGEND

Site Designation

- Management Category "B"
- Management Category "C"
- Management Category "D"
- Management Category "E"
- Gwich'in / Inuvialuit Boundary
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES

Base data source: NTS 1:250,000
Site Designations: Joint Secretariat, Inuvik CCP November 2008

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

All Site Designations in the Inuvik Planning Area

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

10 5 0 10 20

Kilometres

FILE NO.
V23201322_EIS_Map056_SiteDesignations.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 17, 2011

Figure 3.2.9-4

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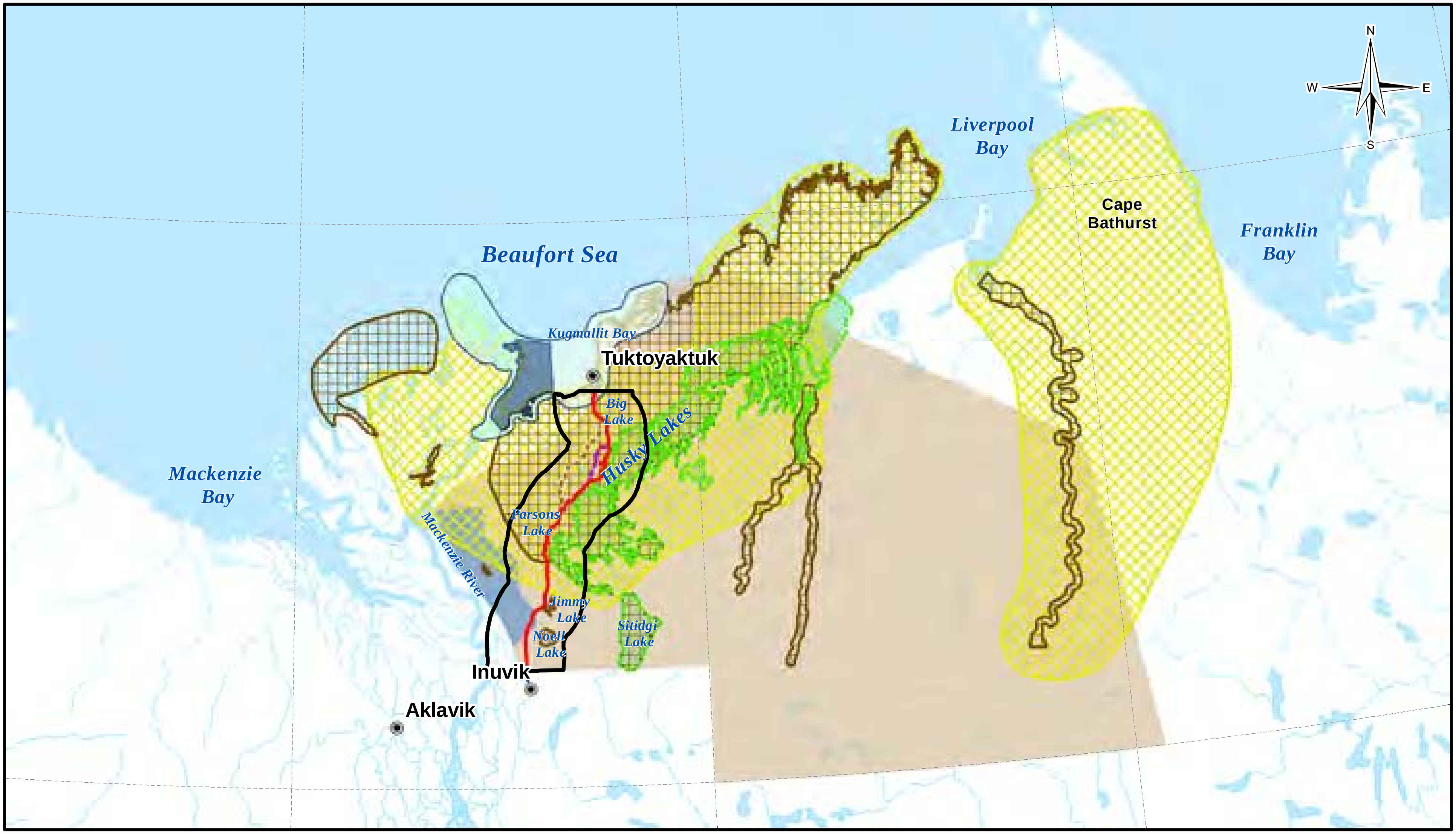

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 322C-Grizzly Bear Denning Areas
- 701E-Bluenose-West Winter Range
- 702B-Caribou Hills
- 704C-Fish Lakes and Rivers
- 705E-Husky Lakes
- 728E-Pingo Canadian Landmark
- 714C-Kugmallit Bay
- 714D-Kugmallit Bay
- 714E-Kugmallit Bay
- Watercourse
- Waterbody

NOTES
Base data source: National Atlas
Management Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

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Scale: 1:2,250,000
20 10 0 20 40 60 80
Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map028_SpecialMngt.mxd

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Special Management Areas

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 17, 2011

Figure 3.2.9-5

The Husky Lakes Integrated Management Planning Study completed in 2001 suggested that the area was already under pressure and that local people were concerned about the deterioration of the "specialness" of Husky Lakes due to increased garbage and crowding from increasing numbers of cabins and residential leases (Hoyt 2001). At that time, there was concern that land use activities could affect the traditional ways of life. As reported in Hoyt (2001), the region was considered to be vital to the community as a place where families could spend time together and pass on the skills and culture of the Inuvialuit.

The EIRB (2009) prepared a draft guidance document for proposed developments in the Husky Lakes Area entitled "Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area (Area Number 2, Annex D, *Inuvialuit Final Agreement*)". This document is a draft update from the version adopted in 2002.

In accordance with the anticipated revisions to the Husky Lakes criteria and the direction provided by the ILA, the initial Primary 2009 Route was re-routed to maintain a minimum setback of 1 km from the boundary of the Husky Lakes Special Management Area, with the exception of one area of encroachment. Alternative alignments have since been developed that do not encroach upon this setback.

This Environmental Impact Statement outlines the methods that will be employed to conform to EIRB's criteria for establishing environmental standards. EIRB's draft criteria are:

Traditional and Beneficiary Usage - Developments shall not produce air conditions, vibrations, noise levels, or any other disturbance that interfere with beneficiaries' use of the Husky Lakes Area.

Development Footprint - Developments shall be carried out so that the area occupied by the project site is no larger than necessary. Ideally, after final remediation, there will remain no evidence of environmental disturbance in and about the development site.

Land-Use Conflicts - Developments shall avoid conflicts with community and beneficiary use of the land. Traditional land use activities will have priority over development activities.

Archaeological and Heritage Resources - Developer must take all reasonable steps to identify, locate and protect known and unknown heritage resources in the Husky Lakes Area.

Flora - Developments will be carried out in such a manner that plants are preserved and undisturbed to the greatest extent possible. Reasonable efforts must be taken to identify and protect areas of rare, at risk, and traditional use plants in the Husky Lakes Area

Water Quality - Developments in the Husky Lakes Area must not result in any adverse impact to the ambient hydrological regime taking into consideration seasonal variations.

Air Quality - Air emissions resulting from a development in the Husky Lakes Area must meet the most current Canadian and Northwest Territories air quality standards.

Soils - Developments must proceed in such a manner that the native soils and any imported project materials (e.g. aggregate, rock, crushed stone) are used in the most appropriate manner to minimize soil degradation and not significantly affect other lands, waterbodies, or marine areas. Every effort shall be made to preserve native soils.

Sediments - Developments must not disturb benthic soils and organic/inorganic materials in any manner that would adversely impact the water quality and/or quantity of that waterbody or feeding/receiving waters beyond seasonal variations.

Kugmallit Bay (714C) - The area managed under category 'C' consists of the eastern portion of Kugmallit Bay. Whales concentrate in these shallow, warm, brackish and highly turbid waters to calve, rear calves, moult and/or socialize. The area is an important historical and current beluga whale subsistence harvesting area from June 15 to August 15.

Creek Crossings – According to the Tuktoyaktuk and Inuvik HTCs, the proposed Highway crosses several creeks where fishing has taken place. These include Jimmy Creek, Trail Creek, Hans Creek and Zed Creek. Further information regarding creeks along the proposed Highway alignment is available in Section 3.1.7.

Caribou Protection Measures

Caribou are protected from harvesting by hunting restrictions. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to declining caribou populations.

Caribou Feeding Areas - According to the Tuktoyaktuk Elders traditional knowledge interviews conducted in 1999, the main feeding area for caribou is along the shore of Husky Lakes. They said the caribou migrate along the shore of the lake, and not on higher ground (where the proposed Highway is) as there is not much food available at the higher elevation. Several Elders stated that the proposed 1999 alignment would not affect caribou (Rescan 1999a). More information about caribou related to harvesting is found in Section 3.2.8.

Bluenose-West Caribou Herd Winter Range (701E) - This area provides important winter habitat for the Bluenose-West caribou herd, which are valued for year-round subsistence harvest. The proposed Highway is located within the Bluenose-West caribou's winter range.

3.2.9.4 Valued Locations and Attributes

Aesthetic Locations

Areas with aesthetic values were not identified during consultation or in the Tuktoyaktuk or Inuvik Inuvialuit Community Conservation Plans.

Special Interest or Valued Locations

Culturally Significant Sites – According to Tuktoyaktuk residents, and supported by historical and archaeological records, the area around Husky Lakes was subject to intermittent, violent conflict between Dene and Inuvialuit individuals and groups.

Saunatuk, although well removed from the proposed alignment of the Inuvik to Tuktoyaktuk Highway, is a particularly important and culturally significant site. It is located on a long sandspit that separates the second Husky Lake from the third Husky Lake. Archaeological work conducted at the site validates the traditional stories of violent conflict between the Dene and the Inuvialuit. More information about the heritage resources in the area is available in Section 3.2.10.

3.2.9.5 Past and Present Non-Traditional Land Uses

The land between Inuvik and Tuktoyaktuk is currently used for a variety of purposes, which are described in this section, as shown on Figure 3.2.9-1.

Ikhil Gas Development and Pipeline Project

The Ikhil Gas Development and Pipeline Project is located approximately 50 km north of Inuvik in the Caribou Hills. It consist of two producing gas wells, associated feeder lines, a small gas processing plant and a 50 km long, 168.3 mm diameter buried gas pipeline. The pipeline extends south to a pressure regulation and metering facility near the Northwest Territories Power Corporation power plant in Inuvik. The project was developed during the period 1997 to 1999 and is expected to be in service for the foreseeable future.

The buried gas pipeline approaches the proposed Inuvik to Tuktoyaktuk Highway alignment at KM 5 and then runs parallel to the proposed Highway alignment heading south towards the end of Navy Road in Inuvik.

Former Northern Canada Power Commission (NCPC) Power Line

In 1972, a 144 km wooden pole power (transmission) line (69 kV) was constructed by the NCPC from Inuvik to Tuktoyaktuk, the only line of its type in the world north of the Arctic Circle (NTPC 2009b). The route of this former power line is shown in Figure 3.2.9-1.

Due to high maintenance costs, this line was abandoned and salvaged in the late 1980s. The former power line ROW was used as a winter trail between Tuktoyaktuk and Inuvik and also helped harvesters on the land to determine their location (G. Colton, NTPC, pers. comm. 2009). Today little physical evidence remains of the former NCPC power line.

Seismic Lines

Since the 1960s the most extensive non-traditional land use that has occurred in the Mackenzie Delta, including the area in the vicinity of the proposed Highway, has been seismic exploration. For example, in the 41,105 ha Parsons Lake Study Area defined for the Mackenzie Gas Project, approximately 1.5% of that area had been subjected to seismic lines and associated activities (IOL et al. 2004). Although from the air the vegetation along the seismic lines sometimes appears to have a different colour, on the ground, little physical evidence remains of these seismic programs.

Oil and Gas Well Sites

A number of exploratory oil and gas wells were completed by Imperial Oil close to the proposed Highway right-of-way near Tuktoyaktuk on the Tuktoyaktuk Peninsula. Thirteen wells were drilled in the mid-1980s during Imperial Oil's Tuktoyaktuk Tertiary program. In addition, Gulf Canada drilled a number of exploratory and development wells in the Parsons Lake area in the early 1970s.

3.2.9.6 Proposed Future Land Uses

Figure 3.2.9-6 identifies the locations of known proposed future projects that may be developed in the region.

Mackenzie Gas Project

Developing a natural gas pipeline from the Mackenzie Delta through the Northwest Territories to southern markets has been contemplated for many years. Various pipeline projects have been proposed during the last 40 years that consider economics, regulatory requirements, socio-economic and environmental conditions, and engineering and geotechnical issues in the decision-making process (IOL et al. 2004).

The proponents of the proposed Mackenzie Gas Project include Imperial Oil Resources Ventures Limited Partnership (IOL), ConocoPhillips Canada (North) Limited (ConocoPhillips), ExxonMobil Canada Properties (ExxonMobil), Shell Canada Limited (Shell) and Mackenzie Valley Aboriginal Pipeline Limited (MVAPL) partnership.

The proposed project would see development of three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and the transportation of natural gas and natural gas liquids (NGLs) by pipeline to southern markets (Figure 3.2.9-6).

The project recently received approval from the National Energy Board and the federal cabinet. The Mackenzie Gas Project partners have until December 31, 2013 to decide whether they will go ahead with the construction of the $16.2-billion project.

Parsons Lake Gas Field Associated Infrastructure and Gathering Pipeline

The Parsons Lake gas field, owed by ConocoPhillips, is located about 55 km southwest of Tuktoyaktuk and 70 km north of Inuvik (Figure 3.2.9-6). The production facilities at the Parsons Lake field will be located on two gravel pads, the most northerly and larger of which will be near the northeast shore of Parsons Lake. The north pad, which will accommodate the gas conditioning facility, camp, fuel storage, and other associated infrastructure, is proposed to be built first. The connection to the Mackenzie Gas gathering system will also be located at the north pad. The second, smaller well pad will be constructed about five or six years later and will be located about 14 km from the north pad at a location south of Parsons Lake. An elevated two-phase flow line will transport natural gas from the south pad to the north pad's gas conditioning facility (ConocoPhillips 2004).

The Parsons Lake gathering pipeline (Parsons Lake lateral) will originate from the gas conditioning facility located on the north pad and will head south around Parsons Lake. From there, the buried lateral will continue southwest between West Hans Lake and East Hans Lake to the Storm Hills Junction (Figure 3.2.9-6).

Tuktoyaktuk Harbour Project

The harbour at Tuktoyaktuk is the only existing natural and active port along the Canadian Beaufort Sea coastline. It has served as the primary base for offshore oil and gas exploration in the 1970s and 1980s. With the recent renewed interest in Beaufort Sea exploration and the possible development of the Mackenzie Gas Project, Tuktoyaktuk harbour may again play an important role as an offshore logistics and service centre for the oil and gas industry.

Currently, the Tuktoyaktuk harbour can only be used by vessels with a draft of 13 feet (4 m) or less. Drillships, ice breakers and supply boats with a draft deeper than 13 feet cannot enter the harbour. With the projected melting of summer ice in the Northwest Passage, the expected increase in global marine traffic through the north and anticipated Beaufort Sea oil and gas exploration and possible development, there could be a need for a harbour for deeper draft vessels. Both government and industry have expressed an interest in developing the Tuktoyaktuk harbour to support deeper draft vessels and proposals for such potential development may be forthcoming.

The option to bring modules for the Parsons Lake gas field through the Beaufort Sea to Tuktoyaktuk is currently under study by ConocoPhillips. To date no formal proposal for the development of Tuktoyaktuk harbour has been put forward.

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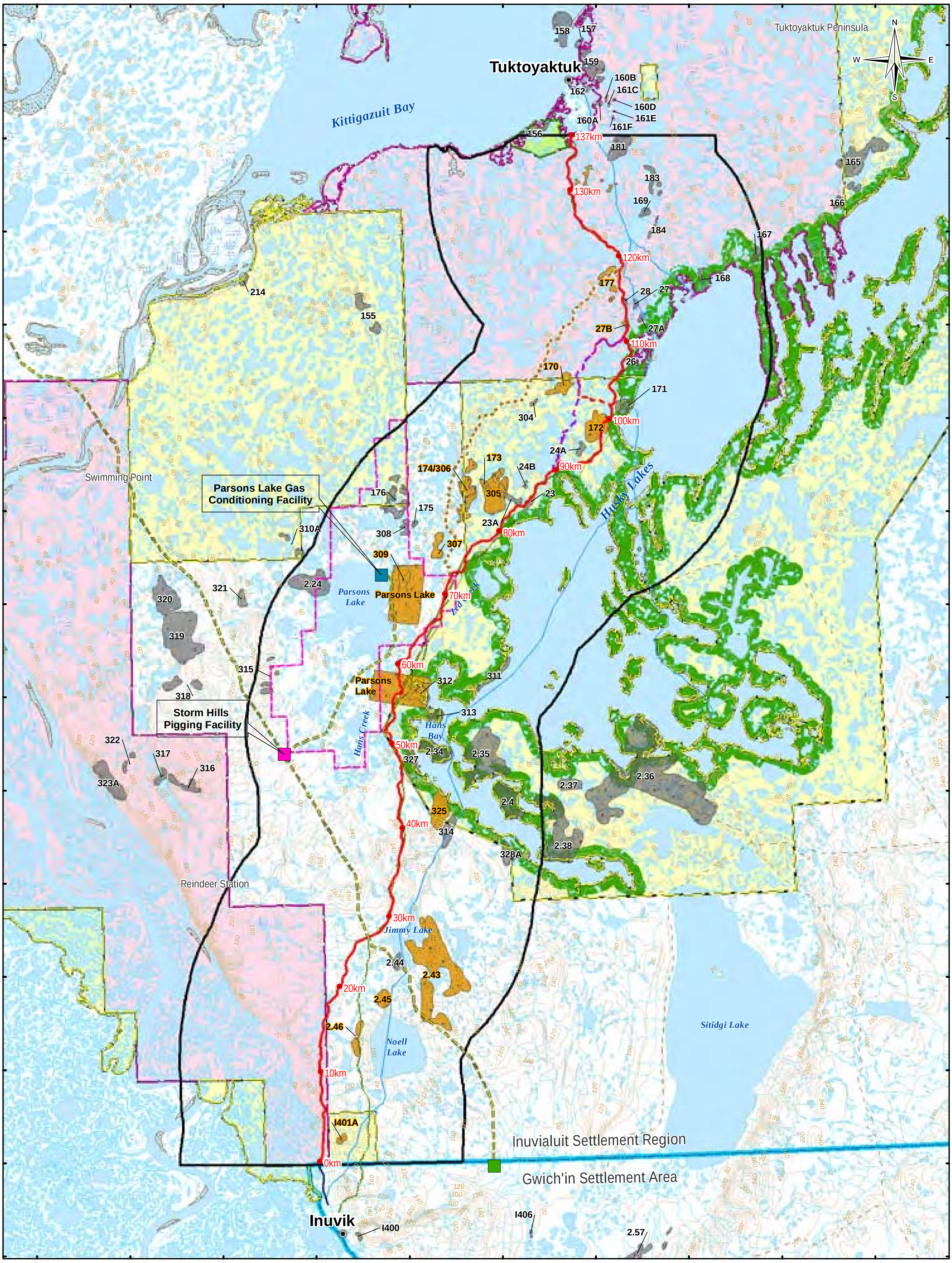

LEGEND

- Facility Site
- Gas Conditioning Facility
- Pigging Facility Site
- Route of Gathering Pipelines
- Significant Discovery Licence Area
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration
Mackenzie Gas Project 2004

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Proposed Future Land Uses

PROJECTION: UTM Zone 8	DATUM: NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO. V23201322_EIS_Map017_CE_PropLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.2.9-6

3.2.10 Archaeological Resources

Archaeological resources are non-renewable and finite. They are important sources of historical knowledge and cultural identity. They are considered of value to local communities, scientists and the Governments of the Northwest Territories and Canada. Consequently, they are protected by legislation. It is illegal to disturb an archaeological site, burial or artifact, and no land use activity is permitted within 30 m of a known monument or known or suspected archaeological site or burial ground.

According to the *Northwest Territories Archaeological Sites Regulations*, archaeological artifacts are defined as any tangible evidence of human activity that is more than 50 years old, in respect of which an unbroken chain of possession cannot be demonstrated. An archaeological site is defined as a site where an archaeological artifact is found.

The following summary is based on research of available archaeological documentary data as well as the preliminary field reconnaissance of the proposed Highway alignment conducted in September, 2009. Sources that were consulted include: archaeological site inventory records held by the Northwest Territories government, early fur trader/explorer accounts, ethnographic/anthropological studies, and reports on past archaeological studies. The methods employed to assess archaeological potential along the proposed alignments is detailed in Section 3.2.10.3. Traditional knowledge studies and pertinent palaeogeological and paleoenvironmental information were incorporated to form a detailed knowledge base in order to assess the potential for archaeological resources.

3.2.10.1 Human History Summary

Prehistory

Unlike many other coastal areas of the Arctic, the low lying nature of the terrain in the Mackenzie Delta region has resulted in land subsidence and coastal erosion that is thought to have obliterated many of the earliest archaeological sites. Northwest Microblade tradition (as old as 6,000 years) has been recognized by the presence of distinctive burins, blades and microblades at sites in the Mackenzie Valley, eastern Mackenzie Delta and as far north as Cape Bathurst (Morrison 1987). This is said to represent seasonal northward movement of interior people over the arctic coastal plain to hunt caribou and muskox (Le Blanc 1994). This group predates and possibly overlaps Paleoeskimo sites, represented by Pre-Dorset or Arctic Small Tool tradition (ASTt). The ASTt began an extremely rapid expansion from western Alaska eastward across the Canadian Arctic about 4,500 years ago. The Paleoeskimo period is sparsely represented in the Mackenzie region, probably mainly due to severe coastal erosion. The sites that are known suggest a regionally distinct variant with western influences (Betts 2008). An early regional variant of the Arctic Small Tool tradition called the Inuvik Phase, dating to 4,300 to 3,400 years ago, has been suggested (Pilon 1994a) for the southeastern portion of the Mackenzie region. ASTt is characterized by microblades and burins with specific characteristics and small, very finely worked bifaces.

Dorset culture expanded across the High and Eastern Arctic from Foxe Basin about 3,000 years ago. Dorset sites have not been identified in the Mackenzie region. It is speculated that due to the warm climate of this period, southern Aboriginal groups expanded north to near the arctic coast, particularly in the forested Delta area, and prevented Dorset people from exploiting the mainland (McGhee 1978).

Approximately 1,000 years ago, another series of rapid eastward migrations from northwestern Alaska began. This was Thule, a culture focused on whaling. Work in Alaska resulted in the definition of a regionally distinct Western Thule culture characterized by multiple room houses built of wood, curvilinear stamped pottery, Thule Type 2 harpoons, and arrowheads with knobbed tangs (Betts 2008). Most researchers now recognize an early and a late Thule period (Betts 2008). The term Neoeskimo (also known as Siglit) is typically applied to cultural remains in the Western Arctic dating between 1,500 and 150 years ago. It includes western Thule, the earliest group, and Mackenzie Inuit, thought to have derived from Thule. Mackenzie Inuit, dated to between 600 and 150 years ago, are associated with the appearance of large whaling villages on the East channel of the Mackenzie River and along the coast east and west of the mouth of the river. Their lifestyles are detailed below. Current Inuvialuit residents of the Mackenzie Delta are considered to have descended from remnants of the Mackenzie Inuit following their decimation by disease and Alaskan Inupiat who migrated to the Delta in early historic times (Betts 2008).

Historic Period

Alexander Mackenzie in 1789 travelled up the Mackenzie River's East Channel on his return journey from the mouth of the river but had no contact with Aboriginal people. A number of subsequent explorers recorded ethnographic details of their encounters with Mackenzie Inuit and later Delta residents:

- 1826 - John Richardson, part of John Franklin's second polar expedition, explored and mapped the East Channel of the Mackenzie River and the arctic coastline to the east (Franklin 1828).
- Late 1860s - missionary Emile Petitot (1887) worked in the Mackenzie region.
- 1906-1912 - the Stefansson-Anderson Arctic Expedition travelled from Alaska to Coronation Gulf; the expedition wintered in the Delta the first year (Stefansson 1919).
- 1913-1918 - the Canadian Arctic expedition was led by V. Stefansson, accompanied by ethnographer Diamond Jenness (1991).
- 1924 - the western team of the Fifth Thule expedition was led by Dr. Knut Rasmussen who made notes and ethnological collections from western Inuit groups (Mathiassen 1930; Rasmussen 1942).

Direct trading for European goods began in earnest in 1889 when whalers came into the Mackenzie Delta-Beaufort sea area (Bockstoce 1986). They frequently traded with the Inuit from their ships, and later established a post on Herschel Island. Whaling in the Beaufort Sea ceased in 1907, but various independent trading posts continued. In 1912, the Hudson

Bay Company opened a trading post at Kittigazuit, a former focal point for Mackenzie Inuit. This post operated until 1934 when the Hudson's Bay Company moved to Tuktoyaktuk (Usher 1971). Several independent traders continued operations at Kittigazuit until 1940.

Inuvialuit Ethnography

Prior to the 1890s, the Mackenzie Inuit were perhaps the most numerous Inuit in Canada. They were culturally most closely related to the Inupiat of Alaska (Morrison and Arnold 1994). Their range extended east and west along the coast from the Delta and south to the head of the Delta and some distance south of Husky (also called Eskimo) Lakes (Stefansson 1919). The rich resource base of the Mackenzie region, anchored by beluga whale, caribou, muskox and fish, permitted the Mackenzie Inuit to develop a semi-sedentary lifestyle.

Historically, the Mackenzie Inuit were reportedly clustered into at least five more or less distinct territorial groups. Each group was centred on a resource focal point that provided sufficient resources for the establishment of a seasonally permanent village. There may have been two or three additional subgroups that had disappeared prior to the arrival of European and Canadian explorers; one of those was Imaryungmiut ("Eskimo Lake people") who inhabited the Husky Lakes area and focused on caribou hunting and fishing (Betts 2008). After that group's disappearance, this territory was exploited by the Kitigaaryungmiut who seasonally utilized the entire area from the lower Tuktoyaktuk Peninsula to the southern Husky Lakes and were probably among the Mackenzie Inuit who annually went as far south along the Mackenzie drainage system as Arctic Red River to trade with the Dene. Trade with Alaskan Inuit was conducted at Barter Island. The Kitigaaryungmiut main winter village, Kittigazuit, located at the mouth of the East Channel served as a summer beluga whale hunting station and winter gathering locale from which sealing and fishing was carried out. They were also reported to make occasional boat trips some 200 miles further up the Mackenzie River to obtain slate from a quarry near the Ramparts (McGhee 1974).

The following subsistence cycle summary is based mainly on Stefansson (1919). During dark winter months, people were relatively sedentary in the larger coastal villages, subsisting on dried or frozen whale, fish and caribou meat and conducting shorter hunting and trapping trips. In June, people dispersed in small family groups inland to hunt and fish at the larger lakes. From late July through August, moderate sized groups of people gathered at whaling camps. These gatherings were usually at the winter villages, but whale hunting also occurred in the Husky Lakes. Stefansson (1919) identified a winter and summer camp location at the southern narrows of Husky Lakes (not identified archaeologically to date). Focus was on caribou hunting in September and October when the animals were well fed and the hides were in prime condition. Cooperative hunting activities commonly included whaling, weir fishing, caribou drives and floe-edge sealing.

Food was generally stored in permafrost pits although raised platforms were also recorded. Fish was eaten raw or frozen, or dried and sometimes partly smoked. Meat was usually stored directly in the pits although some may have been dried. Fats and oils of sea mammals accompanied most meals and sometimes food was preserved in oil. According to Stefansson's informants, the Mackenzie Inuit ate much less raw food than their Alaskan neighbors (Stefansson 1919). Various berries were used, as well as edible roots of young willow and knotweed.

The vast quantities of driftwood available in the Mackenzie Delta meant that, contrary to most of the arctic, people living in the Delta region used wood for construction as well as fuel. The commonly used winter house was a semi-subterranean structure built of wood, often with whalebone, and covered with sod; multiple chambers were connected to a large central area. Such a structure would have been shared by two or more families. Snowhouses were used only when travelling and generally were built for one nuclear family. Skin covered tents were used on summer hunting trips. Winter travel was by dog team and sled. Water travel in summer was by larger whale skin covered boats called umiaks, and the smaller kayaks were used for sea mammal hunts.

Tools comprised more wood components than elsewhere in the Arctic. Most implements were composed of combinations of wood, bone, antler and stone. Harpoon shafts and fish hooks were made of bone. Wooden bows and arrows were used. Projectile points, endblades and knives were made of chipped or polished chert or slate. Labrets, beads and various ornaments were made of polished steatite, antler or ivory. Cooking pots of steatite were traded from the east (Smith 1984).

Burial usually involved placing the body, wrapped in skins, on a low hill and covering it with driftwood. Personal possessions were placed in, near or on top of the grave.

3.2.10.2 Previous Archaeological Studies

A considerable amount of archaeological research has been conducted in certain areas of the Mackenzie Delta-Tuktoyaktuk Peninsula region. Many of the early explorers commented on seeing old camps or graves as they travelled through the region (Franklin and Richardson 1824; Franklin 1828). The first excavations were conducted as part of ethnoarchaeological research during two arctic expeditions: in 1911 by Stefansson and in 1914 by Jenness.

Beginning in the 1950s, several archaeological research projects were aimed at elucidating the early culture history of the Mackenzie region, for example, MacNeish in 1954 and McGhee in 1974. These studies comprised both surveys and excavations conducted at sites on the Mackenzie River and adjacent coastlines. They studied the prehistoric cultural relationships between the Mackenzie Delta and Alaska. Robert McGhee spent several years excavating at Kittigazuit and a nearby smaller site, and developed a preliminary cultural synthesis for the Mackenzie Inuit (McGhee 1974).

Most archaeological investigations since the 1980s related to Mackenzie oil and gas projects (Cinq-Mars and Pilon 1991; Pilon 1994b; Hanna 2002; Clarke et al. 2004). These studies again included both surveys and excavations and provided a substantial body of data relating to the early human history of the Mackenzie region. Two research projects of specific interest to this study are an archaeological survey and testing of several sites in the interior Tuktoyaktuk Peninsula (Swayze 1994), and survey and excavations conducted on limited portions of the Husky Lakes (Morrison and Swayze 1991; Morrison and Arnold 1994). In 2001, the Mackenzie Delta Heritage Resource Survey conducted revisits of 117 previously recorded site locations and found 70 more sites (Hanna 2002). In 2003, archaeological work associated with the Mackenzie Gas Project revisited/recorded 12 sites in the Inuvialuit portion of their study (Clarke et al. 2004). In 2009, an archaeological impact assessment was completed for Tuktoyaktuk to Source 177 Access Road; no sites were recorded (IMG-Golder Corporation 2009a).

Previous studies focused on specific areas, largely the coastal region, the Mackenzie Delta and River, and portions of the Husky Lakes. The latter includes essentially the entire present Project footprint, excluding the northern 19 km (Tuktoyaktuk to Source 177 Access Road). However, substantial portions of the region remain unexamined. In particular, the region south of the Husky Lakes and east of the Mackenzie River has not been subjected to any previous archaeological investigation.

Recorded Archaeological Resources

Given the limited areas previously subjected to archaeological surveys, the site inventory is quite significant, both in terms of numbers of sites and site remains. Within the general study region encompassing the area east of the Mackenzie River and west of the Husky Lakes and from the coast to the southern limits of the Project area, there are 103 previously recorded sites (Figure 3.2.10-1). Types of sites found in this region include: lithic scatters and quarry/workshops; stone features such as tent rings, caches and cairns; hearths and fire cracked rock concentrations; cabin remains and semi-subterranean house remains; cache pits; middens; graves; various types of wood features; and cut/worked wood remains. Excavated sites have revealed cultural deposits often to 30cm below surface and some remains are as deep as 60 cm. Dates from a number of sites confirmed the time periods represented range from Northwest Microblade tradition over 5000 years old and Paleoeskimo as old as 4,300 years ago, through Neoeskimo representations between 1,000 to 200 years old.

There are 12 previously recorded archaeological sites within 5 km of the proposed Highway route, four of which are within prospective gravel sources; one additional site is within a possible borrow source further from the route (Table 3.2.10-1; Figure 3.2.10-1). These sites typically represent Mackenzie Inuit occupations with some small components ascribed to the Paleoeskimo period. Most of these sites are small camps characterized by lithic, bone and artifact scatters, some with structural features such as tent rings, hearths, semi-subterranean house remains, middens and caches.

Artifacts that have been found at some of these sites include harpoon parts, projectile points of flaked stone, fish hooks, net sinkers, and pottery. The Cache site, on a large, unnamed lake along the western Alternative 2 (Upland Route), contains remains of several different occupation periods, from Paleoeskimo to Inuvialuit; remains include wood house remains, hearth, a range of artifacts and numerous animals remains, predominantly fish, waterfowl and caribou. One of the sites on Big Lake (Ilkaasuat) also revealed prehistoric pottery. These are the types of site features and artifacts that can be expected to be present within the Project Study Area.

TABLE 3.2.10-1: ARCHAEOLOGICAL SITES NEAR PROJECT COMPONENTS

Site	Location	Distance to Highway	Type	Features
NeTq-1	Husky Lakes	1.4km+b	tool making	scatter (lithic)
NeTq-2	S. Husky Lakes	borrow	trail	trail
NfTq-1	Husky Lakes	800m+b	campsite	bone scatter; tent ring (fire cracked rock)
NfTq-4	Parsons Lake	3.3km+b	camp	scatter (lithic); sub. house
NfTq-5	large unnamed lake	2.5km+b	tool making	lithic scatter
NgTo-2	Husky Lakes	2 km	isolated find	lithic flake
NgTq-1	large unnamed lake	150m	tool making, campsite	scatter (fire cracked rock), scatter (lithic)
NhTo-1	Sukunnuk Narrows	1.8km	campsite	bone scatter
NhTo-2	Husky Lakes	2.4km	campsite	scatter (bone)
NhTo-4	west of Husky Lakes	1.8km	tool making	scatter (lithic)
NhTp-1	large unnamed lake	4.8km	campsite	cache pits, house, midden, lithic remains, pottery
NhTp-2	Big Lake (Ilkaasuat)	1.5km	campsite	midden, bones, pottery
NhTp-6	Big Lake (Ilkaasuat)	4.5km	isolated find	harpoon frag/wood debris

Note: +b = in proposed borrow source

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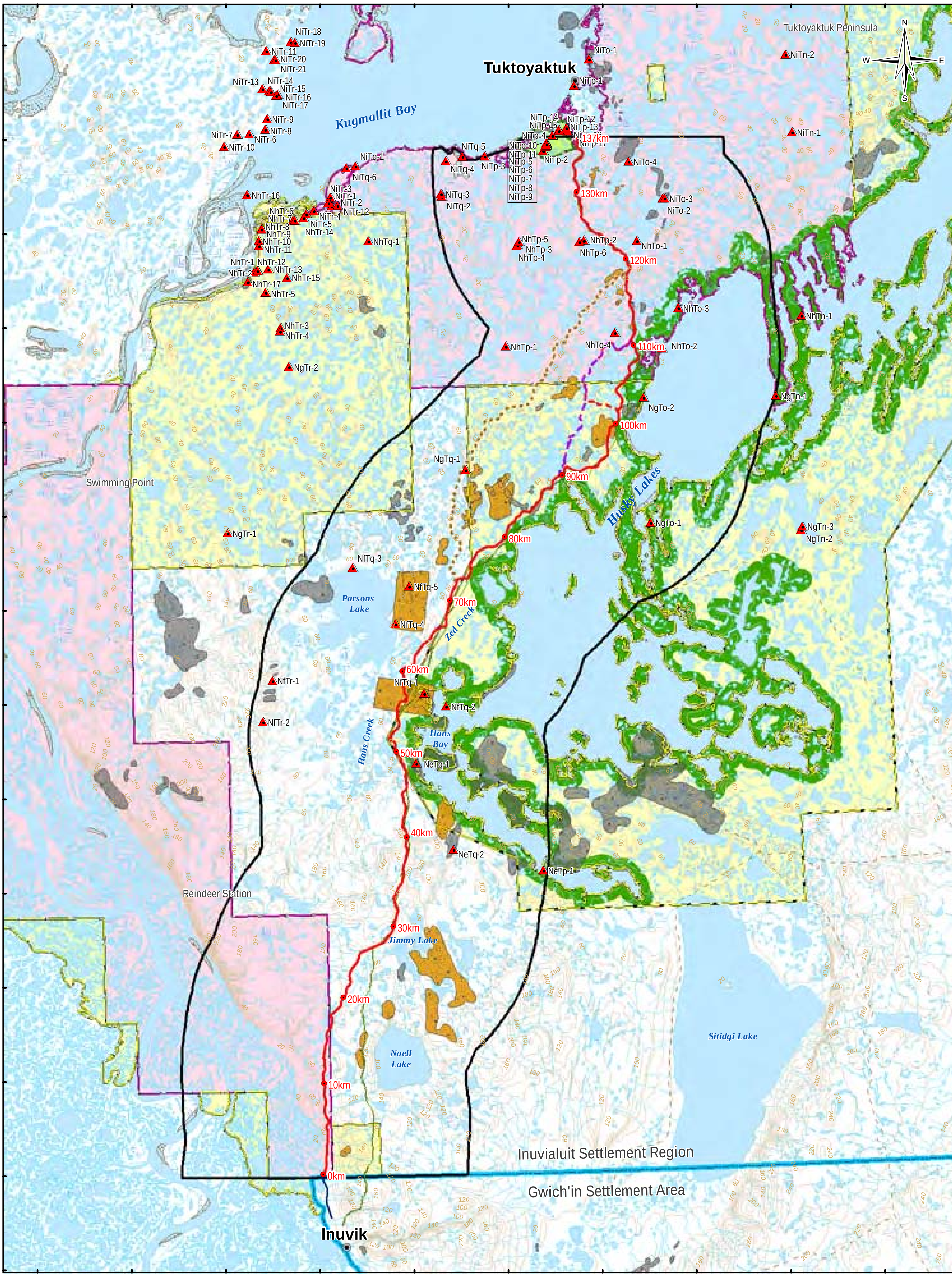

LEGEND

- Archaeological Sites
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)a Lands
- Inuvialuit 7(1)b Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Archaeological Sites Previously Recorded

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map001_Arch_Sites.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.2.10-1

3.2.10.3 Archaeological Overview Assessment

An archaeological overview assessment of the proposed Highway and selected borrow sources was completed in September 2009 by Ms. J. Bussey of Points West Heritage Consulting Ltd. (Kiggiak-EBA 2010a). The main goal was to assess the archaeological potential of terrain to be affected by this Project. The primary method used to rate archaeological potential was visual assessment of terrain by low and slow helicopter overflight following the proposed alignment using GPS coordinates. The route was shown on topographic maps at a scale of 1:25,000. The borrow sources were also overflown, but the boundaries were roughly approximated using topographic maps. Data gathered during the overview assessment were used to identify specific portions of Project components that will require ground reconnaissance surveys during the next phase of study.

The best potential terrain types include level and dry banks, terraces or benches along major streams or lakes. Areas with good potential include well defined, elevated landforms adjacent to larger waterbodies. Low lying expanses of tussock tundra or wet muskeg have limited potential for archaeological resources.

Findings

No previously recorded archaeological sites occur within the primary proposed Highway alignment, assuming a typical right-of-way width. The sections of the Highway route that are close to Husky Lakes and cross elevated, dry terrain (Photo 3.2.10-1) are judged to have good archaeological potential. Elevated terrain features such as moraines, knolls, pingos, esker remnants, and ridges (Photo 3.2.10-2) all have good potential. Major creek crossings are suggestive of good archaeological potential. These sections of the Highway route were roughly outlined on preliminary topographic maps (Figure 3.2.10-2 and 3.2.10-3). It is estimated that about one quarter of the route will require ground reconnaissance.

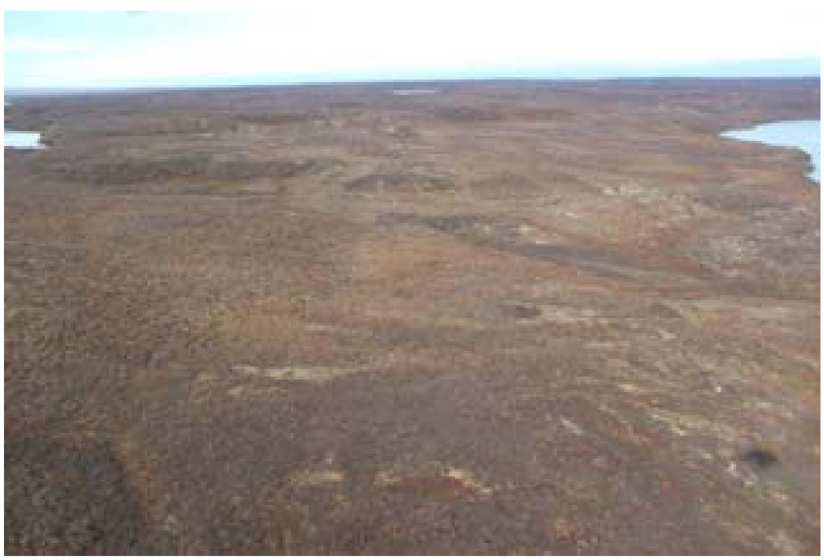

Photo 3.2.10-1
Terraces and benches along Husky Lakes suggestive of good archaeological potential

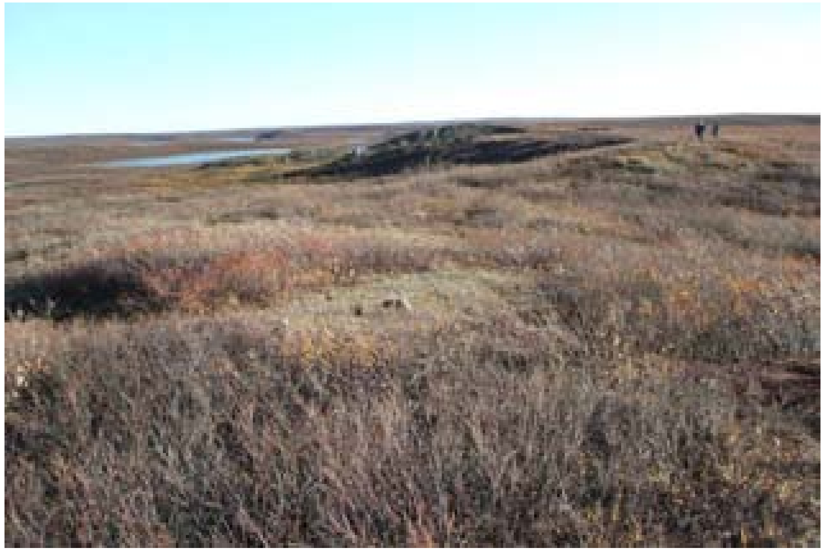

Photo 3.2.10-2
Checking surface exposures on a good potential ridge to be used as a borrow source

Borrow sources were not assessed south of Hans Creek in September 2009 as they had not yet been identified at that time, as well as the time limitations during the September 2009 field investigation. One site is located within or immediately adjacent to Borrow Area 19, and several more may fall within borrow sources that were not assessed. All of the proposed borrow sources that were examined are situated on elevated terrain features that include sections suggestive of good archaeological potential; therefore, ground reconnaissance will be necessary in most of the sources.

Areas with the best potential terrain types include level and dry banks, terraces or benches along major streams or lakes, particularly along Husky Lakes, in close proximity to the Mackenzie drainage system, Zed Creek and Hans Creek; however, any well-defined, elevated landforms adjacent to larger waterbodies have good potential. Low-lying expanses of tussock tundra or wet muskeg have limited potential for archaeological resources. A few such areas will be sampled during ground reconnaissance to ensure that all types of terrain are considered.

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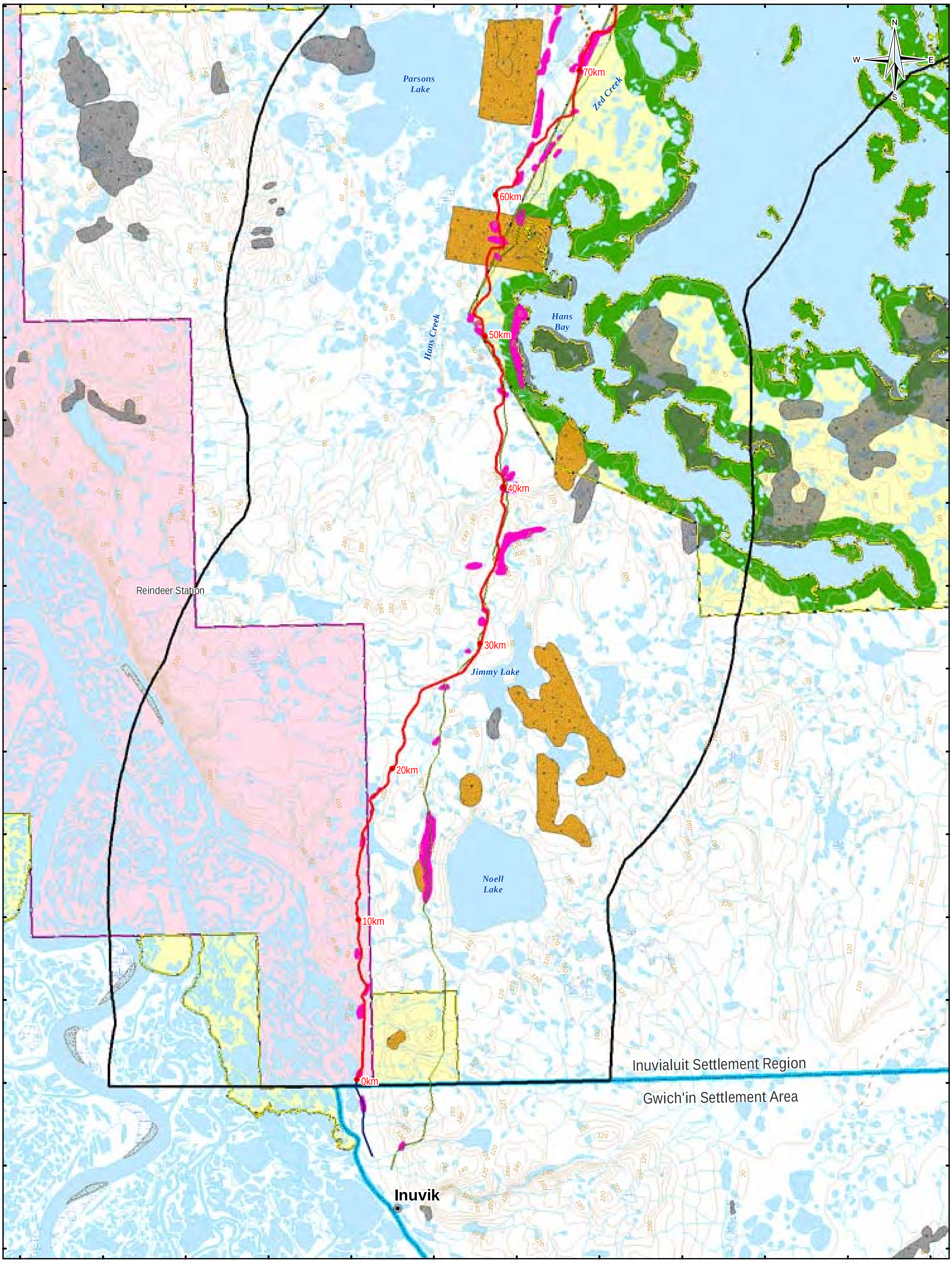

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Archaeological Potential Area
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Archaeological Potential Areas
(Map 1 of 2 - Southern Portion)

PROJECTION: UTM Zone 8
DATUM: NAD83

Scale: 1:225,000
2 1 0 2 4 6
Kilometres

FILE NO.: V23201322_EIS_Map002_Arch_Areas1.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.2.10-2

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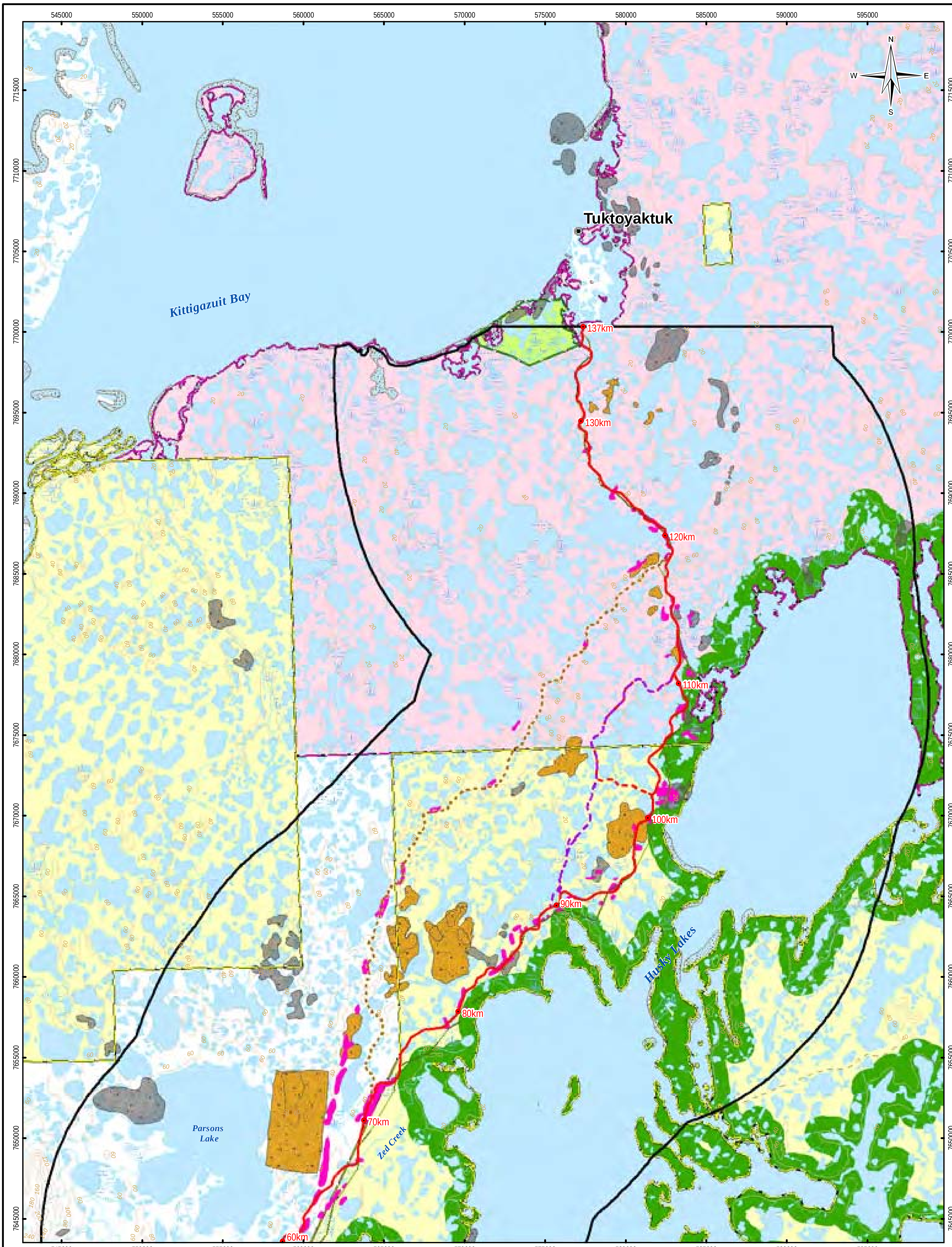

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Archaeological Potential Area
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Archaeological Potential Areas (Map 2 of 2 - Northern Portion)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:225,000
2 1 0 2 4 6
Kilometres

FILE NO.
V23201322_EIS_Map003_Arch_Areas2.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.2.10-3

Archaeological Expectations

The background research and visual assessment conducted of the areas in close proximity to the proposed Highway route and borrow sources provides the basis for some preliminary statements on expected archaeological resources.

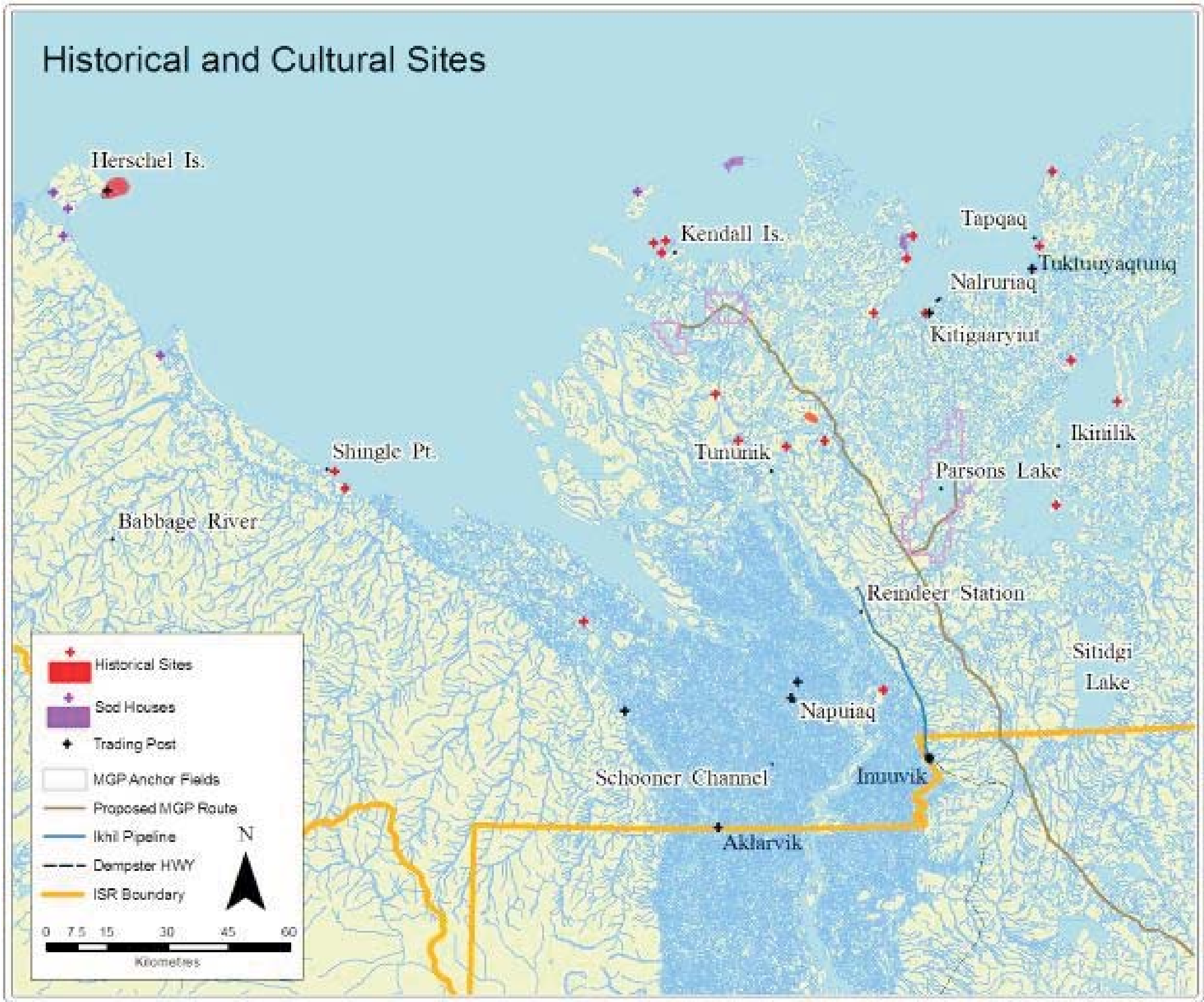
According to the Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al. 2006), there are no historical sites, burial sites or cemeteries documented in the LSA (Figures 3.2.10-4 and 3.2.10-5).

Archaeological Site Locations

Archaeological sites on the Tuktoyaktuk Peninsula and in the Husky Lakes area have most often been recorded on outlet creeks at larger lakes and along the Husky Lakes shoreline. It should be emphasized that this distribution is likely at least partly due to the fact that the research strategies of past studies focused on examination of these high potential locations. Since those are high potential locations, sites can be expected on elevated ridges, hills and terraces adjacent to larger lakes and streams. Besides Husky Lakes, of particularly good potential would be Parsons Lake, the lake known locally as Big Lake (Ilkaasuat), Hans and Zed creeks, and elevated terrain close to channels of the Mackenzie drainage. Old sites have been found on pingos in northern Alaska (Lobdell 1986); therefore, such features are also considered to have archaeological potential.

Archaeological Site Types

Based on ethnographic research and known heritage sites, the types of heritage sites to be expected could include various types of structural remains, stone tools and flakes, a variety of bone and wood artifacts, and bone concentrations. Mounds could be semi-subterranean houses or middens, that is, refuse accumulations. Piles of driftwood could represent graves or house remains. Pits could have been used as caches for food or belongings. Rock piles could represent caches or cairns marking a particular location or feature.



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NOTES

1. Source: Figure 15. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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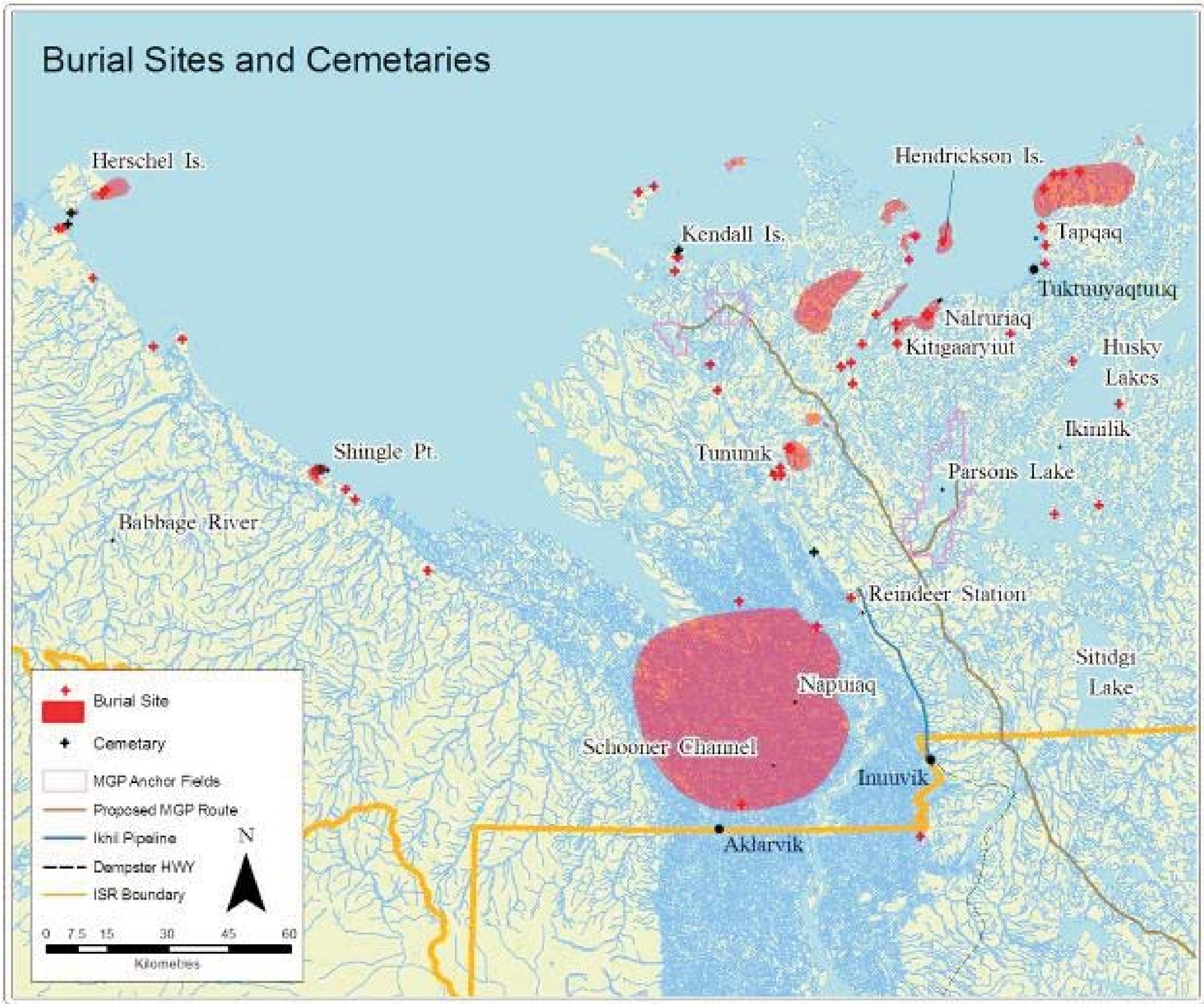
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Historical and Cultural Sites

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0
OFFICE	DATE		
EBA-VANC	March 15, 2011		

Figure 3.2.10-4



NOTES

1. Source: Figure 13. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Burial Sites and Cemeteries

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0
OFFICE	DATE		
EBA-VANC	March 15, 2011		

Figure 3.2.10-5

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4.0 IMPACT ASSESSMENT

This section identifies the potential effects of construction and operation of the Highway, proposed mitigation measures, and any residual effects following implementation of the mitigation measures.

The Developer is committed to constructing the proposed Inuvik to Tuktoyaktuk Highway, borrow sources, and associated winter access roads in a safe and environmentally responsible manner. The Developer is committed to incorporating existing information and building upon this knowledge base. Table 4-1, extracted from the EIRB (2010) Terms of Reference for this Project, identifies the goal statements which the Developer is working towards in the design of this Project.

TABLE 4-1: BIOLOGICAL, PHYSICAL, AND HUMAN ELEMENTS AND GOAL STATEMENTS

Element	Goal Statements
Migratory Birds and Habitat	Protect and avoid disturbance or destruction to migratory birds and their habitat throughout all phases of the proposed development.
Species at Risk	Avoid the loss, damage or destruction of species at risk and their critical habitat throughout all phases of the proposed development.
Wildlife and Wildlife Habitat	Protect all wildlife and wildlife habitat and minimize habitat losses throughout all phases of the proposed development.
Fish and Fish Habitat	Protect all fish and fish habitat and establish a “no-net-loss” of fish habitat throughout all phases of the proposed development.
Vegetation	Maintain the diversity of all vegetation communities throughout all phases of the proposed development.
Waterbodies and Wetlands	Conserve and minimize or avoid negative impacts to all waterbodies and wetlands throughout all phases of the proposed development.
Soil	Protect and sustain soils and minimize losses through erosion throughout all phases of the proposed development
Surface water and Groundwater	Protect or minimize impacts to all ground and surface water throughout all phases of the proposed development.
Permafrost	Protect and minimize impacts to permafrost throughout all phases of the proposed development.
Noise	Minimize anthropogenic noises throughout the duration of the proposed development.
Climate Change	Minimize contributions to climate change throughout all phases of the proposed development.
Air Quality	Minimize air pollution throughout all phases of the proposed development.
Navigation	Avoid impeding navigation throughout all phases of development.
Wildlife Harvesting	Conserve species used for wildlife harvesting throughout all phases of the proposed development.
Culture, Heritage and Archaeology	Preserve culture, heritage and archaeology throughout all phases of development.

TABLE 4-1: BIOLOGICAL, PHYSICAL, AND HUMAN ELEMENTS AND GOAL STATEMENTS

Element	Goal Statements
Communities	Minimize or avoid negative impacts to local communities throughout all phases of the proposed development
Economy	Pursue economic development opportunities that do not adversely impact environmental, social, and cultural conditions/wellness
Human Health and Safety	Avoid negative impacts to human health and safety throughout all phases of development
Land Use	Protect important land use areas.
Participation Agreement (IBA) if required	Commitment from the Developer to participate (section 10 of the IFA.)
Migratory Birds and Habitat	Protect and avoid disturbance or destruction to migratory birds and their habitat throughout all phases of the proposed development.
Species at Risk	Avoid the loss, damage or destruction of species at risk and their critical habitat throughout all phases of the proposed development.
Wildlife and Wildlife Habitat	Protect all wildlife and wildlife habitat and minimize habitat losses throughout all phases of the proposed development.
Fish and Fish Habitat	Protect all fish and fish habitat and establish a "no-net-loss" of fish habitat throughout all phases of the proposed development.
Vegetation	Maintain the diversity of all vegetation communities throughout all phases of the proposed development.
Waterbodies and Wetlands	Conserve and minimize or avoid negative impacts to all waterbodies and wetlands throughout all phases of the proposed development.

The framework for environmental management of the Project will consist of regulatory and other management instruments that define environmental terms and conditions, including:

- EIRB Report, including recommended Terms and Conditions;
- ILA Land Use and Quarry Permit Terms and Conditions;
- INAC Land Use Permit Conditions;
- Northwest Territories Water Board Licence Terms and Conditions;
- Navigable Waters Protection Act Approvals Terms and Conditions;
- Conformance with DFO Operational Statements, Letters of Advice and potential Fisheries Authorization(s);
- Conformance to resource management legislation and regulations including NWT Wildlife Act and Regulations, Migratory Birds Convention Act and Regulations, Migratory Birds Convention Act and Regulations, federal Species at Risk Act, and Species at Risk (NWT) Act;
- Conformance with health and safety legislation and regulations including Public Health Act, Workers Compensation Act, and Explosives Use Act; and
- HTCs, Renewable Resource Committees, and Co-Management Body directions.

Other components of the framework will include:

- Use of experienced, local construction contractors, where possible;
- Avoidance and protection of sensitive terrain and habitats;
- Avoidance of identified heritage and archaeological sites;
- A construction environmental management plan;
- Construction environmental and wildlife protection and monitoring plans;

In addition, the contractor(s) selected to construct the Highway will be required to have the following management plans:

- Contractor health, safety and environment (HSE) manuals including general spill contingency and emergency response plans;
- Contractor work procedures documents;
- Site-specific health and safety plans; and
- Site-specific spill contingency plans.

A copy of INAC's *Guidelines for Spill Contingency Planning*, with which the spill contingency plan will conform to, is provided in Appendix E. The development of site-specific plans will take place in the future upon award of contracts to the successful contractors. All plans must meet the minimum requirements set out in this EIS, the Project's environmental management plans, applicable guidelines, and the terms and conditions required under the regulatory process.

This section of the Environmental Impact Statement focuses on the anticipated environmental effects associated with the relatively short-term construction and how these effects can and will be mitigated. Issues that may arise in the future because of proposed operational changes related to the Highway are also discussed.

4.1 BIOPHYSICAL AND SOCIO-ECONOMIC ASSESSMENT METHODS

The biophysical and socio-economic assessment for the Inuvik to Tuktoyaktuk Highway has been prepared in general accordance with the EIRB's Terms of Reference (2010), to assist the EIRB, regulatory agencies, Inuvialuit and Gwich'in and other interested parties in understanding the anticipated biophysical and socio-economic consequences of the proposed Highway. As a result, this section of the EIS examines the predicted effects of the proposed Highway on the biophysical and human environment components in the proposed development area and the region. Potential cumulative effects on the biophysical and socio-economic environment are discussed in Section 5.0. Potential effects of accidents and malfunctions related to the Highway and associated activities are discussed in Section 4.4.

The impact assessment process employed for the proposed Highway followed a typical environmental impact assessment approach consistent with EIRB and Canadian environmental and socio-economic assessment guidelines and methodologies. The assessment involved project scoping, baseline condition identification, impact assessment and prediction, mitigation planning, evaluation of significance, and follow-up. Each phase is described in detail in the following paragraphs.

Project Scoping – Scoping involves the identification of key issues of concern and the more important biophysical and/or socio-economic components within the area of influence that may be affected by the proposed development. These components are commonly referred to as Valued Components (VCs). VCs are components of the natural and human world that are considered valuable by participants in a public review process (Beanlands and Duinker 1983). VCs need not be restricted to being of an environmental nature. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons (Hegmann et al. 1999).

Project scoping serves to focus the assessment on valued components. The development of appropriate temporal and spatial boundaries for the various biophysical and socio-economic components of concern is also part of the scoping process.

Baseline Conditions – This phase involves the characterization of the pre-disturbance or pre-development biophysical and socio-economic conditions (baseline) in the proposed development area and includes additional site-specific field investigations to address relevant data deficiencies. The type and level of information required is typically related to the type of issue or importance of an issue, the assessment boundaries, and the potential effects predicted to occur.

Impact Assessment and Prediction – Using the baseline data, an understanding of the proposed Highway and available mitigation measures to prevent or minimize impacts, standard assessment tools and professional judgement are employed to assess potential environmental and socio-economic effects (including residual and cumulative effects) associated with the construction and operation of the proposed development. As indicated in the EIRB's Terms of Reference (EIRB 2010), project Project-related effects are typically characterized for each Project phase in terms of criteria, such as:

- The reversibility of the effect;
- The duration of the effect;
- The confidence of the predicted effect, based on the available data;
- The geographic location and range of the effect and any affected groups/individuals; and
- The goal statements outlined in Table 4-1.

For socio-economic parameters, the capacity of potentially affected groups, responsible authorities and/or the developer to manage the effect is an additional criterion that is commonly considered. Additional criteria, typical of environmental assessments, have also been integrated into this assessment and are discussed further in Section 4.1.4.

Mitigation Planning – Appropriate biophysical and socio-economic management and mitigation measures, where applicable, are described and directly integrated into the assessment of the proposed development-related effects.

Evaluation of Consequence – To determine the level of consequence from a residual effect, the magnitude, duration, and location of the effect were the primary factors. Residual effects are those effects remaining after the application of appropriate mitigation measures on the biophysical and socio-economic components of concern.

Follow-up – Construction-related monitoring will be conducted during the construction phase to confirm the accuracy of biophysical predictions and to implement corrective actions if, and as may be, warranted. Follow-up monitoring, during operations, is expected to be led by NWT natural resource agencies, in cooperation with the joint management committees and the HTCs.

4.1.1 Project Scoping

The EIRB (2010) determined that the Scope of Project Components and Activities included those items included in the Project Description Report submitted in 2010 to the Environmental Impact Screening Committee. It was to consist of all the physical works and activities required to construct and operate the Highway between Inuvik and Tuktoyaktuk. Route alignment alternatives were also considered.

More specifically, the EIRB's Terms of Reference (2010) defined the Scope of Project Components and Activities to consist at minimum of the following physical works or activities that are anticipated to occur during the construction, operation and where relevant, modification, decommissioning and abandonment phases:

- All-season Highway from Inuvik to Tuktoyaktuk;
- Temporary winter road parallel to the all season Highway;
- Temporary winter road to access borrow sites;
- Borrow areas to support construction, operations and maintenance requirements;
- Construction equipment staging areas;
- Construction material storage;
- Construction staging areas;
- Maintenance areas;
- Excavation equipment storage areas;
- Culvert, bridge and other water course crossing structures;

- Other drainage and thermal erosion control structures;
- Winter road water course crossings;
- Fuel, oil and other bulk liquids storage areas;
- Equipment maintenance, refilling and refueling areas;
- Temporary construction camp facilities;
- On-going operations and maintenance of the all-weather Highway;
- Temporary electrical or other power supply;
- Wastewater management and treatment;
- Solid and other waste management;
- Water withdrawals;
- Management of excavation material, including stockpiles;
- Construction worksites, storage areas and staging areas;
- Maintenance activities;
- Handling and storage of petroleum products and hazardous materials;
- Handling, storage and use of explosives (if required);
- Personnel, material, liquids, fuel and equipment resupply;
- Vehicle movements and frequency during construction;
- Aircraft use and frequency during construction; and
- The types, numbers, locations and frequency of use of all equipment associated with the development and associated exerted ground pressures, and techniques used to reduce these ground pressures.

The scope of assessment also includes an examination of cumulative effects. Cumulative effects were to focus on other past, present and reasonably foreseeable future developments or human activities that may combine with the impacts of the proposed Highway to affect the same valued components. Such cumulative effects were to be assessed at a geographic and temporal scale appropriate to the particular valued component under consideration.

4.1.2 Valued Components

The assessment methods used to evaluate the potential biophysical and socio-economic effects of the proposed Highway on the local and regional study areas are Valued Ecosystem Components (VECs) or Valued Socio-economic Components (VSCs). VECs are defined as "the environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic, or aesthetic value" (Sadar 1994). VSCs are defined as "Cultural, social, economic or health aspects of the study population that, if affected by the project, would be of concern to local human populations or government regulators" (NEB 2011). The VECs and VSCs collectively are referred to as Valued Components (VCs). Effects are predicted for each VC, particularly as they relate to their role in the ecosystem and the value placed on the component by the Inuvialuit.

The selection of VCs for this EIS is based on a combination of the directions provided in the EIRB Terms of Reference (2010), the Developer's understanding of the biophysical or socio-economic components, traditional knowledge as specified in the CCPs, the *Inuvialuit Final Agreement*, the consultation results, and various other considerations.

Table 4.1.2-1 summarizes the Valued Components that are assessed in the EIS.

TABLE 4.1.2-1: SELECTED VALUED COMPONENTS

Impact Assessment	Valued Components
Biophysical Components	Noise
	Terrain, Geology, Soils and Permafrost
	Water Quality and Quantity
	Changes to Hydrological Regime
	Species at Risk and Species of Special Status including grizzly bear and wolverine Species of high importance subsistence for country foods including barren-ground caribou and moose Species of moderate to high values as furbearers Species rated as high importance to outfitters or tourism guides Migratory and breeding birds
	Fish Species of high importance to subsistence for country foods and fish habitat
Human Environment Components	Land and Resource Use by the Inuvialuit
	Areas of Special Ecological and Cultural Importance
	Land Designation Areas (as per IFA and CCPs)
	Tourism, Commercial and Public Recreational Use
	Heritage and Archaeological Sites

4.1.3 Study Boundaries

The Review Board determined that the Developer should determine the appropriate boundary for biophysical and socio-economic elements assessed (EIRB 2010). Evaluating the significance of each potential effect associated with the Highway requires that appropriate spatial and temporal boundaries (space and time limits of potential effects) be defined.

4.1.3.1 Spatial Boundaries

Local and regional spatial boundaries were determined for biophysical and socio-economic components based on their respective characteristics and anticipated interactions with Highway activities. The spatial boundaries were primarily based on the Project footprint and the zone of influence beyond which the effects of the Highway were expected to be non-detectable.

For the biophysical components, two main assessment areas were defined.

Project Footprint – the area directly under the Highway alignment and the area used during borrow source activities. The Project footprint, shown on Figure 4.1.3-1, covers approximately 383 ha along the Highway (using the Primary 2009 Route) and an estimated 30 ha for the borrow sources.

Local Study Area (LSA) - includes a 0.5 km buffer on either side of the proposed Highway alignment (based on the Primary 2009 Route), including the available borrow sites and the proposed all-season Highway. The total width of the buffer is 1 km. The LSA, shown in Figure 4.1.3-1, covers approximately 13,650 hectares.

Regional Study Area (RSA) – includes a 15 km buffer on either side of the proposed Highway (based on the Primary 2009 Route). The total width of the buffer is 30 km. The RSA, shown in Figure 4.1.3-1, covers approximately 376,959 hectares and incorporates the LSA and the Project footprint.

The geographic scope for assessing effects to the human environment includes potentially affected communities.

Human Environment Study Area – includes the communities of Inuvik and Tuktoyaktuk and the Inuvialuit that may be impacted by the proposed development.

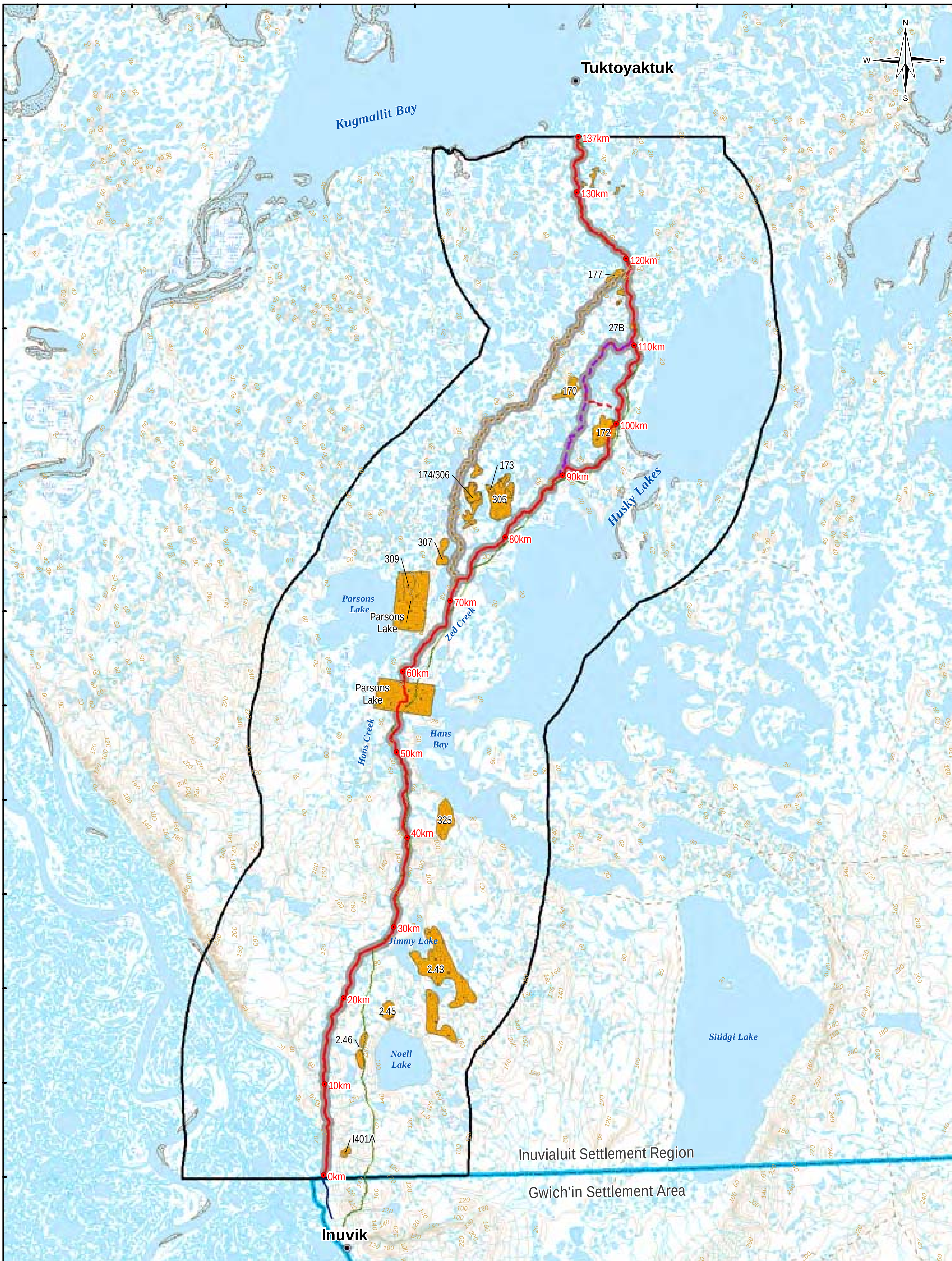
4.1.3.2 Temporal Boundaries

The EIRB (2010) determined that the temporal boundaries should reflect the construction, operation, maintenance and, where relevant, decommissioning and reclamation of the sites affected by the development. The temporal boundaries also consider seasonal and annual variations related to the environmental components for all phases of the development, where appropriate. To determine the temporal boundary of assessment, the following items were taken into account:

- Duration of the construction period;
- Duration of the operational period;
- Design life of engineered structures; and
- Frequency and duration of natural events and human-induced environmental changes (EIRB 2010).

Depending on the activity, the temporal boundaries for the assessment are defined as:

- Short-term – occurs or lasts for short periods of time (i.e., hours, weeks, or months);
- Medium-term – occurs or lasts for the life of the Project; and
- Long-term – extends or lasts beyond the life of the Project.



LEGEND

- Local Study Area (0.5 km buffer)
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources: Inuvialuit Land Administration

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Project Study Areas

PROJECTION: UTM Zone 8	DATUM: NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.: V23201322_EIS_Map032_StudyAreas.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

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Figure 4.1.3-1

4.1.3.3 Effects Assessment

Using the VCs as the primary focus for the analysis, the assessment of potential effects for each environmental component begins with a review of the main Project activities that could cause environmental disturbances during each of the three primary phases of activity (construction, operation and maintenance, and where relevant, decommissioning and reclamation) associated with the development of the Highway.

The evaluation of effects for each VC is addressed in terms of the type or nature of residual effects that remain after the application of appropriate environmental management and mitigation measures on the biophysical and socio-economic components of concern.

Potential residual effects are typically described in terms of a number of possible impact criteria. Table 4.1.4-1 provides the list of possible descriptors and their corresponding definitions used to assess the level of impact in the biophysical and human environments.

TABLE 4.1.4-1: EFFECTS ASSESSMENT AND CONSEQUENCE CRITERIA

Criterion	Descriptor	Definition
Magnitude	Negligible	• Effect will produce no detectable change from baseline conditions
	Low:	• Effect is within the range of baseline conditions or natural variation
	Moderate:	• Effect is at or slightly exceeds baseline conditions or the limits of natural variation
	High:	• Effect will produce a notable change beyond baseline conditions or the upper or lower limit of natural variation
Geographic Extent	Local	• Effect is confined to the LSA
	Regional	• Effect is confined to the RSA
	Beyond Regional	• Effect extends beyond the RSA
Duration	Short-term	• Effect occurs or lasts for short periods of time - hours, weeks, months
	Medium-term	• Effect occurs or lasts for the life of the Highway
	Long-term	• Effect extends or lasts beyond the life of the Highway
Frequency	Isolated	• Effect is confined to a discrete or specific period of time
	Sporadic	• Effect occurs on occasion and at irregular intervals
	Periodic	• Effect occurs intermittently but repeatedly during the life of the Project
	Continuous	• Effect will occur continually during the life of the Project
Reversibility	Reversible Short-term	• Effect can be reversed during the life of the Project
	Reversible Long-term	• Effect can be reversed within 100 years
	Irreversible	• Effect cannot be reversed

TABLE 4.1.4-1: EFFECTS ASSESSMENT AND CONSEQUENCE CRITERIA		
Criterion	**Descriptor**	**Definition**
Likelihood	Low	• Effect is unlikely but could occur
	Moderate	• Effect is likely but may not occur
	High	• Effect will occur
Consequence	Negligible	• Effect may result in a slight decline in condition of the VC in the study area for a very short duration but the VC should return to baseline conditions
	Low	• Effect may result in a slight decline in condition of the VC in the study area during the life of the Project. Research, monitoring, and/or recovery strategies would not normally be required
	Moderate	• Effect could result in a noticeable but stable change in the condition of the VC compared to baseline conditions which persists in the study area after Project closure and into the foreseeable future. **OR** • Effect could result in a noticeable change in the condition of the VC in that established guidelines or thresholds are exceeded but the VC should return to baseline conditions.
	High	• Effect results in notable changes to the condition of the VC.

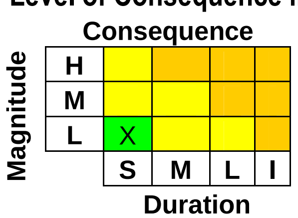
4.1.4 Assessing Level of Consequence

To determine the level of consequence from a residual effect, the magnitude, duration, and location of the effect were the primary factors. In the LSA, the highest consequence rating is moderate. Negligible consequences result from low magnitude and short duration; whereas moderate consequences result from low to high magnitude and medium-term to irreversible duration.

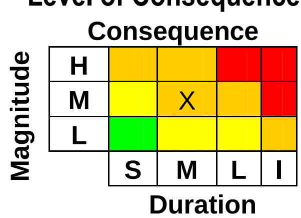
In the RSA, the highest consequence rating is high. Negligible consequences result from low magnitude and short duration; whereas high consequences result from moderate to high magnitude and long-term to irreversible duration.

Consequences are summarized in the following schematics, where the "X" identifies the level of consequence, based on the factors shown in Table 4.1.4-1. The magnitude levels are described as L (low), M (medium) and H (high), and the duration is described as S (short-term), M (medium-term), L (long-term), and I (irreversible).

Level of Consequence in the LSA



Level of Consequence in the RSA



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4.2 BIOPHYSICAL COMPONENTS

4.2.1 Terrain, Geology, Soils and Permafrost

The terrain, geology, soils and permafrost baseline conditions along the alignment and in the general area of the Highway are described in detail in Section 2.0 and Section 3.0 of this EIS. The following few paragraphs provide a summary for convenience.

Terrain along the Highway varies from relatively dry upland and hummocky conditions, to wet, ice-rich lacustrine and thick organic conditions. This can be further categorized into four distinctive landforms; glacial moraine, glaciofluvial outwash, lacustrine and alluvial/colluvial deposits. Surface or exposed bedrock is not visible along the alignment as depth to bedrock in the Mackenzie Delta ranges from about 50 m near Inuvik to greater than 150 m near the seaward limit of the modern delta at Tuktoyaktuk.

The surficial geology and landforms along the Highway are primarily the result of glacial activity in the region. As a result, the route contains many seasonal watercourses, wet lowlands, peatlands and lakes, many of which are remnants of glacial outwash channels.

The Inuvik to Tuktoyaktuk Highway corridor is located entirely within the zone of continuous permafrost. The thickness of the active layer along the Highway is typically between 0.6 m and 0.8 m, but varies from less than 0.5 m to greater than 2.0 m on elevated, organic-free slopes. Common permafrost-related features in the vicinity of the Highway include ice-rich polygonal ground, retrogressive thaw-flow slides, thermokarst and peatland.

Terrain, geology, soils and permafrost are one Valued Component relative to the physical ground upon which the Highway will be built. This VC will be impacted due to both the Highway construction activities and the physical presence and operation of the Highway after it is built.

4.2.1.1 Potential Effects Due to Highway Construction Activities

Highway construction activities are described in detail in earlier sections of this EIS. In general the activities include:

- Development of winter access roads;
- Set up and operation of camps;
- Drilling for geotechnical investigation both along the alignment and in the borrow sources;
- Stripping of organic material from borrow sources;
- Removal of material from borrow sources;
- Hauling and placing of borrow material;
- Installation of bridges and culverts;
- Grading and compaction of constructed embankment; and
- Placement of surfacing gravel.

All of these activities require travel across the ground (as described by the terrain, geology, soils and permafrost) along the alignment and to borrow sources, or working in an area of open cut in a borrow source. The ground, as described above and in earlier sections of the EIS, is in its most vulnerable state in the spring and summer when the air/surface temperature is changing and the active layer is thawing. Travel over the ground with tract or wheeled equipment when it is in this vulnerable state will cause deformation to or shredding of the soil and vegetative surface, compaction of organic peatlands, pumping of water to the surface or collection of surface water in the deformation to form standing water. The effect would be a change in the air/surface temperature balance increasing the depth of the active layer and resulting in thaw slumps, melting of ice-rich soil, slope and soil instability, erosion and subsidence in the permafrost. Subsidence or the presence of new low lying areas or surface channels can also change the drainage and surface hydrology causing collection of water in future years in areas other than where the vehicles travelled creating similar negative effects beyond the area of immediate impact.

Construction will be managed such that travel across the ground, when in its most vulnerable state, does not occur. Such mitigative measures are further described in Table 4.2.1-1.

Extraction of construction materials from borrow sites requires removal of the organic layer and cutting into the ground. Cutting into the ground and removing material exposes the permafrost and ice-rich materials to thaw, creating similar negative effects described above. Development, working and restoration of borrow sources will be done with mitigative measures described in Table 4.2.1-1.

4.2.1.2 Potential Effects Due to the Physical Presence and Operation of the Highway

The ground (as described by the terrain, geology, soils and permafrost) could be affected by the physical presence and operation of the Highway (including embankment, bridges and culverts) after it is built.

As noted above, permafrost and ice-rich soils are highly sensitive to changes in the air/surface temperature balance. Even slight changes can cause an increase in the thickness of the active layer, instability, thaw settlement and subsidence due to loss of permafrost. The introduction of a material layer (the Highway embankment) to the surface could alter that air/surface temperature balance. The granular material will gain heat during warmer periods and if thin enough will transfer that heat to the surface of the natural ground. If the material layer or embankment is thick enough it will act as an insulating layer and the air/surface temperature balance will be maintained or improved.

The presence of the Highway could also affect the air/surface temperature balance in areas beyond the natural ground under the Highway. In the Mackenzie Delta snow normally blows and moves without drifts building along the natural ground particularly where there is little or low (short, stunted) tree cover. The air/surface temperature regime is maintained. Where the air/surface temperature regime is maintained, permafrost does not thaw and settlement does not occur. When the Highway is built, snow will build up on the sideslope and beyond the toe of the slope on the natural ground. This accumulation of snow insulates the permafrost, the air/surface temperature regime is impacted and the result is permafrost thaw and differential settlement.

The Highway also forms a barrier to movement of unchannelized surface water. Surface water can accumulate or pond along the toe of the embankment creating negative effects similar to those described above.

4.2.1.3 Spatial Boundaries

To mitigate the effects described above, Project design elements and measures will be initiated in the design and construction of the Highway to address the causes. The current approach to highway design and construction in permafrost regions is documented in the national guidelines entitled *Development and Management of Transportation Infrastructure in Permafrost Regions* published by the Transportation Association of Canada (TAC) in May 2010. The design parameters and construction techniques presented as mitigative measures in this section are based on experience in the area and the case studies and lessons learned as presented in the TAC guideline.

TABLE 4.2.1-1: SUMMARY OF MITIGATION MEASURES

Cause	Potential Effects	Mitigation Measures
Travel across the ground along the alignment or to borrow sources with tract or wheeled vehicles.	Change in drainage and surface hydrology, thaw slumps, melting of ice-rich ground, slope and soil instability, erosion and subsidence in the permafrost.	Access to and hauling from borrow sources during winter months. Construction of embankment during winter months. Summer activities such as grading and compaction of the embankment, and placing of surfacing materials only where the Highway can be accessed over embankment constructed the previous winter. Stockpiling surfacing material along the previously constructed embankment during the winter for use in the summer.
Cutting into the ground and removing material.	Exposes the permafrost and ice-rich materials to thaw resulting in similar effects to those noted above.	Minimize the surface area of open cut. Grade slopes to minimize slumping. Grade material storage and working areas to promote drainage and avoid standing water. Restore the borrow source when construction is completed by grading slopes to match the natural ground and drainage of the surrounding area, and replacing overburden.
Introduction of the granular material embankment.	Alters the air/surface temperature balance such that heat is gained, the active layer becomes deeper and there is thawing of ice-rich soils and subsidence due to permafrost loss.	Design and construct embankments with thickness or height based on terrain type. Thicker embankments on more thaw-sensitive ground to provide an insulative layer and promote the development of a frozen embankment core. Design the alignment to avoid unfavorable thick organic and ice-rich polygonal terrain.

TABLE 4.2.1-1: SUMMARY OF MITIGATION MEASURES

<table>
<tr><th>Cause</th><th>Potential Effects</th><th>Mitigation Measures</th></tr>
<tr><td>Accumulation of snow on the sideslope and along the natural ground beyond the toe of the slope.</td><td>Insulates the permafrost, the air/surface temperature regime is impacted and the result is permafrost thaw and differential settlement, resulting in areas of standing water that will further result in thaw.</td><td rowspan="2">The installation of culverts to balance seasonal overland surface flows;
Install sufficient cross drainage to prevent or minimize potential water ponding; and spring and fall inspections of drainage.</td></tr>
<tr><td>Introduction of the granular material embankment</td><td>Forms a barrier to movement of unchannelized surface water. Surface water can accumulate or pond along the toe of the embankment creating negative effects similar to those described above.</td></tr>
</table>

4.2.1.4 Residual Effects

There will be residual effects of the Highway construction that are not likely to be fully mitigated. A borrow source will leave some mark on the land even with the best and most well thought out management practices during the material extraction. The construction practices noted above are, therefore, intended to minimize the footprint of a single borrow source and minimize the number of borrow sources that are opened for the construction phase.

4.2.2 Air Quality

Air quality is the VC for this assessment because it has links to human and general ecological health and the aesthetic quality of the Project.

The Project will produce airborne emissions that will slightly increase ambient concentrations of certain substances in the airshed on a temporary and transient basis. The air quality assessment predicts ground-level concentrations of selected substances emitted by Project equipment during construction, and emissions from vehicle traffic during operations, but the levels should have no lasting effect on ambient conditions.

The focus of the air quality assessment is therefore on predicting changes in air quality concentrations. The effects these changes might have on the receiving environment are considered in Section 4.2.6 (Vegetation) and Section 4.2.7 (Wildlife and Wildlife Habitats). Similarly, climate change is discussed in Section 4.5.1.

4.2.2.1 Applicable Standards, Objectives and Guidelines

Due to the potential human health and environmental issues related to poor air quality, there are several applicable territorial and federal air quality standards or guidelines.

The *Canadian Environmental Protection Act* (CEPA) is the principal Act for the regulation of environmental contaminants. The CEPA allows the federal government to regulate and control substances through national quality objectives, guidelines and/or standards (Health Canada 2006). Under CEPA, the federal government can assess air pollutants and control their impact through the setting of *National Ambient Air Quality Objectives (NAAQOs) and Canada-wide Standards (CWSs)*.

National Ambient Air Quality Objectives (NAAQOs) identify benchmark levels of protection for people and the environment. NAAQOs guide federal, territorial and regional governments in making risk-management decisions, such as local source permitting and air quality index, and are viewed as effects-based long-term air quality goals. The current framework establishes a national goal for outdoor air quality that protects health, the environment, or aesthetic properties of the environment. NAAQOs are established under CEPA but may be used differently in each province or territory (Health Canada 2006).

The Government of the Northwest Territories, under the NWT *Environmental Protection Act*, developed the *Guideline for Ambient Air Quality Standards in the Northwest Territories: Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ground Level Ozone (O_3), Total Suspended Particulate (TSP), and Fine Particulate Matter ($PM_{2.5}$)* (GNWT ENR 2011). The guideline sets standards for the maximum concentrations of CO, SO_2, NO_2, O_3, TSP, and $PM_{2.5}$ acceptable in ambient air throughout the Northwest Territories. These standards are applied as a long term management goal for air quality (GNWT ENR 2011).

In June 2000, the Canadian Council of Ministers of the Environment[9] (CCME) endorsed a *Canada-wide Standards (CWS) Agreement for Particulate Matter (PM) and Ozone* in air, in accordance with the 1990 *Canada-wide Accord on Environmental Harmonization* and its *Canada-wide Environmental Standards Sub-Agreement*. The CWSs are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe (Health Canada 2006).

For particulate matter and ozone, the CCME acknowledge that:

- PM and ozone negatively affect human health and the environment;
- There is no apparent lower threshold for the effects on human health; and
- There are additional benefits to reducing and maintaining ambient levels below the standards.

According to the CCME (2007), reducing precursor pollutants, such as NOx and SOx, is a primary means of lowering ambient levels of $PM_{2.5}$ and/or ozone.

[9] With the exception of Quebec.

For the purpose of this proposed Project, the Keeping-Clean-Areas-Clean (KCAC) programs of the CCME's Guidance document are relevant to the Beaufort-Delta Region. In particular, the KCAC "refers to preventative measures applied either across a jurisdiction or within a specified area that are intended to avoid or minimize increases in overall ambient concentrations of PM and ozone in areas not significantly affected by local sources of emissions" (CCME 2007).

A detailed discussion of these standards and guidelines and their goals are located in Section 3.1.3. The goals set by these standards and guidelines were applied to assess the acceptability of potential residual air quality effects resulting from the proposed Project during the Construction and Operations Phases.

4.2.2.2 Key Indicators

Key indicators provide a means of practically measuring and assessing changes in air quality.

For the purpose of this assessment, the rationale used to select key indicators includes:

- Substance emissions are monitored at the regional level, in Inuvik;
- Substance emissions have territorial and/or federal standards and objectives; and/or
- Substance emissions are directly related to this Project, such as coarse particulate matter and greenhouse gas (as it relates to vehicle emissions).

The key indicators selected for this Project include:

- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx);
- Ground level ozone (O_3);
- Greenhouse gas; and
- Visibility.

Indicators with specific standards and objectives, such as carbon monoxide and total particulate matter, are not assessed as key indicators as they are not actively monitored in the local communities or the region.

Arctic haze was not considered as a key indicator because it is a large-scale phenomenon caused by continental movements of fine airborne particles and aerosols and dominated by large Arctic weather systems. As the Project will not influence these systems, Arctic haze was rejected as a key indicator (IOL et al. 2004).

4.2.2.3 Emission Sources

Air pollution is a broad term applied to any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere (Environment Canada 2011). Individual pollutants differ from one another in their chemical composition, reactions with other chemicals, sources, persistence, ability to travel through the atmosphere, and effects. Some of the substances classified as air pollutants are naturally occurring, and come from sources such as forest fires and soil erosion, while others are generated from human activities (Environment Canada 2011). Sources of emissions that may cause air pollution are discussed in this section.

Borrow and Construction Activities

The primary construction-related emissions will be dust generated from borrow sites, heavy equipment, and vehicle movements along access roads and the newly constructed sections of the Highway. Other emissions will be generated from by heavy equipment and construction vehicles, including volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO) and sulphur oxides (SOx). Both nitrogen oxides (NOx) and volatile organic compounds (VOCs) are involved in a series of complex reactions that result in the formation of ground-level ozone (Environment Canada 2011). Construction camps will also be potential sources of other air emissions from space heating. This phase of the Project is anticipated to take up to four years.

Construction-related dust and emissions are expected to be localized, short-term, intermittent and transient in nature. Since traffic will not be stationary but travelling along the access roads and newly constructed Highway, it is highly unlikely that the emissions will have any measureable effect on ambient air quality. Air quality effects from the construction camps would be limited to the immediate vicinity of the camps, and would be consistent with other typical residential air emissions such as occur at Inuvik and Tuktoyaktuk.

Sources of fugitive dust related to the construction phase include: materials handling (excavation of borrow sources and construction activities), vehicle traffic during summer (construction and operations phases), open area wind erosion, and storage pile wind erosion. Construction dust emissions are based on area, amount of earth moved, duration of earth moving and other material movement, and travel distances. Materials handling dust emissions depend on the silt and moisture content of the material. Dust emissions from roads have been found to vary directly with the fraction of silt (particles smaller than 75µm in physical diameter) in the road surface materials. Finally, open area and storage pile wind erosion emissions rely on threshold friction, terrain, threshold wind velocities, wind events, and rainfall events (Western Governors' Association 2006).

Other emissions-producing equipment includes mechanical equipment, power generators and heaters.

Operation and Maintenance Activities

The primary operations-related emissions will be fugitive dust from Highway use (approximately 150 to 200 vehicles per day) and vehicle emissions. Fugitive dust emissions from traffic on the Highway are expected, particularly during the summer months. As required, dust suppression techniques that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998) will be applied. During the winter season, the Highway will typically be covered with snow and ice; therefore, fugitive dust emissions from traffic on the Highway are not expected to be a major air quality issue.

Similar to the construction phase, emissions will be generated from vehicles and maintenance equipment, including volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO) and sulphur oxides (SOx) (Environment Canada 2011).

In general, all emissions from operation of the Highway are expected to be localized, transient and of short duration.

Typical dust sources include: vehicle travel along the Highway, regular grading of the Highway surface. Emissions will be produced from vehicles using the Highway.

4.2.2.4 Emissions of Concern

A variety of emissions, in limited amounts, are anticipated to be generated during construction and operation of the proposed Highway. These key indicators (or emissions of concern) are described according to Project phase in Tables 4.2.2-1 (construction phase) and 4.2.2-2 (operations phase).

The emissions of concern are the same as those generated during the use of the existing winter road, except that the Highway will be used year-round instead of only during the winter months.

TABLE 4.2.2-1: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY CONSTRUCTION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Fine Particulate Matter ($PM_{2.5}$)	Heavy equipment operation (vehicle exhaust, brake wear, tire wear, re-suspension of loose material)	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; forest fires; surface material moisture and temperature (i.e., frozen), vehicle weight, traffic volume, number of wheels per vehicle	Spring and summer	Intermittent, during snow-free periods
Coarse Particulate Matter (PM_{10})	Borrow source and Highway construction activities	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; forest fires; surface material moisture and temperature (i.e., frozen), vehicle weight, traffic volume, number of wheels per vehicle	Spring and summer	Intermittent, during snow-free periods

TABLE 4.2.2-1: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY CONSTRUCTION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Sulphur Dioxide (SO_2)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use; forest fires	Year-round	Intermittent
Nitrogen Dioxide (NO_2)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Ground Level Ozone (O_3)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Carbon Monoxide (CO)	Construction vehicles; transporting staff to work site	Regular vehicle use	Increased vehicular use	Year-round	Intermittent
Greenhouse Gas (GHG)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

TABLE 4.2.2-2: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY OPERATION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Fine Particulate Matter ($PM_{2.5}$)	Vehicle exhaust, brake wear, tire wear, re-suspension of loose material	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; traffic volumes, surface material moisture content, forest fires	Spring and summer	Intermittent, during snow-free periods
Coarse Particulate Matter (PM_{10})	Highway surface during summer	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; traffic volumes, surface material moisture content, forest fires	Spring and summer	Intermittent, during snow-free periods
Sulphur Dioxide (SO_2)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use; forest fires	Year-round	Intermittent
Nitrogen Dioxide (NO_2)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

TABLE 4.2.2-2: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY OPERATION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Ground Level Ozone (O_3)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Carbon Monoxide (CO)	Highway traffic and maintenance vehicles	Regular vehicle use	Increased vehicular use	Year-round	Intermittent
Greenhouse Gas (GHG)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

As stated previously, the primary emission of concern is dust. Dust emissions are anticipated to remain primarily in the LSA. Dust, in the form of fine ($PM_{2.5}$) and coarse (PM_{10}) particulate matter and total suspended particulates, is expected to be emitted during the construction and operations phases. The review of scientific literature identified consistent factors that affect dust deposition behaviour and include the deposition load, duration, frequency, and chemical properties of the dust. Particle size also plays a role in determining how far away from a source dust effects can be expected to occur. The effects of road dust on vegetation have been detectable 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away from a source (Lamprecht and Graber 1996). These distances are consistent with United States Environmental Protection Agency (US EPA 1995) observations of the deposition properties of particles with various aerodynamic diameters (under more "typical" conditions).

Larger dust particles (e.g., with aerodynamic diameters more than 100 μm) typically settle within 10 m of a source, while particles with aerodynamic diameters between 30 to 100 μm settle out within 100 m. Smaller particles than these are less susceptible to gravitational settling and can be transported over greater distances (US EPA 1995). It is anticipated that the largest effects to vegetation ecosystems and plants from fugitive dust will occur within 100 m of a dust source.

Seasonal variations may affect dust deposition as patterns of dust deposition on vegetation are a function of various factors including wind and ambient moisture. During periods of rain, snow, or freezing temperatures, dust is not expected to be generated by any Project activities during construction and operations. Dust previously deposited on vegetation is also expected to be reduced following heavier rain events in particular. However, if dust is generated, dust may be deposited further from the Highway during periods of wind.

4.2.2.5 Potential Effects

Dust and air emissions associated with the relatively short-term construction and longer term operation of the Highway are expected to have limited, localized and relatively temporary effects on air quality and the sound environment in the vicinity of the Highway. These effects, in turn may have effects on the adjacent natural environment and habitats.

The potential effects of each of the following substances are described in this section:

- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx);
- Ground level ozone (O_3);
- Carbon monoxide (CO);
- Greenhouse gas (GHG); and
- Visibility.

Fine Particulate Matter ($PM_{2.5}$)

Particulate emissions occur whenever vehicles travel over a paved or unpaved surface. On an unpaved road, the force of the vehicle's wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. Particulate emissions are due to direct emissions from vehicles in the form of exhaust, brake wear, and tire wear emissions and re-suspension of loose material on the road surface (US EPA 2006). The quantity of dust emissions varies linearly with the volume of traffic, as well as other source parameters that characterize the condition of the road, including the fraction of silt (particles smaller than 75 μm) in the surface materials.

Since the Highway will operate during winter periods, when the Highway is typically frozen and covered with snow and ice, fugitive dust emissions from traffic on the Highway are not expected during this time.

The following is a summary of the relevant sources and quantities of $PM_{2.5}$ generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 12 tonnes;
- All off-road vehicles: 105 tonnes;
- Dust from unpaved roads – 312 tonnes; and,
- Forest fires – 36,464 tonnes.

In 2009, the average monthly concentrations of $PM_{2.5}$ in Inuvik were 5 µg/m^3, with only two exceedances of the NWT 24-hour standard (30 µg/m^3) for $PM_{2.5}$. The exceedances were attributed to the long distant transport of smoke from forest fires burning in Alaska and the Yukon at that time (GNWT ENR 2009f).

A review of the $PM_{2.5}$ levels during the periods when the winter road is open (i.e., December to April) indicates the monthly average to be between 2-3 µg/m^3.

The anticipated effect of the proposed Highway is negligible compared to the use of off-road vehicles or natural sources of $PM_{2.5}$, during construction and operation. Although there will be increased traffic during summer months when dust and particulate matter are more likely, Highway dust may be mitigated with the implementation of dust suppression measures.

Coarse Particulate Matter (PM_{10})

The following is a summary of the relevant sources and quantities of PM_{10} generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 13 tonnes;
- All off-road vehicles: 110 tonnes;
- Dust from unpaved roads – 2,358 tonnes; and,
- Forest fires – 44,229 tonnes.

In 2009, the monthly concentrations of PM_{10} in Inuvik ranged between 6-35 µg/m^3. Although there is no NWT standard or objective for PM_{10}, the NWT reports 10 exceedances of an 'adopted' 24-hour standard (50µg/m^3), which generally occurred in the snow-free months. Similar to previous years, the spring-time levels were elevated and were representative of the typical 'spring-time dust event' associated with residual winter gravel and from local construction activities (GNWT ENR 2009f).

The anticipated effects of PM_{10} from the proposed Highway are of low significance during construction and operation of the Highway, following implementation of dust suppression measures. Currently, the monthly averages of PM_{10} in Inuvik are maximum 35 µg/m^3 during spring. The proposed Highway is located in a remote area, with minimal traffic, and is not anticipated to greatly affect the existing PM_{10} levels.

Sulphur Dioxide (SO_2)

The following is a summary of the relevant sources and quantities of SOx generated in the NWT in 2008, including sulphur dioxide (SO_2) and sulphur trioxide (SO_3) (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 3 tonnes
- All off-road vehicles: 9 tonnes

- Dust from unpaved roads – no data or not applicable
- Forest fires – 31 tonnes.

Sulphur dioxide (SO_2) is the predominant form of sulphur dioxides found in the lower atmosphere.

In Inuvik, the 2009 annual average of SO_2 was less than 1 µg/m³, the maximum 1-hour average was 8 µg/m³. The SO_2 concentrations measured in 2009 were very low and similar to previous years' results, with no exceedances of the NWT or National Ambient Air Quality Objectives (GNWT ENR 2009f).

The sources of SO_2 along the proposed Inuvik to Tuktoyaktuk Highway are on-road vehicles. In the NWT, on-road vehicle-related SO_2 comprises approximately 7% of the total SO_2 emissions. While increased movements of vehicles between Inuvik and Tuktoyaktuk are expected, the increased amount of SO_2 generated is anticipated to be minimal.

Nitrogen Oxides (NOx)

Nitrogen oxide (NOx) typically refers to nitrogen oxide (NO) or nitrogen dioxide (NO_2). The following is a summary of the relevant sources and quantities of NOx generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 636 tonnes;
- All off-road vehicles: 1,226 tonnes;
- Dust from unpaved roads – no data or not applicable; and,
- Forest fires and biogenics (vegetation and soils) – 20,816 tonnes.

In the absence of 2009 data, data from 2008 in Inuvik revealed that there were no exceedances of the 1-hour and 24-hour national standards for NO_2 (GNWT ENR 2008a) even though the area typically has winter inversions, which include consecutive days of extremely cold temperatures accompanied with very low wind speeds (calms), reducing dispersal of pollutants (GNWT ENR 2008a).

The sources of NOx along the proposed Inuvik to Tuktoyaktuk Highway are on-road vehicles. In the NWT, on-road vehicle-related NOx comprises less than 3% of the total NOx emissions. With increased movements of vehicles between Inuvik and Tuktoyaktuk expected, the proposed Highway is anticipated to minimally increase NOx levels in Inuvik. This effect is anticipated to be minimal when compared to the effects that off-road vehicles and forest fires have on NOx levels.

Ground Level Ozone (O_3)

Neither the 1-hour national standard (160 μg/m^3) nor the 8-hour NWT standard (127 μg/m^3) for ground level ozone was exceeded in 2009. The annual average was 40 μg/m^3, which is typical of background levels. The maximum 1-hour average was 112 μg/m^3, while the maximum 8-hour average was 106 μg/m^3. Elevated readings typically occur in spring (GNWT ENR 2009f).

Previous studies indicate that consistently elevated ground level ozone concentrations likely result from the intrusion of stratospheric ozone from weather systems passing through the region (IOL et al. 2004).

Since ground level ozone is formed through a series of complex chemical reactions involving other pollutants, such as NOx, the anticipated relatively small NOx increase along the Highway suggests a corresponding minimal increase in O_3 levels. The levels of O_3 are relatively constant in Inuvik throughout the winter months, with a spike in the spring. According to IOL et al. (2004), emission of NOx and VOCs could contribute to higher ground level ozone concentrations when meteorological conditions are suited to photochemical ozone formation. However, such conditions are rare in northern Canada; therefore, no effects are anticipated.

Carbon Monoxide (CO)

Carbon monoxide is not actively monitored at the Inuvik station. Carbon monoxide in the environment typically results from partial or incomplete combustion, usually from vehicle exhaust.

The following is a summary of the relevant sources and quantities of CO generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 6,357 tonnes;
- All off-road vehicles: 7,486 tonnes;
- Dust from unpaved roads – not applicable;
- Forest fires and biogenics (vegetation and soils) – 428,515 tonnes.

As well, the Northwest Territories Power Plant for Inuvik reports 70 tonnes of carbon monoxide emitted in 2009 (Environment Canada 2008).

Carbon monoxide will be generated from vehicle traffic using the proposed Highway. However, due to the relatively short length of Highway and minimal traffic expected (150 to 200 vehicles per day), the effects are anticipated to be minimal when compared to CO generated from existing on and off-road traffic and/or forest fires in the NWT.

Greenhouse Gas Emissions

Greenhouse gas emission data are collected at the territorial level. Currently the NWT is producing around 2300 Kt of CO_2e/year. GHG emissions in the NWT are increasing steadily due to oil and gas and mining activities. The GHGs generated from transportation have remained constant since 2001 and are forecasted to remain constant, even if such major undertakings as the Mackenzie Gas Project proceed (GNWT ENR 2009a). It seems reasonable to expect, therefore, that the effect of the proposed Highway on GHGs will be negligible.

Visibility

Ice fog forms in calm conditions when there is excess moisture in the air and conditions are cold enough for moisture to freeze; this is aggravated by local emission sources such as idling vehicles (IOL et al. 2004).

The number of vehicles anticipated to use the proposed Highway is between 150 to 200 vehicles per day. Vehicles will be traveling (not idling) on the Highway, which would not lead to a build-up of emissions in one location. As well, due to the lack of other emission sources along the length of the proposed Highway that could contribute to ice fog conditions, an increase in ice fog is not anticipated during the Highway's operation.

Potential increase in ice fog may occur during the construction phase of the Highway when construction vehicles are operating for a period of time in a specific location for a period of time, such as at the borrow source or the portion of the Highway being constructed. By operating in one location, a build-up of emissions from construction vehicles may contribute to ice fog conditions; however, these effects are anticipated to be minimal, of short duration, transient in nature, and would not affect the general public. In particular, ice fog is a naturally occurring event in the region, and should it occur, it will not be a new phenomenon in the region.

4.2.2.6 Project Design and Mitigation Measures

The schedule of the construction phase, Highway design and application of mitigation measures will help to minimize potential air quality effects. Earth moving construction activities are scheduled to occur primarily during winter months, when frozen ground conditions naturally minimize the amount of fugitive dust that would otherwise be created, although some grading and compaction are scheduled during summer.

The Developer will conform to applicable ambient air quality objectives, by using pollution prevention measures and best management practices (CCME 2007).

Mitigation measures during the construction phase include:

- The application of water as per the GNWT's *Guideline for Dust Suppression* (GNWT 1998) during summer months. Water will be effective in controlling dust created by loading and unloading materials, stockpiling and wind erosion;

- To the extent possible, aggregate stockpiling activities will be conducted well downwind of potentially sensitive receptors (based on prevailing winds);
- Effective logistics planning such as the use of buses to haul workers to minimize vehicle movements;
- Closing and progressively reclaiming borrow pits as soon as they are no longer required to reduce potential fugitive dust;
- Ensure proper maintenance of heavy equipment to minimize air emissions;
- Restrict speed limits along the access roads and Highway during construction; and
- Temporarily avoid areas with sensitive wildlife activity or migration (based on recommendations from wildlife monitors).

The GNWT Department of Transportation will be responsible for the ongoing maintenance of the Highway during the operations phase. Specific mitigation measures during the operations phase include conforming to the GNWT's *Guideline for Dust Suppression* (GNWT 1998).

4.2.2.7 Residual Effects

Construction and operations phase traffic are expected to have temporary and intermittent effects in the immediate vicinity of the proposed Highway. Following the application of mitigation measures during construction and operation of the Highway, no residual effects in terms of substances are anticipated. Potential residual effects on wildlife, vegetation and humans are discussed in the corresponding effects sections of this document.

4.2.3 Noise

Noise is considered a VC for this assessment because it has the potential to affect both humans and wildlife. This assessment focuses on environmental noise effects to the general public and wildlife, rather than on occupational (i.e., workplace) noise effects. Project-related activities will occur in remote, uninhabited locations away from the Town of Inuvik and Hamlet of Tuktoyaktuk. Noise sources during construction and operations phases are expected to be intermittent, further reducing the effects.

4.2.3.1 Noise Emission Sources

Construction Phase

Noise generated during the construction phase will be intermittent and temporary. During construction most noise sources are related directly to construction activities (i.e., heavy equipment, trucks, generators, hand tools etc.) and aggregate borrow activities (i.e., blasting frozen borrow material during excavation).

According to *Construction Noise,* an engineering report produced by the Workers' Compensation Board of British Columbia (Eaton 2000), noise levels associated with road construction averages approximately 93 dBA with a maximum of just over 100 dBA.

Trucks will typically be dump trucks or other haul trucks, operating at slow speeds. Noise levels associated with such trucks are typically within 84-86 dBA at 15 m from the truck. Although these levels are of high magnitude they are of short-term duration, intermittent in nature, and are not expected to contribute excessive noise at distances outside the immediate work area.

Aggregate borrow activities are another noise source during construction. Most of the noise will be associated with earth-moving equipment operation during periods of aggregate borrow activity. Blasting activities associated with the borrow source operations will likely be the noisiest activity, producing peak sound pressure levels of approximately 110 dBA at 100 m, but only for very short durations of less than 1 second per blast. In flat open topography, blasting can generate a sound level of approximately 76 dBA at 5 km from the source. Blasting is an infrequent activity during borrow source activities, and ceases completely when construction is finished. The United States Department of Transportation Federal Highway Administration (US DOT FHWA) reports that noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles (US DOT FHWA ND).

Since most activities will occur more than 8 km from the residential centres of Inuvik and Tuktoyaktuk, effects from noise on the general public are expected to be negligible. Although there are no local noise regulations that directly apply to construction noise, the Developer will apply reasonable mitigation to reduce the impact of construction noise. Prudent design, best management practices and mitigation can be combined to minimize sound levels during the construction phase.

Operation Phase

Traffic along the Highway will occur year round. The Highway is designed for travel at 80 km/h. Current use of the winter road indicates approximately 139 average daily trips (GNWT DOT 2009b). It is anticipated that once the Highway is constructed that approximately 150 to 200 vehicles will use the Highway each day. Vehicles will include personal vehicles (likely light to heavy trucks) and conventional heavy-duty vehicles (i.e., tractor trailers or fuel trucks), potentially operating at slower speeds.

Noise levels associated with passenger vehicles travelling at speed limit are typically within 72-74 dBA at 15 m from the vehicle (Michael Minor & Associates ND). Heavy-duty trucks traveling at the speed limit are typically within 84-86 dBA at 15 m from the truck, which would not be expected to create excessive noise levels beyond the immediate vicinity of the Highway. These levels are intermittent, short in duration, and transient in nature.

4.2.3.2 Potential Effects

Effects on Humans

The most common effect of noise on humans is annoyance and impairment of daily activities. Noise can have a physical effect on humans, especially with prolonged exposure. The potential health effects are dependent on duration of exposure (acute versus. chronic) and intensity (dBA level).

The physical effects of noise on humans outside the immediate exposure area are typically minimal and limited to an annoyance factor. Since most of the Project will occur in remote areas, noise will primarily affect those working or visiting cabins in the immediate area. Further, exposure will be temporary and/or intermittent, occurring mostly during the construction phase when activities are concentrated in particular areas.

To protect people from occupational noise effects, various federal and provincial standards are implemented to limit noise levels (see Section 3.1.4.2). The Town of Inuvik and the Hamlet of Tuktoyaktuk have no local noise regulations.

Because the noise emissions will be temporary and intermittent there are no anticipated residual negative effects impacting traditional or recreational use of the area.

Effects on Wildlife, Birds and Fish

The effects of the Highway on wildlife and birds are discussed in Section 4.2.7, although a brief summary is provided here.

It is generally accepted that the effects of noise on most wildlife species are poorly understood (Larkin et al. 1996; Brown 2001; OSB 2003). Furthermore, Larken et al. (1996) suggest that response to noise disturbance cannot be generalized across species or among genuses. Wildlife's response to noise can depend on a variety of factors, including:

- Noise level and type;
- Frequency distribution;
- Variation over time;
- Duration;
- Number of events;
- Ambient noise level;
- Time of day and time of year;
- Animal activity and location;
- Age and sex class; and
- Past experience (Larkin et al. 1996; Voipio et al. 1998; Pater 2001; OSB 2003).

An animal's sensitivity to sound varies with frequency and its response to a sound depends largely on the presence and levels of sound in the frequency band (range of frequencies) to which it is most sensitive (Richardson et al. 1995; Larkin et al. 1996).

AMEC Americas Limited (2005) reports that although barren-ground caribou appeared to avoid active roads it was unclear whether it was noise or visual stimuli that caused the disturbance. Some studies suggest that caribou were displaced up to 2 km from a road with moderate to heavy traffic for a two to three-week period around calving time (Dau and Cameron 1986; Cameron et al. 1992). Calving grounds for barren-ground caribou are located away from the Project's RSA (Figure 3.2.9-5). In addition, the Highway is expected to generate a low volume of traffic, approximately 150 to 200 vehicles per day, which is approximately 8.3 vehicles per hour in a 24-hour period). It was also reported that caribou appear to habituate to some industrial activity, including noise (Valkenburg and Davis 1985).

Observations by Hanson (1981) suggest that barren-ground caribou were not greatly affected by diesel generators and vehicle traffic at Prudhoe Bay. A quantitative study of steady-state noise was conducted by McCourt et al. (1974), which indicated that the simulated sound of a gas compressor elicited an increased incidence of alert postures in caribou passing within 300 m of the simulator, with some apparent avoidance of this zone, but no strong reactions observed. This is substantiated by Hanson (1981) where individual caribou appeared undisturbed by steady noise from the generator located approximately 60 m away.

Caribou have shown either no response or a short run-resume feeding response to dynamite blasts. Russell (1977) observed that caribou located 1.2 km from a series of seismic detonations looked up after one of eleven detonations, but otherwise continued to feed or bed. Grindal (1998) confirms that no overt response was detected when barren-ground caribou were exposed to a mine blast approximately 500 m away.

Grizzly bears have shown avoidance and altered behaviour in response to road presence, seismic blasting and other industrial activities (Harding and Nagy 1980, Archibald et al. 1987, McLellan and Shackleton 1988, Mace et al. 1996, Mueller 2001, Gibeau et al. 2002, Wielgus et al. 2002). Follmann and Hechtel (1990) indicated that grizzly bears can habituate to noise disturbance, citing examples of bears that habituate to human developments if there are energetic benefits. Grizzlies typically select den sites >1 km from human activities; dens are abandoned or habitat not selected when closer than 1 km (Harding and Nagy 1978).

Limited information is available for potential effects on moose related to noise. Anderson et al. (1996) found that human sources of disturbance, such as skiers, created flight responses at greater distances and elevated heart rates for longer periods than mechanical sounds. Anderson et al. (1996) attributed this difference to past experience, as moose in the study areas were hunted by hunters on foot or skis, rather than motorized vehicles.

For birds, as well as other wildlife, sound is an important communication and survival tool. Songs are important in the isolation of species, pair formation, mating, territory defence, flocking, and danger alerts. Various studies have indicated that birds were generally displaced, particularly showing a reduction in nesting density, near roadways and in areas of construction (US DOT FHWA 2004). However, the US DOT FHWA (2004) also reported that at light traffic volumes (between 3,000 and 4,000 vehicles per day), which is much higher than the anticipated Highway traffic volumes, both presence and breeding of birds near roads were not affected.

4.2.3.3 Applicable Standards and Guidelines

Occupational noise guidelines, as indicated in Section 3.1.4.2, are applicable during all phases of the Project.

Because of the proximity of the potential borrow sources to waterbodies, some blasting activities may occur near waterbodies that provide fish habitat. The Developer and its contractors will be required to adhere to the DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998). Highlights of the Guidelines include:

- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish.
- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 m/s in a spawning stream bed during the period of egg incubation. For confined explosives, setback distances from the land-water interface (e.g., the shoreline) or burial depths from fish habitat (e.g., from under the riverbed) that will ensure that explosive charges meet the 100 kPa overpressure guideline are identified in the guidelines.

4.2.3.4 Project Design and Mitigation Measures

The schedule of the construction phase, Highway design and application of mitigation measures and best management practices are intended to minimize the potential effects of noise, including the following practices:

- Limit construction activity during sensitive periods (based on recommendations from wildlife experts) to minimize effects on wildlife, particularly blasting activities;
- Effective logistics planning such as the use of buses to haul workers to minimize vehicle movements; and,
- Maintenance of equipment in good repair and provision of appropriate mufflers for all internal combustion engines.

4.2.3.5 Residual Effects

Noises produced by construction and operation activities are anticipated to have a localized, temporary, and intermittent effect in the immediate vicinity of the Highway.

During construction, noise contributions will be of low to moderate magnitude and will be continuous during work hours, but of temporary duration overall. That is, at the end of construction all noise contributions from these activities will cease. It is anticipated that wildlife and birds may temporarily avoid areas with construction or excavation due to human activity and/or noise. However, no residual effects, following completion of construction activates, are anticipated for noise emissions generated during construction.

Noise contributions during the operations phase will be highly limited in duration because of the mobile and temporary nature of noise emission sources (i.e., trucks moving along the Highway will not contribute noise to any one area for a long period of time). Due to the limited amount of traffic (150-200 vehicles per day) anticipated for the Highway, the average noise levels associated with vehicles being (72 to 86 dBA), and the diminishing nature of sound levels with increased distance from the source, it is anticipated that noise contributions during the operations phase will be negligible within the LSA and RSA and no residual effects are anticipated during this phase.

4.2.4 Water Quality and Quantity

Water quality is an important consideration for protection of the aquatic environment within the development area as the lake and stream waters of the watersheds crossed by the proposed Highway are inextricably linked to fish and fish habitat abundance and quality, provide fish habitat, and are sources of freshwater for the Inuvialuit. Changes in water quality and quantity can affect fish and fish habitat and the use of surface water by people. The assessment of the potential effects of the proposed Highway construction on aquatic resources, including water quality and quantity, and the development of effective avoidance or mitigation measures, are major components of the environmental assessment of the proposed Inuvik to Tuktoyaktuk Highway. Effects of works and activities associated with the Highway on water quality and quantity relate primarily to the construction phase of the Project, and secondarily to the operations phase.

Potential effects on water quality and quantity may result from site preparation, road construction activities (including clear-span bridge and culvert installation), and operational maintenance. Most effects to water quality resulting from projects of this nature are due to soil exposure, erosion, and the subsequent flow of suspended sediments to watercourses, while effects to water quantity are due to water extraction, changes to surface drainage patterns and blockages to surface drainage.

Potential effects of the Project on water quality and quantity, and a discussion of mitigation measures necessary to prevent adverse effects are provided in the following subsections. Criteria for the assessment of residual effect significance are shown in Table 4.1.4-1 in Section 4.1.2. However, following the application of suitable mitigation, Highway construction and operation is not expected to result in adverse residual effects to water quality or quantity.

4.2.4.1 Potential Effects

Potential effects (or effect-inducing stressors) that can occur during the construction and operation of the Highway are detailed below and summarized in Table 4.2.4-1. Overall, it is concluded that construction and operation-related effects with respect to water quality and quantity will:

- Be confined to the local study area;
- Persist for short-term duration;

- Be infrequent, since effects occur in isolation from one another; and
- Generally be reversible in the short-term.

By their nature, road construction activities have the potential to cause erosion and consequent sedimentation of receiving streams and lakes. Sediment released to streams and lakes, both in suspended and settled forms, can pose a risk to water quality. However, available guidelines and Best Management Practices (BMPs), such as DFO *Land Development Guidelines* (1993), DFO *Operational Statements*, and INAC *Northern Land Use Guidelines for Roads and Trails* (INAC 2010c), can be effective to avoid or mitigate effects to water quality and quantity.

In addition, the scheduling of embankment construction and most culvert installation activities during the winter period will help to avoid or minimize erosion and sedimentation due to the absence of flowing water during that time. However, some activities, such as final compaction, placement of surfacing materials on the sections of Highway embankment, and adjustments to or installation of certain culverts, will be undertaken in summer periods using appropriate erosion and sediment control measures.

The proposed Highway will cross numerous ephemeral and permanent stream channels and wetland areas, and as such, may affect local hydrological characteristics. The alignment crosses through the Delta Hydrologic Region, which is characterized by very large numbers of shallow lakes and ponds that generally drain through small streams into either the Mackenzie River or the Husky Lakes.

Due to the low relief of the Tuktoyaktuk Peninsula, Rescan (1999a) anticipated that the highway route proposed at that time could possibly cause some disruption to surface drainage patterns. Unless properly mitigated, terrain disturbance and road construction could potentially result in a number of smaller lakes completely drying up or conversely, result in blocked flow paths causing ponding due to (Percy and Hoban 1975). These issues are addressed in the Highway Design Effects section below.

Highway Design (Pre-construction)

The Highway design is influenced by the hydrologic patterns and characteristics of the Project area. Stream crossing structures and cross drainage culverts will be appropriately sized to accommodate flash freshet flows, which can be sudden and intense. Extensive background work has therefore been carried out to develop the current Highway design. Mitigating potential effects and eliminating residual effects to water quality and quantity, which will occur as a result of constructing the Highway, is most effectively accomplished through detailed planning of the Highway route and design and installation of approved crossing structures.

Potential sources of suspended sediment occur from land disturbance, disturbance of bottom or bank sediments during construction, surface runoff from the Highway during the snow-free period, and dust generation during operation. Land disturbance has the potential to occur throughout construction, although the magnitude of such effects is minimized due to frozen conditions during the primary construction season and conformance to available guidelines and BMPs.

Potential effects to water quality and quantity as a result of Highway design include:

- Reduced water quality due to erosion and sedimentation from construction; and,
- Alteration of surface drainage patterns due to stream constriction at stream crossing sites or through obstruction of overland drainage.

Effects to water quality and quantity as a result of Highway design will be minimized by:

- The design and use of crossing structures that are appropriate for site-specific flow conditions;
- Employing erosion and sediment control best management practices (BMPs) and DFO Operational Statements (where possible) as per an approved environmental management plan (EMP);
- Installing appropriately sized cross culverts to divert and manage Highway and surface drainage flows; and
- Undertaking primary Highway embankment construction activities during the winter months.

Each of these potential effects and proposed associated mitigation is described further in the following sections.

Clear-span Bridge Construction (Construction)

As described in the fish and fish habitat impact assessment section, clear-span bridges were recommended to be installed to cross 11 large watercourses but currently it has been determined by the Project Team that about 8 bridges may be needed. Based on field reconnaissance, siting and construction of these bridges will be consistent with the DFO Operational Statement (OS) for Clear Span Bridges (DFO 2009b). Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Culvert Installation and Maintenance (Construction and Operation)

Culverts will be necessary at approximately 35 identified watercourse crossings along the Highway alignment. Additional cross-drainage culverts will need to be installed along the Highway as necessary to accommodate seasonal overland drainage. At each watercourse crossing, culverts will be appropriately sized to avoid or minimize changes in water flow patterns and timing, and will follow installation guidelines such as those contained within the DFO *Land Development Guidelines* (1993) and the INAC *Northern Land Use Guidelines for Roads and Trails* (2010c). These measures are necessary due to the potential effects on water quality and water flow of improper sizing and installation, which can result in:

- Ponding, when culverts are insufficient to handle high flows;
- High water velocities, due to improper culvert sizing; and,
- Bank and stream bed erosion, due to exposure of unconsolidated bank material, excessive flows, lack of suitable armouring, and culvert perching (i.e., culvert not buried sufficiently into the stream bed).

Appropriate culvert sizing, the application of recognized installation guidelines and adherence to erosion and sediment control measures will reduce the magnitude, frequency, and duration of potential effects related to ground disturbance and culvert installation. When watercourse crossings are completed, disturbed materials will be replaced with similar-sized substrates and the stream bed and banks of the watercourse will be stabilized and restored.

Routine monitoring and inspections at watercourse crossings will be carried out to confirm the proper performance of each culvert. This will involve examination for debris buildup, culvert subsidence or lifting, and stream bank or bed erosion. Where necessary, maintenance activities will be carried out in conformance with the DFO (2010) Culvert Maintenance OS, which includes the removal of accumulated debris (e.g., woody debris, boulders, garbage, and ice build-up) that prevents the efficient passage of water and fish through the structure and may also include the reinforcement of eroding inlets and outlets.

As a result of these measures, it is concluded that culvert installation and maintenance will not result in residual adverse effects to water quality or water flow.

Use of Heavy Equipment (Construction)

Heavy equipment will be on-site throughout the Highway construction process and during isolated events for Highway maintenance. Effects on water quality due to the operation of heavy equipment relate primarily to the potential for ground disturbance, soil exposure, rutting, and the consequent mobilization and flow of suspended particulates to streams during snowmelt and rainfall events.

The use of heavy equipment for Highway embankment construction will occur during the winter months when all stream crossing locations will be frozen. Therefore, the potential for erosion and sedimentation from this activity is very low. Highway surface grading and compaction activities, to be conducted in the summer months, will help to mitigate surface runoff associated with the thawing of the surface of the embankment.

Potential effects resulting from erosion and sedimentation will be mitigated by the construction schedule, and implementation of erosion and sediment control plans contained in the construction EMP, an example of which is located in Appendix E. In addition, monitoring of construction works by environmental and wildlife monitors will ensure the application of prescribed mitigation, identify unforeseen and potential erosion sites that could lead to the discharge of sediment to surface or groundwater, and prevent erosion and subsequent sedimentation.

Based on adherence to the proposed mitigation measures, the BMPs, and the EMP, residual effects on water quality from the use of heavy equipment during construction are not anticipated.

Water Extraction (Construction)

Considerable amounts of water will be required for annual winter access road construction. Water for this purpose will be extracted from suitably sized lakes in proximity to the Highway corridor, and will be naturally replenished the following spring. It is anticipated that total water requirements will exceed 300 m^3/day, which will likely trigger the need for a NWTWB Type A Water Licence.

Water withdrawal will be regulated by criteria set out in the Water Licence and the DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories* (see Section 4.2.5.1 for discussion of water withdrawal requirements with respect to fish and fish habitat). As such, no adverse residual effects are anticipated from this activity.

Road Drainage (Construction)

The potential exists for sediment releases to ephemeral and permanent streams due to drainage in summer months from the newly constructed road embankments, and slumpage of road slopes prior to compaction and stabilization. However, since vegetation will not be disrupted at the toe of the road slopes, it is expected that sediment flow will be slowed and filtered by this vegetation to reduce this potential risk. In addition, silt fences will be installed at each road-channel intersection to prevent sediment releases to streams. Silt fences will be left in place until roadways are compacted and stable, and will be routinely monitored and maintained. Cross drainage culverts, which will be installed at regular intervals, will channel road drainage away from streams and allow filtration by natural vegetation. Because of these measures, no residual effects on water quality due to road drainage are anticipated.

Dust Generation (Operation)

Water quality is not expected to be affected by dust during the majority of the Highway's construction, since most work is scheduled to occur during the winter. However, dust generation and subsequent effects may occur periodically during the grading and compaction activities that will take place in summer, and during Highway operation through the dry summer months. Potential effects of dust generation include a reduction of water quality as a result of dust and fines settlement on adjacent waterbodies. However, effects to water quality from dust generation and settlement will be short term and are not anticipated to be significant due to mitigation by the application of non-toxic dust suppression techniques (water trucks) that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998).

Highway Maintenance (Operation)

During Highway operations, it is anticipated that the Highway surface and culverts will require regular maintenance during summer months. Potential effects of Highway operations (i.e. vehicles driving on the Highway surface) relate to erosion of road surfaces or embankments and dust generation, possibly resulting in sedimentation of adjacent watercourses.

Based on adherence to the GNWT DOT's erosion and sediment control BMPs and the *Guideline for Dust Suppression* (GNWT 1998), the residual effects on water quality during regular maintenance activities are not anticipated.

4.2.4.2 Project Design and Mitigation Measures

Table 4.2.4-1 provides a summary of the expected activities, potential effects and mitigation measures that apply to the design, construction and operation of the Highway. The potential for erosion and sedimentation effects exists at all phases of the Project due to the nature of Highway construction activities. In recognition of the potential adverse effects of sediment, an environmental management plan (EMP) will be prepared prior to construction and submitted to regulators for approval, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment. The EMP will refer to appropriate erosion and sediment control guidelines, GNWT erosion and sediment control best management practices (currently being prepared in coordination with DFO), and measures outlined in the DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat*.

Some of the important measures to be followed include:

- Limiting the use of construction equipment to the immediate footprint of the Highway or borrow source;
- Minimizing vegetation removal and conducting progressive reclamation at the clear-span abutments, culvert installations and borrow sources;
- Keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out by vehicles;
- Avoiding the use of heavy equipment in streams or on stream banks during summer months, and the adherence to the DFO Operational Statement for Temporary Stream Crossings (DFO 2008), where this is deemed necessary;
- Installing silt fencing and/or check dams, and cross drainage culverts as necessary to minimize siltation in runoff near waterbodies; and,
- Appropriate sizing and installation of culverts, based on hydrological assessments and local experience, to avoid backwatering and washouts.

TABLE 4.2.4-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON WATER QUALITY AND QUANTITY

Activity	Potential Effect	Avoidance or Mitigation
Highway Construction	Erosion and sedimentation	Complete Highway embankment construction during winter months Implement erosion and sediment control plan and best management practices, as appropriate
	Surface drainage pattern changes due to stream constriction	Abutments to be placed in accordance with DFO's *Operational Statement for Clear-Span Bridges* Appropriate sizing of culverts based on hydrological assessments and local experience
	Temporarily reduce lake levels due to water extraction	Follow DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories*
Clear-span Bridge Construction	Sediment release during construction of abutments	Employ erosion and sediment control best management practices and guidelines, as appropriate; adhere to DFO *Clear-span Bridge Operational Statement* Complete abutment construction during winter period
	Flow changes due to stream constriction	Abutments to be placed at a sufficient distance from active stream channel
Culvert Installation	Sediment release during culvert installation	Implement erosion and sediment control best management practices, and culvert installation guidelines, as appropriate (e.g. DFO *Land Development Guidelines*, Dane 1978)
	Changes in surface drainage patterns	Appropriate sizing of culverts based on hydrological assessments and local experience
Use of Heavy Equipment	Soil erosion and sedimentation	Apply erosion and sediment control best management practices
Highway Operation and Maintenance	Increased dust generation and fine particle settlement into adjacent waterbodies	Effective dust suppression (water trucks) during dry season
	Sediment release during maintenance	Implement erosion and sediment control best management practices as appropriate
	Temporarily reduced surface water quantity	Water withdrawal to occur from appropriately sized lakes Water License and DFO protocol to be followed.
Road Drainage	Sediment discharge to watercourses	Filtration by natural vegetation Silt fences installed at each road-stream intersection Regular spacing of cross-drainage culverts
Culvert Maintenance	Sediment release during maintenance	Apply erosion and sediment control best management practices Inspect and maintain culverts, as needed, in the spring and fall Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2010) as appropriate

4.2.4.3 Residual Effects

Based on the previously discussed assessments of the various components of Highway construction, operation, and maintenance, the Project is not expected to result in residual effects on water quality, or water quantity and flow patterns, following the implementation of mitigation.

4.2.5 Fish and Fish Habitat

The assessment of the potential adverse effects of Highway construction and operation on aquatic resources, including fish and fish habitat, and the development of effective avoidance or mitigation measures, are major components of the environmental assessment of the proposed Inuvik to Tuktoyaktuk Highway. Effects of construction and operation activities associated with the Highway on fish and fish habitat relate primarily to the construction phase of the Project, and secondarily to the operations phase. Except for the installation of culverts in key fish-bearing streams, stream crossing construction works will be undertaken during the winter months when streams are frozen, as recommended by Percy and Hoban (1975).

As per Section 3.1.7.10, three categories of streams are recognized along the proposed route from the perspective of identifying engineering constraints related to the protection of fish and fish habitat:

- *Ephemeral streams that are not utilized by fish for any part of their life cycles, and are therefore not considered to be fish-bearing.* Crossings over such streams require culverts that are appropriately sized to prevent ponding and erosion (27 crossings);
- *Perennial (except in winter) streams that are potentially utilized by one or more life cycle stages of fish for migration during open water periods.* Appropriately sized and installed culverts are required to permit unimpeded fish passage (8 crossings); and
- *Perennial (except in winter) streams that are utilized by one or more life cycle stages of fish for spawning, rearing and feeding during open water periods, in addition to migration.* Clear span bridges were recommended (11 crossings).

The effects of a linear development were considered by the Mackenzie Environmental Monitoring Program (MEMP), an initiative of INAC, DFO and the governments of NWT and Yukon Territory in 1985 (Rescan 1999a). The findings of that program suggested that linear development, or increased access, could result in potentially increased fishing pressure, leading to decreased distribution and abundance of fish (Rescan 1999a). The species deemed to have the highest potential to be affected by construction and increased harvest pressure were lake trout and whitefish.

However, it was also suggested that these effects could be mitigated by careful route selection, site supervision during construction, and post-construction monitoring. Further, the issue of increased fishing pressure should be jointly resolved through regulation, monitoring and enforcement by stakeholders, such as the FJMC, in consultation with DFO (Rescan 1999a). It was further determined that potential negative effects on fish quality were invalid because there were insufficient data to indicate land disturbance ever affecting palatability of northern fishes.

Additional information exists which shows that many connecting streams, which link small lakes within a watershed to the sea, such as the Mackenzie Delta and Beaufort Sea, may be important migration corridors for coregonids (whitefish) which use lakes as nurseries (Rescan 1999a). This stresses the importance of stream crossing design within potential migratory watercourses. However, very few of the streams along the Highway corridor possess sufficient flow or upstream habitat conditions to support coregonid populations. Whitefish require lakes for spawning that do not freeze to the bottom and are well oxygenated in winter. Lakes with these properties are uncommon in the headwaters of most of the streams crossed by the Highway.

The greatest direct effect from Highway construction on fish and fish habitat (i.e., obstruction or sedimentation of fish migration corridors) will be mitigated by properly designed watercourse crossings and appropriate timing of construction.

Potential effects of the Project on fish and fish habitat, recommended mitigation measures, residual effects, and proposed effect significance levels are provided below. Criteria for the assessment of residual effect significance are shown in Table 4.1.4-1 in Section 4.1.

4.2.5.1 Potential Effects and Mitigation Measures

The principal fish habitat issues and mitigation measures that should be considered as part of the regulatory approval process are discussed below and summarized in Table 4.2.5-1. The appropriate crossing structures and avoidance or mitigation measures designed to achieve no net loss (NNL) of productive capacity of fish habitat will be guided in part by the designated category of stream for each site (as stated previously).

Road embankment construction activities will primarily be conducted during the winter months when all of the watercourse crossings will be frozen. Summer-related work will be on a smaller scale and will include compacting and grading of the embankment (Highway surface), installation of certain culverts, or adjustments to culverts installed in the previous winter.

The installation of culverts in fish-bearing streams in summer is necessary due to the requirement that culverts be buried into the stream bottom to prevent downstream erosion and culvert perching. This latter effect is common when culverts are set on (rather than into) the stream bottom, resulting in undercutting of the stream bottom, leaving the downstream end of the culvert raised (or perched) above the water surface. This creates a barrier to upstream fish passage, particularly for small fish. Frozen channel and stream bed conditions preclude the partial burial of culverts in winter.

In accordance with DFO (2009a), the installation of culverts in fish-bearing streams is not permitted between April 1 and July 15 for watercourses that provide habitat for spring/summer spawners (i.e. grayling, which is the only species potentially spawning in Project area streams). These installations will adhere to appropriate guidelines, such as those contained in the DFO *Land Development Guidelines for the Protection of Aquatic Habitat*

(DFO 1993) and in Dane (1978), to avoid or minimize the potential for erosion, sedimentation or channel effects. Various methods are available for installing culverts in flowing streams. Appropriate techniques will be determined on a site specific basis by qualified biologists working in conjunction with fluvial geomorphologists and road construction engineers, and in consultation with DFO habitat biologists.

Cross drainage culverts or those installed in non-fish bearing streams will be installed under frozen conditions in winter and as such, construction of these watercourse crossings will not result in effects to downstream fish habitat. No other instream work will occur in fish-bearing streams during critical time periods.

Construction-related effects with respect to fish and fish habitat are all considered to be local effects, as they are confined to the local study area, of short-term duration and are infrequent, since effects occur in isolation spatially and temporally from one another. Operational effects of the Highway with respect to fish and fish habitat are similarly considered to be local effects but will vary in duration and frequency.

Several components of the Project have the potential to result in erosion and sedimentation effects on fish and fish habitat in the absence of appropriate mitigation measures. Sediment released to streams and lakes, both in suspended and settled forms, presents a risk to fish and fish habitat. The effects of sediment on fish and their habitat include, but are not limited to:

- Degradation of potential spawning areas;
- Smothering of eggs and benthic invertebrate food supply;
- Reduction in feeding efficiency;
- Avoidance of potentially suitable habitats; and
- Abrasion of fish tissues (Birtwell 1999; Lloyd et al. 1987).

For example, Arctic grayling have been found to be displaced downstream of their preferred habitats at suspended sediment levels greater than 100 mg/L (McLeay et al. 1987); Scannell (1988) determined that only 10% of Arctic grayling food supply would be available at suspended sediment concentrations of about 63 mg/L; and, Birtwell (1999) reports dramatic decreases in salmonid egg survival with increasing levels of fine sediments in the gravel. Effects due to erosion and sedimentation will largely be avoided due to construction being limited to the winter period when flow (and hence, fish) will be absent from the streams being crossed by the Highway, and when frozen soils are not subject to erosion.

For construction activities taking place in summer, potential erosion and sedimentation effects will be minimized or avoided through approved design and the application of appropriate guidelines and BMPs, as described previously. An erosion and sediment control plan will be developed to integrate existing guidelines and to provide site-specific erosion and sediment control guidance.

TABLE 4.2.5-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT		
Activity	**Potential Effect**	**Avoidance or Mitigation**
Highway Construction	Direct loss of habitat	Avoid critical habitats Design appropriate crossing structures based on site conditions
	Erosion and sedimentation	Complete Highway embankment construction activities during winter months Apply erosion and sediment control plan and best practices
Clear-span Bridge Construction	Direct loss of riparian habitat within abutment footprints	Minimize riparian disturbance (footprint) Follow the DFO *Operational Statement for Clear-span Bridges* (DFO 2009b) where appropriate
	Sediment release during construction of abutments	Apply erosion and sediment control plan and best practices Complete primary construction activities during winter period
	Flow changes due to stream constriction	Abutments to be placed at a sufficient distance from active stream channel
Culvert Installation	Direct loss of habitat	Avoid critical habitats
	Barrier to migration	Employ best management practices for culvert installation Annual monitoring to detect culvert subsidence or lifting
	Sediment release during construction	Construction during winter in non-fish bearing streams Apply appropriate design and erosion and sediment control plan and best practices
	Changes in stream flow patterns	Appropriate sizing of culverts based on hydrological assessments and local experience
Use of Heavy Equipment	Soil erosion and sedimentation	Apply erosion and sediment control plan and best practices
Borrow Source Development	Erosion and sedimentation	Maintain sufficient buffer of undisturbed land between borrow sources and waterbodies Apply erosion and sediment control measures and best management practices
	Fish mortality due to blasting	Follow DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998).
Water Extraction	Oxygen level depression Exposure of eggs and larvae Reduction of available habitat for spring spawners	Follow DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories*
Road Drainage	Sediment discharge to watercourses	Filtration by natural vegetation Silt fences installed at each road-stream intersection Regular spacing of cross-drainage culverts
Culvert Maintenance	Sediment release during maintenance	Employ erosion and sediment control measures as per an Approved erosion and sediment control plan Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2009b) where applicable
Highway Operation and	Sediment release during maintenance	Implement erosion and sediment control best management practices as appropriate

TABLE 4.2.5-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT		
Activity	**Potential Effect**	**Avoidance or Mitigation**
Maintenance		Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2009b) where applicable
	Dust generation and fine particle settlement into adjacent waterbodies	Effective dust suppression (water trucks) during dry season Water License and DFO protocol to be followed.
Increased Access to Fish Resources	Increased harvest pressure due to improved access to remote fishing areas	Creation and enforcement of Regulations or guidelines on fish harvest by FJMC with input from DFO, local fisherman and Hunters and Trappers Committees Signage posted at regular intervals on Highway

Highway Design (Pre-construction)

The mitigation of potential effects to fish and fish habitat is most effectively accomplished during Highway routing and design. Appropriate planning will avoid or minimize potential effects due to:

- Loss of instream and riparian habitat at crossing footprints;
- Reduced habitat quality due to erosion and sedimentation from construction activities; and,
- Alteration of surface drainage pattern due to stream constriction.

Effects to fish and fish habitat as a result of Highway construction will be minimized by the planned avoidance of critical fish and fish habitat areas, where possible. Where critical fish habitat cannot be avoided, mitigation will be incorporated into the design, including:

- Sizing and design of appropriate crossing structures based on site conditions present at each crossing;
- Employing erosion and sediment control best management practices according to an approved EMP;
- Undertaking Highway embankment construction during the winter months; and
- Constructing or installing stream crossing structures to avoid the impingement of the active stream channel.

Clear-span Bridge Construction (Construction)

As noted in Section 4.2.4.1, the siting and construction of bridges will be consistent with the DFO Operational Statement (OS) for Clear Span Bridges (DFO 2009b). Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation. Hydrological analysis will be completed prior to bridge design to determine suitable span widths and abutment placement.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Erosion during site preparation and bridge construction will largely be avoided due to restriction of construction to the winter period. However, any exposed areas will be suitably stabilized prior to the spring thaw period. As a result, erosion and sedimentation can be avoided or minimized and residual adverse effects are anticipated to be minor.

Culvert Installation and Maintenance (Construction and Operations)

As discussed in Section 4.2.4.1, appropriate culvert sizing, the application of recognized installation guidelines and adherence to erosion and sediment control measures will reduce the magnitude, frequency, and duration of potential effects related to ground disturbance and culvert installation. In addition, since Highway embankment construction is to occur primarily during winter months, to the extent possible, the potential for erosion and sedimentation effects will be minimized or avoided. Culverts in fish-bearing streams will be installed during the fish window and will be sized and carried out using methods determined on a site specific basis to minimize erosion and sedimentation, and to ensure that flow is maintained during installation. Generally, summer flows in such streams are low and fish movements are very limited. As a result, it is anticipated that effects on water quality, fish habitat, and fish behaviour will be minor.

Routine monitoring and inspections at watercourse crossings will be carried out to confirm the correct performance of each culvert. This will involve examination for debris buildup, culvert subsidence or lifting, and stream bank or bed erosion. Where applicable, maintenance activities will be carried out in adherence to the DFO Culvert Maintenance OS (DFO 2010), which includes the removal of accumulated debris (e.g., logs, boulders, garbage, ice build-up) that prevents the efficient passage of water and fish through the structure and may also include the reinforcement of eroding inlets and outlets.

The measures outlined above are proposed to mitigate potential adverse effects to fish and fish habitat that can result from culvert installation, which include:

- Loss of instream habitat to culvert footprints;
- Creation of migration barriers;
- Reduced habitat quality due to erosion and sedimentation; and
- Changes in surface drainage patterns.

Culverts will be designed and installed according to established guidelines (DFO 1993; INAC 2010c) to avoid the creation of migration barriers, which can occur when culverts are embedded too deeply into the substrate, or more likely, when they are perched above the substrate. Periodic monitoring during the operations phase of the Highway will be carried out routinely to identify culvert maintenance requirements, which will adhere to the DFO Culvert Maintenance OS (DFO 2010).

In summary, no residual effects on fish and fish habitat are anticipated from culvert installation and maintenance due to application of the mitigation measures prescribed.

Use of Heavy Equipment (Construction)

Heavy equipment will be on-site throughout the Highway construction process and during isolated events for Highway maintenance. Effects on fish habitat due to the operation of heavy equipment relate primarily to the potential for ground disturbance, soil exposure, rutting, and the consequent mobilization and flow of suspended particulates to streams during snowmelt and rainfall events. The effects of sedimentation on fish and fish habitat were discussed earlier in this section.

The use of heavy equipment during Highway embankment construction will occur through the winter months when all watercourse crossing locations will be frozen. Therefore, the potential for erosion and sedimentation from this activity is very low.

Potential effects resulting from erosion and sedimentation during the summer months will be mitigated by the implementation of approved erosion and sediment control plans contained in the construction EMP. In addition, monitoring of construction works by environmental and wildlife monitors will: ensure the application of prescribed mitigation; identify unforeseen and potential erosion sites that could lead to the discharge of sediment to surface or groundwater; and, prevent erosion and subsequent sedimentation.

Based on adherence of approved guidelines and BMPs, and the EMP developed for this Project, residual effects on water quality from the use of heavy equipment during construction are not anticipated.

Borrow Source Development (Construction)

Borrow source locations between Inuvik and Tuktoyaktuk are identified in Figure 1.5-2. This figure identifies the general location of borrow sources, some of which are in the vicinity of streams or lakes. However, borrow sources will not be developed immediately in or adjacent to any watercourse. A minimum 50 m vegetated setback will be retained between borrow sites and watercourses.

Drill-and-blast methods may be used to excavate the required volumes of material for construction from frozen borrow sources; therefore, borrow source development near waterbodies has the potential to affect fish and fish habitat. Potential direct effects include reduced habitat quality while indirect effects include the potential for erosion and sedimentation into fish-bearing waterbodies.

Borrow pits will be developed, operated and decommissioned in full compliance with all regulatory requirements (e.g. ILA Land Use Permit and Quarry Permit, INAC Quarry Permits, ILA's ISR *Pits and Quarries Guidelines*, INAC's N*orthern Land Use Guidelines: Pits and Quarries* and according to pit development plans (PDPs). PDPs will include mitigation measures to address potential environmental concerns, and operational and reclamation plans. Mitigation includes developing borrow sources primarily during winter periods, maintaining sufficient distance of undisturbed land between borrow source locations and any waterbody, and application of appropriate erosion and sediment control BMPs for the borrow source activities.

Monitoring of borrow source development will be undertaken by environmental and wildlife monitors to ensure the application of prescribed mitigation, identify unforeseen and potential erosion sites that could lead to the discharge of sediment to watercourses and prevent erosion and subsequent sedimentation by stopping specific activities causing or likely to cause erosion and off-site discharges of turbid water. If blasting is required, it will be conducted according to DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998).

Highlights of the Guidelines include:

- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish.
- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 m/s in a spawning stream bed during the period of egg incubation. For confined explosives, setback distances from the land-water interface (e.g., the shoreline) or burial depths from fish habitat (e.g., from under the riverbed) that will ensure that explosive charges meet the 100 kPa overpressure guideline are identified in the guidelines.

Care will be taken when using explosives in borrow sources located near a stream or lake as the pressure from blasting may harm fish and fish habitat in the proximity of the blasting area. Potential effects include loss of fish and fish habitat and the contamination of waters by blasting residues. Blasting, if required, will occur primarily during winter borrow source development when streams within the Project footprint area are frozen and fish are absent. DFO blasting guidelines (Wright and Hopky 1998) will be followed to preclude the possibility of adverse effects.

Through implementation of mitigation measures during borrow source development, significant adverse residual effects are not expected.

Water Extraction (Construction)

Considerable amounts of water will be required for annual winter access road construction. It is proposed that water for this purpose will be extracted from lakes of suitable size in proximity to the Highway corridor. It is anticipated that water requirements will exceed 300 m^3/day, which will trigger the need for a NWT Water Board Type A Water Licence.

Excessive water withdrawal from small ice covered lakes can potentially result in: the depression of dissolved oxygen concentrations, leading to lethal and sub-lethal effects on fish; exposure or freezing of littoral spawning beds due to falling water levels; and, loss of important habitats for spring spawning fish (e.g., northern pike) if water levels do not sufficiently rebound to flood critical spawning habitats (Cott et al. 2008a and 2008b).

To mitigate these effects, DFO, in conjunction with other regulators and industry, developed the *Protocol for Winter Water Withdrawal in the Northwest Territories* (DFO 2010), for projects where a water withdrawal of greater than 100 m^3 is required from any individual waterbody that has the potential to provide fish habitat. Based on recent research in NWT lakes, this protocol sets limits to water withdrawal as a percentage of available under ice water volume, with consideration given to latitude and maximum lake water depth (Cott et al. 2008b). Water withdrawal thresholds for the region encompassing the Inuvik to Tuktoyaktuk Highway are:

- 0% for lakes with less than 1.5 m of free water below the maximum ice thickness (i.e., 2 m);
- 10% of available under ice water volume for lakes with a minimum depth of ≥ 3.5 m; and
- 100% if the maximum depth of the waterbody is less than the predicted maximum ice thickness (implying no available overwintering fish habitat).

In addition, the protocol directs that water be withdrawn from depths greater than 2 m below the ice surface to avoid removing the more highly oxygenated water that tends to collect at the water-ice interface. Water intake screening with mesh of 2.5 mm should be used to avoid entrainment of fish (DFO 1995).

To conform to the thresholds set out in the *Protocol for Winter Water Withdrawal in the Northwest Territories* (DFO 2010), it will be necessary to carry out bathymetric surveys on all lakes proposed for water extraction. Minimum requirements for the collection and submission of bathymetric survey information are provided in the Protocol, and are further detailed in Cott et al. (2005).

Following criteria set out in the water withdrawal protocol (2010) and any criteria included within a Type A Water Licence, residual effects on fish and fish habitat are not anticipated.

Road Drainage (Construction)

The potential exists for sediment releases to ephemeral and permanent streams due to drainage in summer months from the newly constructed road embankment, and localized slumpage of road slopes prior to compaction and stabilization. However, since vegetation will not be disrupted at the toe of the road slopes, it is expected that sediment flow will be limited and filtered by this vegetation to reduce this potential risk. In addition, silt fences will be installed at each road-channel intersection to prevent sediment releases to streams. Silt fences will be left in place until roadways are compacted and stable, and will be routinely monitored and maintained. Cross drainage culverts, which will be installed at regular intervals, will channel road drainage away from streams and allow filtration by natural vegetation. Because of these measures, no residual effects on fish habitat due to road drainage are anticipated.

Highway Maintenance (Operations)

During the operations phase of the Highway, it is anticipated that the Highway surface will require routine maintenance (e.g., grading, resurfacing, and dust suppression). The frequency of Highway maintenance is dependent on factors such as Highway safety and condition, the impact of periodic severe weather, and the extent of required maintenance. Highway maintenance and the application of dust suppression techniques can result in the release of fine or granular material directly into streams, and the creation of fine dust, which can settle in nearby watercourses. When discharged or settled in fish-bearing waters, these particulates can potentially affect fish habitat, as described at the beginning of Section 4.2.5.1.

Potential effects to water quality from dust generation and settlement are anticipated to be minor and of short-duration due to mitigation by the application of non-toxic dust suppression techniques (water trucks) that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998). Based on adherence to the dust suppression guidelines, no adverse residual effects are anticipated from maintenance activities.

Increased Access to Fisheries Resources (Operations)

Rescan (1999a) concluded that the greatest potential indirect impact from Highway construction is the potential increase in fish harvest pressure through domestic and sport fishing. This is due to the improved access that will be afforded by the Highway to important, but remote, fish harvest areas in some of the lakes along the proposed Highway, as well as the numerous watercourse crossings. Potential effects of increased harvest pressure include:

- Reduced levels of fish available for subsistence fishing; and
- Increased potential for anthropogenic disturbances to remote fishing areas (i.e., garbage and/or disruption of fish habitat, and increased use of waterbodies for recreational purposes, such as boating).

Potential effects can be avoided or minimized through consultation with and involvement of stakeholders, such as the FJMC and the HTCs in identifying issues of concern and jointly developing strategies and guidelines, in conjunction with regulatory bodies, to manage sensitive fisheries resources. For example, appropriate signage posted at regular intervals on the Highway, and public education can assist with the minimization of effects due to habitat damage and overexploitation of resources.

However, while it is likely that effects will be minimized, it is unlikely that these measures will entirely mitigate the potential for increased harvest pressure during operation of the Highway and residual effects are, therefore, expected. With public involvement and coordination of efforts, adverse residual effects to fish and fish habitat are anticipated to be low and not significant.

4.2.5.2 Monitoring

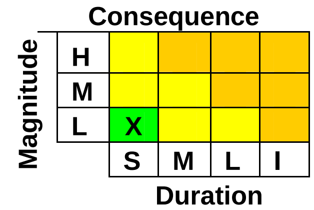
Monitoring of the Highway construction will be carried out by ILA environmental monitors and HTC wildlife monitors who will be on-site throughout construction. Construction monitoring will be carried out as required to ensure that prescribed mitigation measures and BMPs are implemented and to detect and correct unanticipated problems. Post-construction monitoring will be carried out according to the extent, frequency and duration required by regulators to evaluate the success of mitigation measures and to identify required modifications, repairs, or maintenance. Since the Highway construction will proceed over successive years, there is an opportunity to apply adaptive management procedures to this Project. Adaptive management includes learning from experience and applied practices so that modifications can be applied to improve results, if necessary. Methods and procedures applied during a construction season can therefore be evaluated and modified, if necessary, to improve environmental protection in the following construction period.

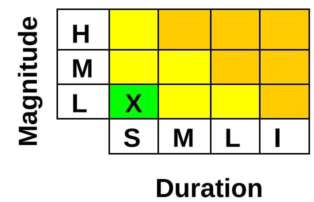
4.2.5.3 Residual Effects

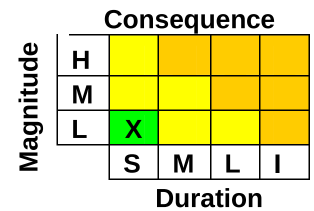
Based on the previously discussed assessments of the various components of Highway construction, operation, and maintenance, and following the implementation of mitigation measures, the Project may result in residual effects on fish or fish habitat. However, these effects are expected to be minor and will not significantly reduce the productive capacity of fish habitat within the area. Specific assessment of the significance of each anticipated residual effect is provided in Table 4.2.5-2. Summaries of the rationale for each assessment are provided following the table.

TABLE 4.2.5-2: RESIDUAL EFFECTS ASSESSMENT FOR FISH AND FISH HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Fish and Fish Habitat - Construction Phase - Loss of Riparian Habitat from Bridge Abutment Construction	High	Local	Long-term	Continuous	Irreversible	High
Fish and Fish Habitat - Construction Phase - Reduced Quality of Habitat from Erosion and Sedimentation during Bridge Construction	Low	Local	Short-term	Isolated	Reversible Short-term	Low
Fish and Fish Habitat - Construction Phase - Direct Loss of Instream Habitat from Culvert Installation	Low	Local	Long-term	Continuous	Irreversible	High
Fish and Fish Habitat - Construction Phase - Reduced Quality of Habitat from Erosion and Sedimentation during Culvert Installation	Low	Local	Short-term	Isolated	Reversible Short-term	Low







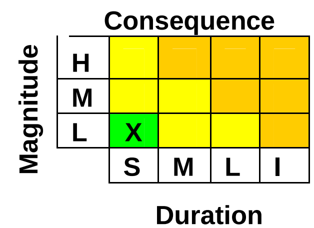


TABLE 4.2.5-2: RESIDUAL EFFECTS ASSESSMENT FOR FISH AND FISH HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						Consequence
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Fish and Fish Habitat - Operation Phase - Increased Harvest Pressure	Low	Local	Short-term	Isolated	Reversible Long-term	Moderate	Magnitude L / Duration S (X)

Consequence

Magnitude				
H				
M				
L	X			
	S	M	L	I

Duration

Clear-span Bridge Construction (Construction)

Siting and construction of bridges will be consistent with the DFO *Operational Statement for Clear Span Bridges*. Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation. Hydrological analysis will be completed prior to bridge design to determine suitable span widths and abutment placement.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Culvert Installation (Construction)

Culverts will be designed and installed according to established guidelines to avoid the creation of migration barriers, which can occur when culverts are embedded too deeply into the substrate, or more likely, when they are perched above the substrate. Periodic monitoring during the operations phase of the Highway will be carried out routinely to identify culvert maintenance requirements, which will adhere to the DFO Culvert Maintenance OS.

Adherence to culvert installation and sediment and erosion control measures contained in Dane (1978), DFO *Land Development Guidelines,* and GNWT erosion and sediment control best practices will result in minimal and non-significant releases of sediment.

Use of Heavy Equipment (Construction)

As Highway embankment construction is to occur during the winter months, potential effects resulting from erosion and sedimentation during this time will be negligible. Sedimentation associated with drainage from the embankment during the summer months is expected to be localized and limited. With the use of silt fences at road-channel intersections and the natural filtration provided by the vegetation in overland areas, no significant residual effects on fish or fish habitat are expected to occur.

Borrow Source Development (Construction)

No significant residual effects are expected to occur as a result of borrow source development on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between borrow source developments and fish and fish habitat is expected.

Borrow Source Blasting (Construction)

No significant residual effects are expected to occur as a result of blasting on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between blasting and fish and fish habitat is expected.

Water Extraction (Construction)

No significant residual effects are expected to occur as a result of water extraction on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between the water extraction and fish and fish habitat is expected.

Culvert Maintenance (Operations)

No significant residual effects are expected to occur as a result of culvert maintenance on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between Highway culvert maintenance and fish and fish habitat is expected.

Highway Maintenance (Operations)

No significant residual effects are expected to occur as a result of highway maintenance on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between Highway maintenance and fish and fish habitat is expected.

Increased Access to Fisheries Resources (Operation)

It is likely that effects resulting from increased access to fisheries resources will be minimized through mitigation measures described. However, it is unlikely that these measures will entirely mitigate the potential for increased harvest pressure effects during operation of the Highway and adverse residual effects are, therefore, expected. Following establishment, monitoring and enforcement of guidelines and regulations, residual effects to fish and fish habitat are anticipated to be low and not significant due to the low magnitude and negligible frequency rating for anticipated increases to fishing harvest.

4.2.6 Vegetation

The main effects of the proposed Inuvik to Tuktoyaktuk Highway will be the removal and/or burial of vegetation types and plant species by the Highway footprint. Other anticipated effects include the deposition of dust on plants and substrates adjacent the roadway, the potential introduction and spread of invasive or non-native plant species into natural areas, and changes to local surface hydrology. These effects can directly or indirectly affect the heath and function of the plant species and vegetation types present. The assessment of Project effects included looking specifically at effects to rare plant species and unique vegetation types in the study areas.

4.2.6.1 Removal and/or Burial of Vegetation Types and Plant Species

The proposed Inuvik to Tuktoyaktuk Highway footprint will disturb approximately 383 ha which is 2.8% and 0.1% of the LSA and RSA, respectively (Table 4.2.6-1). Of the EOSD land cover classes present within the proposed footprint, the Bryoids, Shrub Low, Shrub Tall, Broadleaf Dense, and Mixedwood Dense classes will be most affected overall. These classes could represent various vegetation types in the study area such as the Dwarf Shrub Heath, Upland Shrub, Upland Alaska Birch-Spruce, Riparian Shrub, and Riparian Black Spruce/Shrub types. With the exception of the Riparian Black Spruce/Shrub vegetation type, all are fairly extensive throughout the LSA and RSA.

The Riparian Black Spruce/Shrub vegetation type was only identified in the vicinity of Holmes Creek and Hans Creek, and represents the only forested vegetation type in the Tundra Plains Ecoregion. It is also the northernmost extent of black spruce in the area. While it is unlikely that any stream crossings will be developed through this vegetation type, assessments of stream crossings in the vicinity of Holmes and Hans creeks will be carried out ahead of construction for this vegetation type specifically, and if present, it will be avoided.

Although not identified spatially, approximately 50 ha of additional area will be disturbed as a result of the excavation of borrow sources for construction material. These areas would likely be associated with the Exposed/Barren Land or Rock/Rubble EOSD land cover classes due to their lack of vegetation cover and higher possibility of containing granular material. The Exposed/Barren Land cover class in particular could represent the Dry Saxifrage Tundra vegetation type, which was identified as having a high potential of supporting suitable habitat for the Sensitive plant, Yukon stitchwort (*Minuartia yukonensis*).

All borrow source locations will be surveyed by a qualified biologist/botanist for the presence of Yukon stitchwort and other rare plant species in advance of construction. Should any rare species be present, they will be avoided wherever possible. If avoidance is not possible, other suitable mitigation strategies, such as transplanting or collecting specimens for donation to a herbarium, will be developed.

Approximately 62 ha of treed area will be affected by the proposed Inuvik to Tuktoyaktuk Highway footprint (Table 4.2.6-1). The majority (57 ha) occurs either near or below the treeline and are composed primarily of broadleaf or mixedwood stands. The trees themselves are likely of little merchantable value.

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA								
Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha)			Local Study Area[2] (ha)			Regional Study Area[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Mackenzie Delta HS	Water		Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	1.7	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	9,092.9
	Not Classified (Cloud)	0.04			29.3			2,783.0
	Coniferous Dense				1.3			2,776.9
	Broadleaf Dense	2.5			95.0			2,440.0
	Mixedwood Dense	2.1			55.2			2,160.0
	Wetland Shrub				4.2			1,246.4
	Exposed/Barren Land							1,112.0
	Wetland Herb				0.2			1,095.2
	Coniferous Sparse	1.8			31.3			854.0
	Coniferous Open	0.1			2.7			513.8
	Broadleaf Open	1.2			39.5			375.5
	Mixedwood Open				0.1			332.1
	Wetland Treed							326.1
	Shrub Tall	0.1			0.7			301.5
	Bryoids							293.6
	Shrub Low				0.4			245.4
	Herbs							24.9
	Rock/Rubble							0.2
Mackenzie Delta HS Total		**7.9**			**261.7**			**25,973.7**
Sitidgi Plain HS	Broadleaf Dense	4.0	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	142.7	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	916.8
	Mixedwood Dense	3.0			99.9			466.9
	Coniferous Sparse	1.4			62.1			260.9
	Broadleaf Open	1.3			49.6			218.4
	Not Classified (Cloud)				0.1			76.1
	Water				10.2			34.8
	Coniferous Dense	0.1			6.2			33.4
	Coniferous Open	0.2			5.7			25.8
	Wetland Shrub	0.5			4.8			13.0

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA

Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha)			Local Study Area[2] (ha)			Regional Study Area[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Sitidgi Plain HS (cont'd)	Shrub Low	0.1	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	2.4	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	11.7
	Herbs				0.2			3.6
	Wetland Herb				0.4			3.0
	Wetland Treed				0.7			2.8
	Bryoids				1.0			1.0
	Shrub Tall	0.1			0.4			0.8
	Exposed/Barren Land				0.4			0.4
	Mixedwood Open							0.2
Sitidgi Plain HS Total		**10.7**						**2,069.9**
Caribou Hills LA	Bryoids	38.4	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	1,244.5	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	25,917.2
	Coniferous Sparse	10.6			446.7			17,208.5
	Shrub Low	26.1			684.7			16,832.6
	Water	0.1			343.6			14,309.3
	Exposed/Barren Land	12.6			448.5			9,092.8
	Mixedwood Dense	6.8			255.5			6,986.7
	Shrub Tall	6.7			276.3			4,801.5
	Broadleaf Dense	17.7			370.8			4,179.7
	Coniferous Open	1.0			73.0			2,885.2
	Herbs	2.8			95.6			1,886.0
	Coniferous Dense	0.3			49.8			1,853.3
	Wetland Herb	0.4			53.9			1,694.3
	Broadleaf Open	2.8			84.2			1,665.9
	Wetland Shrub	1.7			87.9			1,660.5
	Rock/Rubble	2.4			68.7			1,009.7
	Not Classified (Cloud/Shadow)				16.4			608.7
	Wetland Treed	0.03			13.3			395.0
	Mixedwood Open				5.2			214.1
Caribou Hills LA Total		**130.4**			**4,618.5**			**113,200.9**

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA

Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha)			Local Study Area[2] (ha)			Regional Study Area[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Tuktoyaktuk Coastal Plain LA	Water	0.4	0.1	0.2	1,426.4	1,377.6	1,540.2	109,974.7
	Bryoids	88.3	68.4	81.0	2,370.7	1,789.9	2,126.1	39,434.5
	Shrub Low	89.4	99.1	91.0	2,238.3	2,457.8	2,200.8	38,586.9
	Shrub Tall	28.6	35.6	29.6	960.2	1,105.8	992.4	16,871.8
	Wetland Herb	3.2	2.8	3.1	311.7	354.2	305.0	7,728.5
	Wetland Shrub	7.4	4.5	7.5	346.5	299.3	331.5	6,435.3
	Exposed/Barren Land	6.8	4.3	5.8	270.2	171.0	247.0	5,886.4
	Herbs	5.3	6.5	6.6	232.4	297.9	250.2	4,477.8
	Coniferous Sparse	1.7	2.9	1.7	86.8	109.1	86.6	2,673.8
	Coniferous Open	1.5	1.8	1.5	69.0	112.2	69.0	1,650.3
	Wetland Treed	0.2	0.3	0.2	25.5	43.5	26.4	959.1
	Rock/Rubble	0.9	1.1	0.8	39.1	26.2	38.2	513.6
	Mixedwood Open	0.8	0.5	0.8	13.4	15.5	13.4	242.5
	Mixedwood Dense	0.01		0.01	1.1	1.3	1.1	157.8
	Coniferous Dense							78.0
	Broadleaf Open							22.0
	Not Classified (Cloud/Shadow)							17.0
	Broadleaf Dense							4.3
Tuktoyaktuk Coastal Plain LA Total		**234.3**	**227.9**	**229.7**	**8,391.3**	**8,161.4**	**8,228.0**	**235,714.4**
Grand Total		**383.3**	**376.9**	**378.7**	**13,658.3**	**13,428.4**	**13,494.9**	**376,958.9**
Proportion of LSA (%)		**2.8**	**2.8**	**2.8**				
Proportion of RSA (%)		**0.1**	**0.1**	**0.1**				

[1]As per Wulder et al. (2004)
[2]The route alignment options only occur within the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion; therefore, all other Ecoregion calculations will remain the same for all alternatives.
[3]All route options
[4]Approximately 50 ha of additional area will be disturbed as a result of excavation for borrow source materials and could be represented by the Exposed/Barren Land or Rock/Rubble land cover classes

4.2.6.2 Effects of Dust

Construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. The principal air quality concerns related to vegetation effects arise from the deposition of fugitive dust and gaseous emissions, primarily NOx and SO_2.

Activities associated with the construction of the Highway and vehicle traffic will generate dust. Undisturbed areas of the Arctic tundra are relatively free of natural dust sources, so the consequences from anthropogenic sources can be noticeable. Fugitive dust emissions can have both direct and indirect effects on vegetation.

Patterns of dust deposition on vegetation are a function of various factors including particle size, wind, ambient moisture, and vehicle and traffic characteristics. Small particles travel farther, especially if borne by strong winds.

Dust particle size plays a role in determining how extensive the effects of dust can be. Road dust has been detected on vegetation 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away from a source (Lamprecht and Graber 1996). These distances are consistent with deposition studies conducted by the United States Environmental Protection Agency (US EPA) on particles with varying aerodynamic diameters (US EPA 1995).

Dust particles with larger aerodynamic diameters (e.g., >100 μm) were found to settle within 10 m of a source. Smaller particles (e.g., with aerodynamic diameters between 30 to 100 μm) settled out within 100 m. Particles smaller than 15 μm tend to be less influenced by gravitational settling and can be transported over greater distances (US EPA 1995). For the proposed Inuvik to Tuktoyaktuk Highway, it is anticipated that the largest effects to ecosystems and plants from fugitive dust will occur within 100 m of the Highway.

Common effects of dust on vegetation include the physical smothering of leaf surfaces, the blocking of stomata, and the alteration of leaf physiology. The deposition of dust onto leaf surfaces can reduce photosynthetic efficiency in the plant by physically blocking stomata and restricting the amount of light reaching photosynthetic organs (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993). Dust can also alter leaf physiology by increasing leaf surface temperatures, which can negatively affect photosynthesis but can positively affect respiration (Eller 1977).

The more indirect effects of dust can manifest as changes to the surrounding environment such as alterations to soil pH, soil nutrient regime, the depth of permafrost thaw, and earlier snowmelt due to changes in the surface albedo of snow (Walker and Everett 1991; Auerbach et al. 1997; Gunn 1998). These more subtle changes can induce subsequent changes in plant species composition as they adjust to the altered growing conditions.

Dust effects may also be more prevalent on plant groups that are more sensitive to disturbance, such as lichens and some moss species, such as *Sphagnum* (Spatt and Miller 1981). Lichens in particular are often used as indicators of air quality conditions due to their sensitivity to environmental pollutants (Tyler 1989; Markert 1993). Lichens often accumulate substances such as sulphur, nitrogen, and metals from atmospheric sources better than vascular plants (Blett et al. 2003). Local lichen populations may be negatively affected by regular dust deposition. *Sphagnum* moss species are often indicative of nutrient poor and low pH conditions which could change with regular dust deposition as well.

4.2.6.3 Potential Introduction and Spread of Invasive Plants

Several factors contribute to the successful colonization of an area by invasive plant species, and include the provision of suitable habitat, access to a source of invasive plant material, a means of access to unaffected areas, and a mechanism of dispersal. Activities associated with major development projects can coincidentally supply all of these factors, from exposed soils and ground disturbance to the import and export of dirty machinery and equipment that may contain seeds and/or vegetative parts (propagules) of invasive plants.

Currently the incidence of invasive plants in the Arctic is low, however recent studies from Alaska suggest invasions may just be delayed or had not been formally documented until more recently (Schrader and Hennon 2005; Carlson and Shephard 2007). The increased level of development in more remote areas combined with a more deliberate assessment of invasive plant species presence suggest invasions are on the rise.

The introduction, spread, and overall effects of invasive plant species on the surrounding environment can be controlled through effective management strategies established early on in Project planning and carried out through operations. Preventing the introduction of invasive species into an area is the most effective and efficient management strategy compared to managing their removal once established (Clark 2003; Polster 2005; USDA 2006; Carlson and Shephard 2007).

While invasive plant species are largely restricted to populated and high-use areas in the Arctic, development and operation of the proposed Inuvik to Tuktoyaktuk Highway could result in an increase in invasive plant species presence, primarily along the roadside.

4.2.6.4 Alteration of Local Hydrology

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, which can result in changes to both upstream and downstream plant communities (Pomeroy 1985; Spellerberg and Morrison 1998; Trombulak and Frissell 2000). The interception or diversion of surface and shallow subsurface flows by roads can increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions (Pomeroy 1985; Trombulak and Frissell 2000). Ponding can also lead to permafrost degradation and the development of thermokarst conditions (Pomeroy 1985).

Sedimentation from the Highway surface as well as from diverted surface and subsurface flows can result in localized sediment and nutrient loading in receiving areas. During the first summer following winter construction, sedimentation and runoff from the Highway surface could occur in some areas, resulting in the deposition of granular material immediately adjacent to the embankment. Associated runoff is expected to filter through the existing tundra vegetation. Vegetation types that are naturally nutrient poor (e.g., *Sphagnum*-dominated vegetation types) or more sensitive to changes in their environment (e.g., lichens) would likely be affected most.

Vegetation types in the Project area that are likely to be most affected by altered hydrological conditions include those that are lichen or *Sphagnum*-dominated, wetlands, and very dry vegetation types, all of which are either composed of sensitive plant species or species assemblages adapted to a particular moisture regime.

4.2.6.5 Contaminants in Plants

Similar to terrestrial wildlife, levels of organochlorines (OCs) and metals in Canadian Arctic vegetation is minimal therefore few studies have been conducted and little data exists on the subject. Air quality effects associated with specific Project activities will be minimal and temporary.

The accidental spillage of fuel, lubricants, and/or anti-freeze at a work site or during the construction phase represents a potential hazard. In the event of a spill, clean-up measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. Further information regarding accidents and malfunctions is found in Section 4.4.

4.2.6.6 Project Design and Mitigation Measures

The primary mitigation measure for reducing potential effects to vegetation types will be to restrict the size of the overall Highway footprint, where possible, and to carefully plan the overall route, which includes avoiding sensitive and unique vegetation types and rare plant species (Table 4.2.6-2). The route options limit effects to Bryoids and Shrub Low land cover types by avoiding more sensitive areas such as wetlands and riparian areas.

The most effective mitigation strategy for rare plant species that may be present within the Project footprint is avoidance. Additional surveys will be conducted throughout the construction phase in areas with a high potential of supporting rare plants, such as in borrow source areas that are characterized as the Dry Saxifrage Tundra vegetation type. Should rare plants be identified, they will be avoided where possible. If avoidance is not an option, specimens will be collected, transferred to another suitable location, and/or donated to local herbaria for educational purposes.

Areas in the vicinity of Holmes Creek and Hans Creek that are characterized as the Riparian Black Spruce/Shrub vegetation type will also be avoided if possible. If disturbance to this vegetation type is unavoidable, efforts will be made to maintain as much of this vegetation type intact and limiting potential fragmentation.

Borrow source areas will be recontoured progressively once activities are completed, if possible. The principal means of revegetation associated with abandoned borrow sources will be by natural colonization. Those areas that could support deliberate re-vegetation efforts will be scarified and seeded with appropriate northern, native plant species.

Even with the application of reclamation measures, areas used for borrow material will not be completely restored to their previous state due in part to the alteration of local surface topography resulting from excavation. Re-vegetation efforts, combined with slow natural re-vegetation processes, will lead to the slow re-establishment of vegetation characteristic of naturally granular upland areas.

The primary mitigation measure to control the effect of dust during construction and operation of the Highway will include applying water as needed, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998).

Potential strategies for mitigating potential effects on the vegetation types in the vicinity of the Highway and associated borrow operations are provided in Table 4.2.6-2. With the application of the proposed mitigation measures, effects on vegetation are generally expected to be limited to the physical footprint and are considered to be minor in the context of the overall Project area.

There is a potential for contaminant spills to occur during the construction phase of the Highway. In the event of a spill, clean-up measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

TABLE 4.2.6-2: POTENTIAL EFFECTS AND MITIGATION STRATEGIES FOR VEGETATION ALONG THE HIGHWAY

Potential Effect	Potential Consequence	Mitigation Measures
Vegetation – Removal and Burial	Removal of vegetation; reduction of vegetation types with restricted distribution	Minimize footprint; Minimize development on vegetation types with restricted distribution; Avoid sensitive or rare plant vegetation types; Restrict off-site activities (e.g., ATV use) to footprint area; Reclaim to viable and self-sustaining vegetation types.
Dust	Potential reduction in vegetation health and productivity	Application of dust suppressants, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998).
Potential Introduction and Spread of Invasive Plants	Displacement of native species and alteration of plant species composition of adjacent vegetation types	Minimize footprint; Ensure machinery and equipment is clean prior to use on site; Periodic monitoring of roadsides for invasive species establishment

TABLE 4.2.6-2: POTENTIAL EFFECTS AND MITIGATION STRATEGIES FOR VEGETATION ALONG THE HIGHWAY

Potential Effect	Potential Consequence	Mitigation Measures
Alteration of Surface Hydrology	Change in water flow patterns and quantity; possible nutrient and sedimentation loading in receiving areas	Design and engineering of roadbed and drainage structures tailored appropriately to accommodate unique environmental conditions; Adequate drainage in wet lowland areas through the installation of culverts as necessary.
Contaminant Spills	Reduction in vegetation health and productivity due to spills	Contain and clean-up spills immediately. Contact authorities immediately to determine appropriate course of action. Respond according to site-specific spill contingency plan and the contractor's HSE manual and procedures.

4.2.6.7 Residual Effects

Within the LSA, the removal or burial of vegetation types and plant species/groups will occur during construction and the effects will remain so long as the Highway is in place (Table 4.2.6-3). The effect is considered a high magnitude and of moderate consequence overall.

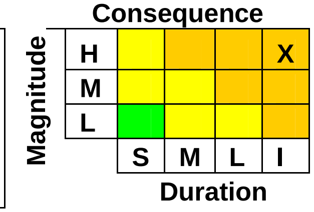
The effects of borrow source development on vegetation types and plant species/groups will also occur during construction however the duration is short-term. The effect is still of high magnitude, however, due to the reversibility of the effect over the long-term, the consequence is low. The structure and species composition of reclaimed borrow source areas may be different than what was originally present; however, efforts will be made to establish a self-sustaining vegetative cover that is appropriate for the surrounding environment.

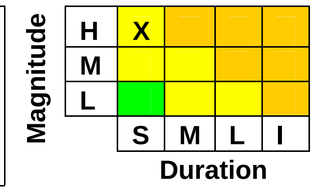
The potential degradation of vegetation types and plant species resulting from dust deposition, the introduction of invasive plant species, and the alteration of local hydrology has been assessed as a low magnitude, local effect that will persist over the long-term. Effects will be periodic throughout the life of the Project and are reversible over the long-term. As such the effect has been rated as being of low consequence.

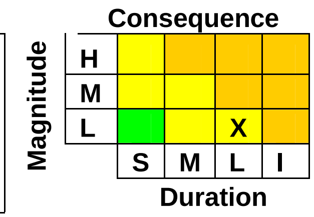
Residual effects to vegetation types and plant species are anticipated to be negligible in the context of the RSA, and as such have not been assessed further.

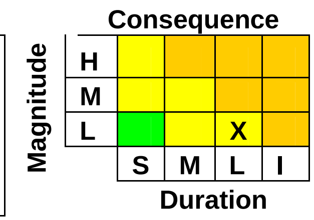
TABLE 4.2.6-3: RESIDUAL EFFECTS SUMMARY FOR EFFECTS TO VEGETATION TYPES

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Removal/Burial of Plant Species and Vegetation Types (Highway Alignment)	High	Local	Long-term	Continuous	Irreversible	High
Removal/Burial of Plant Species and Vegetation Types (Borrow Sources)	High	Local	Short-term	Sporadic	Reversible Long-term	High
Dust Deposition	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Introduction of Invasive Plant Species and Alteration of Local Hydrology	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate









4.2.7 Wildlife and Wildlife Habitat

Potential effects and mitigation measures for wildlife species identified as VCs are described in this section. Wildlife species identified as VCs include:

- Caribou – Barren-ground and woodland caribou;
- Grizzly Bears;
- Moose
- Furbearers –Wolverine, red fox and Arctic fox; and,
- Birds.

According to Jalkotzy et al. (1997), corridors function in five different ways for wildlife, acting as habitat, conduits, filters or barriers, sources, and sinks. Roads may be considered habitat when they provide wildlife with some requisites for survival such as food or shelter (e.g., insect relief for caribou). A road is a conduit when wildlife moves along it (e.g., a wolf traveling on a wind-swept road during winter). Roads may be barriers or filters if wildlife movements across them are blocked completely or selectively, respectively. Roads may act as sources (provide habitat) if wildlife living in the corridor disperses into surrounding habitat (e.g., small mammals such as ground squirrels). Alternatively, they may act as sinks if wildlife are attracted and dies as a result (e.g., collisions).

The physical existence of the Highway, the habitats it traverses, patterns and intensity of use by wildlife, and patterns and intensity of vehicle traffic all play major roles in determining the extent to which a road may affect wildlife (Del Frate and Spraker 1991; Oosenbrug et al. 1991; Underhill and Angold 2000). Wildlife responses to the construction activities of the proposed Highway and its associated borrow source developments, the physical presence of the proposed Highway, and human activity along the proposed Highway depend, in part, on whether or not they are resident, seasonally resident or migratory.

4.2.7.1 Species at Risk

Three wildlife species were identified as at risk within the study area, grizzly bears, wolverines, and Boreal Woodland Caribou. Grizzly bears and wolverines are ranked by COSEWIC as Special Concern and by NWT General Status Ranking as Sensitive. Boreal Woodland Caribou are currently listed under SARA as Threatened (COSEWIC 2009).

Potential effects and mitigation measures for grizzly bears are described in the grizzly bears section (Section 4.2.7.3). Potential effects to wolverines are discussed in the Furbearers section (Section 4.2.7.5). Boreal caribou have been shown to be affected by linear development (GNWT ENR NDg); however, the density of linear development in the RSA is less than the threshold predicted to impact populations (Canadian Boreal Initiative 2007). Potential effects to caribou are discussed in Section 4.2.7.2.

4.2.7.2 Caribou and Caribou Habitat

Effects associated with the construction of the proposed Highway and its associated borrow sources can be in the form of effects on caribou and effects on their habitat. Habitat effects include the loss, fragmentation, or degradation of habitat. Habitat loss will occur during the construction phase, along the Highway and borrow source footprints. Degradation of habitat is a secondary effect of habitat loss during construction and operation.

The majority of construction for the proposed Highway and excavation of the associated borrow sources will occur during the winter period. The work will occur within caribou winter range and as such a caribou monitoring and protection plan during construction will be required (see Section 7.1).

Potential effects on caribou from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Physical and physiological disturbance;
- Displacement away from the proposed Highway;
- Increased activity and energy expenditure near the proposed Highway;
- Delayed crossing or failure to cross the proposed Highway;
- Altered migration;
- Reduced use of habitats adjacent to the proposed Highway;
- Habituation to the Highway;
- Injury or death from collisions with vehicles; and,
- Increased hunting pressure along the proposed Highway.

Potential effects on caribou are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following section.

Potential Effects

<u>Habitat Loss</u>

The direct effects of the proposed Highway include the loss of existing habitat under the Highway footprint and the excavation of the borrow sources. Roads eliminate the habitat upon which they are built by burying the vegetation that it covers. The footprint of the proposed Highway is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the Highway is estimated to be 383 ha, approximately 0.002% (217 ha) of the Bluenose-West Herd winter range, approximately 0.019% (212 ha) of the

Cape Bathurst Herd winter range and approximately 0.0008% (32 ha) of suitable Boreal caribou habitat.

The majority of the proposed Highway alignment is situated on upland tundra habitats. Caribou tend to favour wetland and riparian habitats during the early growing season, shrub dominated sites in the summer and wind-swept ridges with accessible lichens during the winter. Upland, snow free areas are more important in the winter for easier access to food. Within the RSA, the Bryoid, Exposed/Barren Land and Shrub Low habitats were identified as lichen dominated upland tundra sites likely to be important caribou feeding habitats in winter. While the removal of upland tundra habitat will represent a loss, at the landscape scale the loss is small compared to the amount of similar habitat available (137,414 ha) within the RSA. The Highway footprint represents approximately 0.005% of upland tundra in the RSA.

Boreal caribou are dependent on arboreal lichens which are associated with coniferous trees. Within the RSA the coniferous and mixedwood habitats were identified as arboreal lichen sites likely to be important for boreal caribou feeding and life requisites. While the removal of forested habitats will represent a loss, at the landscape scale the loss is small compared to the amount of similar habitat available (41,374 ha) within the RSA of which the Highway footprint represents approximately 0.007% of that habitat type.

Borrow excavation activities will cause some localized, temporary habitat loss. Borrow source areas will be re-contoured progressively once activities are completed. The principal means of re-vegetation associated with abandoned borrow sources will be by natural colonization. Those areas that could support deliberate re-vegetation efforts will be scarified and seeded with appropriate northern, native plant species. Re-vegetation efforts, combined with slow natural re-vegetation processes, will lead to the slow re-establishment of vegetation characteristic of natural granular upland areas. Since terrestrial lichens are slow growing, it is likely to be decades before there will be sufficient lichen to provide food for caribou.

Limited effects related to habitat fragmentation and edge effects are expected to occur because the proposed Highway is primarily located in the tundra and does not involve the creation of openings in forest canopy.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation.] Changes in plant species composition could alter the availability of food and the effect could be positive or negative, depending on the specific conditions.

Dust deposition from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations can cover vegetation and decrease the abundance of forage. Dust created by Highway traffic during the summer months is expected to settle within 100 m of roads (see Section 4.2.6.2 for a more complete description of effects of dust on vegetation). This represents 2,740 ha (0.007%) of caribou winter range. However, the quantity of dust is unlikely to have a major effect on vegetation and food availability. Dust suppression methods as described in *Guideline for Dust Suppression* (GNWT 1998) will be employed to minimize potential issues associated with dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for wildlife. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents another potential hazard. In the event of a spill, cleanup measures will be implemented immediately. All spills will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Activities related to the construction and operation of the Highway may alter the behaviour or distribution of caribou in the RSA. Caribou can be sensitive to sensory disturbance (noise from machines, human presence and vehicles) and displacement from habitat adjacent to roads has been reported. Habitat displacement can result in reductions in access to security areas and in the efficiency of foraging strategies, with possible population-level consequences. Disturbances such as traffic noise and blasting can result in high metabolic stress levels in caribou (Bradshaw et al. 1998). Vehicle traffic along roads can also affect migration movements during certain periods of the year.

Caribou may avoid areas within a zone of influence of the Highway. Many factors affect the distance of a zone of influence, such as topography and the presence of security cover and environmental conditions such as wind and snow cover. How caribou respond to various stimuli is influenced by the degree of habituation of the individual involved. Studies of roads and barren-ground caribou report varying effects. Studies on oilfield development in Alaska report that calving caribou were displaced within 2 to 4 km of roads (Dau and Cameron 1986; Cameron et al. 1992, 2005). Also in Alaska, Curatolo and Murphy (1986) reported that caribou crossed roads and pipelines as frequently as control areas. Caribou around diamond mines in Northwest Territories have been commonly observed resting and feeding near airstrips and roads (Gunn et al. 1998; BHPB 2007). A review by Wolfe et al. (2000) reports that infrequently travelled transportation corridors did not deter crossing by caribou and had no observable effect on traditional migration routes or annual distribution, whereas heavy traffic accentuated the reaction to roads and may impede crossing and serve as a barrier. The elevate road structure itself could present a visual barrier to caribou and could result in delayed crossing. Wolfe et al. (2000) concluded that roads elevated more than 1.2 above ground level were more likely to deflect caribou from crossing.

It is expected that caribou will generally avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. The degree of avoidance is likely to be higher once construction is complete and regular vehicle traffic commences.

Mortality

Caribou mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access.

Traffic-related mortality can be linked to several factors including traffic density, vehicle speed and/ or road width. Any of these factors can directly affect the success of wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely. The Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day), which can be expected to minimize potential traffic-related mortality along the Highway. Speed limits, giving wildlife the right-of-way, and signage in areas with caribou concentrations could help minimize the potential for caribou-vehicle collisions.

Caribou mortality could increase should hunting be allowed near the Highway. The Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality for caribou will increase. Residents of Tuktoyaktuk and Inuvik have expressed concern that hunting pressure on caribou and other wildlife may increase as a direct consequence of building the Highway. To protect wildlife, organizations such as the ILA, HTC, ITC, WMAC, and GNWT (DENR and DOT) will need to continue to work cooperatively to develop guidelines and conditions for use of the Highway. Discussions with these agencies identified a shared view that the success of this approach would require a high level of voluntary compliance from the users of the proposed Highway and a public education program that would include signage along the Highway highlighting current hunting regulations and discouraging excessive hunting along the corridor.

The implementation of hunting restrictions and other proposed mitigation measures could be used to minimize the effects of hunting on caribou. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to low caribou numbers. Should the caribou population recover, the creation of hunting restrictions along the Highway corridor could be considered on the basis of public safety or conservation as per the IFA. No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4). These no-hunting corridors apply to all hunters, and represent a significant cooperative venture in the wildlife management field (Treseder and Graf 1985).

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on caribou in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase;
- Minimize disruption of migration patterns due to vehicle traffic; particularly when the barren-ground caribou arrive within the study area for the fall rut and their departure to the calving grounds in the spring;
- Minimize direct mortality due to collisions with vehicles;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage agencies such as the HTCs, WMAC and GNWT ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-1 presents the mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on caribou.

TABLE 4.2.7-1: MITIGATION MEASURES FOR CARIBOU AND CARIBOU HABITAT

Project Activity	Potential Effect	Mitigation Measures
All Activities	Habitat Disturbance/ Degradation	• Project footprint has been minimized and previously disturbed areas will be used, wherever. • A wildlife protection plan will be implemented for the construction phase. • Waste will be trucked out, rather than using a sump. • Application of dust suppressants (water) during the summer, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998), to limit potential reduction in caribou winter forage quality and productivity.
All Activities	Sensory and other Disturbances	• Highway access will be restricted during peak barren-ground caribou migration periods (i.e. arrival during fall rut and departure to calving grounds in the spring). • Wherever possible, technologies to minimize sound disturbance have been incorporated into Project design. • Blasting activities, if required, will be limited to borrow sites and will only occur when caribou are > 500 m from the blast site.
All Activities	Caribou Incidents	• Provide field workers with education and awareness of the wildlife protection plan guidelines and programs.

TABLE 4.2.7-1: MITIGATION MEASURES FOR CARIBOU AND CARIBOU HABITAT

Project Activity	Potential Effect	Mitigation Measures
		• The Field Supervisor and Safety Advisor will educate all field workers on the applicable practices contained within the wildlife protection plan. • All sightings of caribou will be reported to environmental staff on-site. • Maintain a minimum distance of 500 m between field operations and caribou for the duration of the Project. • Workers must avoid all interactions with caribou unless crew safety is at risk. • Field workers will not feed, harass or approach caribou. • Any caribou encountered will have the right-of-way. • All human/caribou conflicts and incidents will be reported to the Wildlife Monitor, Field Supervisor and Safety Advisor and documented. • Access to the surface facilities will be limited to authorized personnel during construction. • No hunting by Highway construction and maintenance workers. • Caribou sightings will be recorded (including location data, GPS if possible) to be submitted to the GNWT DOT Planning, Policy and Environmental Division and GNWT ENR's Inuvik office upon completion of the Project.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm caribou.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage caribou from entering the affected area.
Mortality	Vehicular impacts and hunting.	• Caribou have the right-of-way at all times. • During construction, the presence of caribou in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when caribou are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of caribou mortality due to collisions. • Caribou advisory signs will be placed along the Highway, as needed. • Highway closures will be required during periods of high caribou presence. • No hunting by Highway construction and maintenance workers. • Any caribou mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009)

Residual Effects

Table 4.2.7-2 and 4.2.7-3 provides a summary of residual effects on caribou and caribou habitat in the LSA and RSA, respectively.

The amount of habitat lost to the Highway is estimated to be 383 ha, approximately 0.002% (217 ha) of the Bluenose-West Herd core winter range, approximately 0.019% (212 ha) of the Cape Bathurst Herd core winter range and approximately 0.0008% (32 ha) of suitable Boreal caribou habitat. In the context of both the LSA and RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

It is expected that caribou will generally avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. In the LSA, the effect is considered moderate in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of moderate. In the context of the RSA, the magnitude changes to low, resulting in a consequence rating of low.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-2: RESIDUAL EFFECTS ASSESSMENT FOR CARIBOU AND CARIBOU HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Moderate	Regional	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Consequence

Magnitude				
H				
M				
L			X	
	S	M	L	I
	Duration			

Consequence

Magnitude				
H				
M				
L			X	
	S	M	L	I
	Duration			

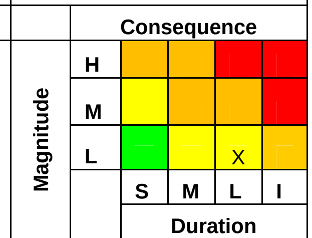
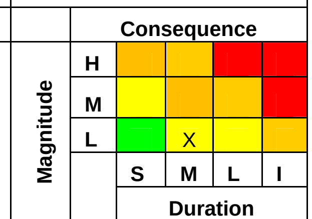
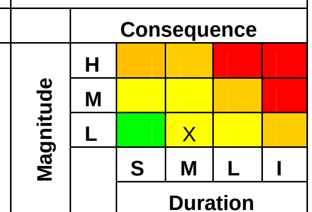
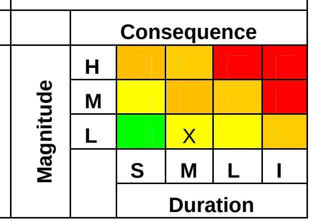
Consequence

Magnitude				
H				
M		X		
L				
	S	M	L	I
	Duration			

Consequence

Magnitude				
H				
M				
L		X		
	S	M	L	I
	Duration			

TABLE 4.2.7-3: RESIDUAL EFFECTS ASSESSMENT FOR CARIBOU AND CARIBOU HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Low	Regional	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

4.2.7.3 Grizzly Bear and Grizzly Bear Habitat

Effects on grizzly bear and their habitats may occur during construction and operation of the proposed Highway. Effects on grizzly bear include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation and fragmentation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on grizzly bear from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Increased activity and energy expenditure near the Highway;
- Delayed crossing or failure to cross the Highway;
- Reduced use of habitats adjacent to the Highway;
- Attracted to waste from temporary construction camps;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Disturbance of denning bears;
- Increased direct mortality due to defence of life and property incidents;
- Injury or death from collisions with vehicles; and
- Increased harvesting of bears near the Highway.

Disturbance arising from construction, maintenance, and use of linear developments can result in individual grizzly bears becoming vulnerable (COSEWIC 2007).

Potential effects on grizzly bear are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following section.

Potential Effects

<u>Habitat Loss</u>

The direct effects of the proposed Highway include the loss of existing habitat under the Highway footprint and the excavation of the borrow sources.

The primary diet of grizzly bears in the Mackenzie Delta consists of horsetail (*Equisetum* spp.), grass, sedge (*Carex* spp.), sweetvetch (*Hedysarum* spp.) and all available berry species as well as caribou, moose and beaver (Edwards et al. 2010). Grizzly bears within the central and western Arctic have also been observed hunting reindeer, muskrat, Arctic hare, lemmings, voles, and ground squirrels, which they excavate from burrows, and fish such as whitefish (*Coregonus* spp.) and longnose sucker (*Catostomus catostomus*) (Edwards et al. 2010; Gau et al. 2001).

High quality grizzly bear feeding habitats include productive wetlands, riparian zones and berry producing sites. The majority of the proposed Highway alignment is situated on upland tundra habitats. Overall, approximately 21.3 ha of wetland habitat, 80.3 ha of riparian habitat and 135.0 hectares of berry-producing habitat will be lost. The amount of overall habitat loss within the RSA is small (0.20%) compared to the amount of similar habitat available (120,012 ha).

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., berry producing plants for grizzly bears). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For grizzly bears, this may result in a reduction of food through reduced productivity or loss of berry-producing species (including lingonberry and blueberry) during late summer and fall. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that grizzly bears will therefore, not be directly affected by changes to vegetation as a result of dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for wildlife. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. In the event of a spill, cleanup measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Grizzly bears can be sensitive to disturbance, and displacement from habitat adjacent to roads can result in blockage to movements. Habitat displacement can result in reductions in access to areas that provide food and security. Disturbance can affect bears within a zone of influence around the source. However, habitat within the zone of influence is not lost; it is just reduced in effectiveness.

Grizzly bears are sensitive to human activity and are frequently displaced by industrial developments (McLellan 1990). During construction of the Highway and excavation of borrow sources, there is a risk of disturbance to denning grizzly bears. Typical den sites are situated on steep, southerly slopes. From the last week of October to the last week of April, nearly all grizzly bears are in dens (McLoughlin 2000). According to Harding and Nagy (1980), bears may be displaced from their dens by intensive industrial activity. Disturbance during denning may lead to den abandonment, cub mortality and decreased survival (Goodrich and Berger 1994). Specifically, Linnell et al. (2000) reported that grizzly bears might abandon dens in response to activity within 1 km, and especially within 200 m, but that responses were variable. Bears that leave their dens during winter will likely experience severe nutritional and physiological stress and may die, and abandoned cubs will not survive (Reynolds 1981).

Other studies have reported that while in their dens, grizzly bears may be relatively tolerant of disturbance. Reynolds et al. (1986) found that no bears deserted their dens despite seismic activity within 800 m and, in one instance, the passage of a supply train within 100 m. The amount of snow cover for insulation, proximity of activities (Blix and Lentfer 1992), and the type, intensity and duration of activities may be factors contributing to whether bears in dens are disturbed.

Grizzly bears may habituate to predictable disturbances, as long as they are not associated with strongly negative consequences such as hunting or direct harassment. Several studies (Tracy 1977; McLellan and Mace 1985; McLellan and Shackleton 1989; Bader 1989) suggest that grizzly bears may become accustomed to predictable occurrences, including traffic. Aune et al. (1986) found that road-habituated bears “showed no significant road avoidance in spring or summer in the study’s 0-500 m category”. In the case of the proposed Highway, it is likely that bears will initially behave warily, but may habituate over time. The degree of avoidance is likely to be higher once construction is complete and regular vehicle traffic commences.

The risks associated with Highway construction and borrow source activities is that precise locations of dens for that season are not known, and construction and excavation activities may inadvertently encroach on dens. This risk can be mitigated by conducting grizzly bear den surveys in the fall within the LSA and documenting their locations, prior to construction and excavation activities. Freshly dug dens can be mapped such that construction activities will avoid active dens during the hibernation period. The potential effects to grizzly bear denning disturbance are eliminated once construction is completed. Presumably, bears will not den in close proximity to the active Highway.

The proposed Highway alignment occurs within the Community of Tuktoyaktuk Grizzly Bear Denning Areas, site 322C (Community of Tuktoyaktuk 2008). A fall den survey will be conducted prior to any winter work. Wildlife monitors will be made aware of known denning areas for the purposes of avoidance and worker safety.

Mortality

Grizzly bear mortality could increase through hunting and collisions with vehicles. Mortality associated with roads is categorized by direct and indirect causes. Death caused by vehicular collision is an example of direct mortality, while increased hunting as a result better access with a new road is an example of indirect mortality.

Traffic-related mortality can be linked to several factors including traffic density, vehicle speed and/ or road width. Any of these factors can directly affect the success of wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely.

Several studies have reported collision mortality in grizzly bear populations (LeFranc et al. 1987; Gunson 1995; Huber et al. 1995; Gibeau and Heuer 1996). In the Prudhoe Bay oilfield development, at least one grizzly bear was killed in a collision, and there have been several near misses (R. Shideler, pers. comm). Bears that are attracted to roads as travel routes may be more likely to be struck by vehicles. Use of roads as travel routes may also lead bears into developed areas with increased risk of negative interactions with humans.

The Inuvik to Tuktoyaktuk Highway is expected to have low levels of traffic (approximately 150-200 vehicles per day). Such low levels of traffic would be expected to limit the risk of potential traffic-related mortality along the Highway.

Grizzly bear mortality could increase should hunting be allowed near the Highway. The Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality could increase. Grizzly bears are harvested under quota in the ISR so the overall harvest will not exceed the quota but the number of tags available for subsistence harvesting may be reduced if DLP or vehicle collisions increase.

Bears are currently managed by Wildlife Management Advisory Councils, Inuvialuit Game Council, HTCs and ENR. It is anticipated that these organizations will continue to work together with DOT to develop strategies to reduce impacts on grizzly bears, after the Highway is constructed. The success of this approach would require a high level of voluntary compliance from the users of the proposed Highway. Additional public education campaigns, such as highway signs, may be necessary to encourage good hunting practises along the corridor and to avoid potential bear-human conflicts.

Indirect mortality from hunting has also been documented for grizzly bears. Gut piles from harvesting other species could attract bears to the Highway. Indirect mortality can also result from potential bear-human conflicts due to bears being attracted to garbage and human settlements, including camps.

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on grizzly bear in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase.
- Identification of active grizzly bear dens in the fall prior to each construction season in order to avoid denning bears;
- Minimize direct mortality due to collisions with vehicles;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage agencies such as the HTCs, WMAC and GNWT ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-4 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on grizzly bears.

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR

Project Activity	Potential Effect	Mitigation Measures
All Activities	Disturbance or injury to bears and their habitat.	• Project personnel will be provided with wildlife awareness training. • Wildlife monitors will be on-site during construction to monitor wildlife and manage risks.
All Activities	Denning bears could be disturbed and could abandon den sites	• Den surveys will be conducted in the fall prior to construction and excavation activities. Freshly dug dens will be mapped such that construction activities will avoid active dens during the hibernation period. • If possible, no activities will occur within 500 m of an active den during the denning period, between October and April. • If active dens or if a grizzly bear are observed within 500 m of the construction site after the pre-construction survey, GNWT ENR will be contacted immediately to determine a course of action. • No blasting will occur if active bear dens are confirmed within 500 m of proposed blasting areas.

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR		
Project Activity	**Potential Effect**	**Mitigation Measures**
		• Wildlife monitors will be on-site during construction to monitor wildlife and manage risks.
All Activities	Disturbance of denning bears by workers walking off-site during the winter months.	• Workers will not walk off-site onto land at any time of year, unless there is a specific requirement (i.e., waste recovery), and these activities will be scheduled to avoid sensitive wildlife periods. • All workers will receive, at minimum, a basic wildlife orientation and GNWT Bear Safety Guidelines training, and will be instructed not to disturb any wildlife. • Personnel are to maintain a minimum distance of 500 m between sighted and/or known bear den sites for the duration of the Project.
All Activities	Grizzly bears may approach construction sites, potentially resulting in an incident or mortality.	• Grizzly bears have the right-of-way at all times. • ENR will be contacted if an active grizzly bear den is identified within 500 m of Project activities to determine appropriate course of action. • The wildlife monitor and designated, trained staff will have access to bear deterrent materials including bear spray, cracker shells, and a 12 gauge shotgun with plastic slugs and slugs. All work crews will have at least one can of bear spray while bears are active. The use of any deterrent method will be reported to ENR.
All Activities	Grizzly bear may approach camp, potentially resulting in an incident or mortality.	• Snow will be removed around buildings and work areas to increase visibility. • Adequate lighting will be installed in areas where it is essential to detect bears that may be in the vicinity. • Camps and associated infrastructure will be designed to incorporate proper bear safety, including installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, and wildlife detection.
Waste Storage	Wildlife Attraction to Site and Waste Management	• Waste Management that minimizes and disposes of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances will include the following measures: - Minimize and dispose of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances. - Store all food and garbage in either: airtight sealed container, bear proof containers or in an enclosed bear proof area. - Store on-site grease, oils, fuels in bear-proof areas or containers. - No waste will be incinerated on- or off-site. Waste will be transported and disposed of at the Tuktoyaktuk and/or Inuvik municipal solid waste facilities in accordance with the municipalities' terms and conditions for usage of the facilities. The following will be identified: • List of hazardous, non-hazardous waste and any wastes of special concern, if any. • Waste types and volumes expected to be produced

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR		
Project Activity	Potential Effect	Mitigation Measures
		• List of storage and transport methods and disposal locations for these wastes. • List of odorous wastes that may attract wildlife, and the identification of its storage and method of transport to prevent wildlife attraction. • Indicate whether odorous waste is stored for the purpose of on- or off-site disposal (i.e. road or air transport).
Waste Storage	Poorly secured waste can blow off site and pose risk of injury or mortality to bears.	• All waste products will be properly secured, stored and transported. This includes the use of bear-proof storage containers that reduce odours at all times. • Waste removal crews will be sent out to areas surrounding each construction site to collect and properly dispose of any waste material that have blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm grizzly bears.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage grizzly bears from entering the affected area.
Vehicle/ Equipment Use	Vehicular impacts may cause mortality.	• Grizzly bears have the right-of-way at all times. • During construction, the presence of grizzly bears in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when grizzly bears are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of grizzly bear mortality due to collisions. • Grizzly bear advisory signs will be placed along the Highway, as needed. • Any grizzly bear mortalities will be reported to ENR.
Hunting	Hunting may cause grizzly bear mortalities.	• No hunting by Highway construction and maintenance workers. • Any grizzly bear mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

Residual Effects

Table 4.2.7-5 and 4.2.7-6 provides a summary of residual effects for grizzly bears and grizzly bear habitat in the LSA and RSA respectively.

The loss of habitat due to the development of the proposed Highway will be approximately 236.6 ha of high rated bear feeding habitat. This will result in a loss of 0.20% of available high-rated bear feeding habitat within the RSA.

In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. At this time the amount of suitable grizzly denning habitat (south-facing slopes ≥ 25% grade; McLoughlin et al. 2002) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

It is expected that grizzly bear will avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. In the LSA, the effect is considered moderate in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of moderate. In the context of the RSA, the magnitude changes to low, resulting in a consequence rating of low. Since den surveys will be completed in fall prior to each winter construction season, no effects on denning bears are anticipated.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-5: RESIDUAL EFFECTS ASSESSMENT FOR GRIZZLY BEAR AND GRIZZLY BEAR HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	Table A
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	Table B
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate	Table C
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	Table D

Consequence – Habitat Loss (Table A)

Magnitude \ Duration	S	M	L	I
H				
M				
L			X	

Consequence – Habitat Degradation (Table B)

Magnitude \ Duration	S	M	L	I
H				
M				
L			X	

Consequence – Disturbance (Table C)

Magnitude \ Duration	S	M	L	I
H				
M		X		
L				

Consequence – Mortality (Table D)

Magnitude \ Duration	S	M	L	I
H				
M				
L		X		

TABLE 4.2.7-6: RESIDUAL EFFECTS ASSESSMENT FOR GRIZZLY BEAR AND GRIZZLY BEAR HABITAT IN THE RSA

<table>
<tr><th rowspan="2">Description of Residual Effect (after Mitigation)</th><th colspan="6">Evaluation of Residual Effect</th><th rowspan="2"></th></tr>
<tr><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th><th>Reversibility</th><th>Likelihood</th></tr>
<tr><td>Habitat Loss</td><td>Low</td><td>Local</td><td>Long-term</td><td>Continuous</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="5">Magnitude</td><td></td><td colspan="4">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td>X</td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Habitat Degradation</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Periodic</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="5">Magnitude</td><td></td><td colspan="4">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td>X</td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Disturbance</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Periodic</td><td>Reversible Long-term</td><td>Moderate</td><td><table><tr><td rowspan="5">Magnitude</td><td></td><td colspan="4">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td>X</td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Mortality</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Isolated</td><td>Reversible Short-term</td><td>Moderate</td><td><table><tr><td rowspan="5">Magnitude</td><td></td><td colspan="4">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td>X</td><td></td><td></td></tr><tr><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
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4.2.7.4 Moose and Moose Habitat

Effects associated with the construction of the proposed Highway and its associated borrow sources can be in the form of effects on moose and effects on their habitat. Habitat effects include the loss, fragmentation, or degradation of habitat. Habitat loss will occur during the construction phase, along the Highway and borrow source footprints. Degradation of habitat is a secondary effect of habitat loss during construction and operation.

The majority of construction for the proposed Highway and excavation of the associated borrow sources will occur during the winter period when moose are mainly south of the treeline or within the riparian areas of the Mackenzie River and its major tributaries.

Potential effects on moose from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Physical and physiological disturbance;
- Displacement away from the proposed Highway;
- Increased activity and energy expenditure near the proposed Highway;
- Delayed crossing or failure to cross the proposed Highway;
- Altered migration;
- Reduced use of habitats adjacent to the proposed Highway;
- Habituation to the Highway;
- Injury or death from collisions with vehicles; and,
- Increased hunting pressure along the proposed Highway.

Potential effects on moose are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

Habitat Loss

The proposed Highway traverses four Ecoregions, which include the Mackenzie Delta, Caribou Hills, Sitidgi Plain, and Tuktoyaktuk Coastal Plain. The footprint of this proposed Highway is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the Highway is estimated to approximately 383 ha. The Mackenzie Delta Ecoregion's northern extent corresponds with the treeline and represents the highest quality moose habitat within the local study area. The habitats south of the treeline provide deciduous shrubs for fall and winter food and thick conifers for winter cover (GNWT

ENR 2011). Less than 8 ha of potential winter moose habitat will be impacted within the Mackenzie Delta Ecoregion.

North of the treeline the local study area falls within the Caribou Hills, Sitidgi Plain, and Tuktoyaktuk Coastal Plain Ecoregions. The boreal forest extends into parts of the Caribou Hills Ecoregion and as such limited winter moose habitat (12 ha) also occurs with this Ecoregion. Riparian habitats north of the treeline are utilized for feeding during the growing season (GNWT ENR 2011) when accessibility related to snow depths and climatic factors are not limiting (Dussault et al. 2005, Stephenson et al. 2006).

Within the study area the community of Tuktoyaktuk has identified the south boundary at Sitidgi Lake, northward to the southern end of Husky Lakes, east to Kugaluk River as important spring harvest areas for moose (Community of Tuktoyaktuk et al. 2008). The Alternative 2 (Upland Route) option would avoid habitats associated with the spring moose harvest area. Away from the lakes and wetlands moose are predominantly found within the tall shrub riparian zones within the river valleys as these habitats provide both food and security cover (GNWT ENR 2011). The majority of the proposed Highway occurs on uplands and intersect with the riparian zones at river crossings. Riparian communities are known only from two creek valleys, where the Project stream crossings are limited and it is not expected to significantly impact this community type.

In addition to the proposed Highway, borrow sites will also alter vegetation cover. The gravel borrow sources typically occupy upland areas which are dominated by bryoids and low shrub cover types. These are considered low quality moose habitats due to the limited available preferred food (willows and aquatic vegetation) and security cover; consequently, it is anticipated that the vegetation classes lost due to gravel extraction are insignificant to moose.

The overall effect of habitat loss to moose from the proposed Highway and the proposed gravel borrow sources is considered to be very small and insignificant and will not affect the population at the local level.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation.] Changes in plant species composition could alter the availability of food and the effect could be positive or negative on moose, depending on the specific conditions.

Dust deposition from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations can cover vegetation and decrease the abundance of forage. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway (see Section 4.2.6.2 for a more complete description of effects of dust on vegetation). In a fugitive dust assessment of an Arctic road through tundra habitat conducted in northwest Alaska the authors concluded that the effects of fugitive dust on moose forage would not affect moose on a population level (Exponent 2007). However, the quantity of dust is unlikely to have a major effect on vegetation and food availability. Dust suppression methods as described in *Guideline for Dust Suppression* (GNWT 1998) will be employed to minimize potential issues associated with dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for wildlife. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents another potential hazard. In the event of a spill, cleanup measures will be implemented immediately. All spills will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Moose may be disturbed and/ or displaced by the presence of the proposed Highway and/ or human activities associated with the Highway. This is most evident in hunted populations as moose populations are sometimes reduced adjacent to roads (Rolley and Keith 1980). In a study of moose distribution in an area of oil and gas development in northwestern Alberta, use of habitat near roads was significantly reduced compared to control areas away from a road (Intera Environmental Consultants 1973). The degree of avoidance varies greatly depending on the species, habitat attributes, and prior disturbance history. Human activity associated with development corridors is the primary source of disturbance for wildlife (Jalkotzy et al. 1997).

The majority of the proposed Highway traverses habitats not likely to be utilized moose for forage. The higher quality moose forage habitat is restricted to a few tall shrub riparian zones found in the river valleys where the Highway will cross at 90 degrees. The proposed Route design and the fact that there are few moose occurring in the LSA, the potential disturbance effects will be limited. The net disturbance effects from the proposed development are expected to apply only to the local populations.

Mortality

Moose mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access.

Collisions with vehicles can be a significant source of human-related mortality. The numbers of moose killed can be substantial in some regions of North America. For example, between 1984 and 1989, an average of 216 moose was killed each year on Alaska's roads (Del Frate and Spraker 1991). Road mortality appears to be related to traffic volumes and speed (Del Frate and Spraker 1991; Oosenbrug et al. 1991; Underhill and Angold 2000). Collisions in Alaska were found to be grouped in the winter months and typically were more severe where roads crossed moose winter range during deep snow conditions (Del Frate and Spraker 1991).

The proposed Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day), which can be expected to minimize potential traffic-related mortality along this Highway. Speed limits, giving wildlife the right-of-way, and signage in areas with caribou concentrations could help minimize the potential for moose-vehicle collisions.

The proposed Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality for moose could increase. There is little documented information for Northwest Territories, though the effect of increased hunting with road development is well documented elsewhere. Moose attracted to, or crossing, a disturbance corridor may suffer greater mortality than elsewhere within their home ranges; the mortality often occurs as a result of hunting (Jalkotzy et al. 1997). In New Brunswick, Boer (1990) found that hunter kills of moose were highly clumped; 92% of moose were killed within 1 km of forest roads. Major access routes radiating from population centres seemed to direct the flow of hunters in Quebec (Bider and Pimlott 1973). Overharvests of moose occurred in areas with greater access (Bider and Pimlott 1973). Lynch (1973) documented increased moose harvests in an area of development with associated increases in access. Most hunting activity occurred within 1.6 km of roads. Similar results have been documented in the NWT along the Liard and Mackenzie Highways (Treseder and Graf 1985).

Despite these impacts the situation in the Project area would likely be different due to fewer hunters and fewer moose. Human-induced mortality is higher in areas associated with major access routes radiating from population centres in southern localities (Bider and Pimlott 1973). In the north this effect would be reduced as a result of fewer hunters and fewer access roads. For example, one study from the Kenai Peninsula in Alaska found the mean annual survival rate of female moose was 0.92, the mean annual mortality rate as a result of collisions with vehicles was 0.04 while the annual hunting mortality rate was just 0.01 (Bangs et al. 1989). In isolation these mortality rates probably would not result in population declines (Jalkotzy et al. 1997).

The impact on the few individual moose occurring along the proposed Highway might be significant at the local level. However, with the implementation of the proposed mitigation measures and voluntary compliancy for no-hunting along the proposed Highway corridor from community members, these impacts would be greatly reduced, if not eliminated. No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4). These no-hunting corridors apply to all hunters, and represent a significant cooperative venture in the wildlife management field (Treseder and Graf 1985). Consultation with local residents would be a prerequisite for a wildlife management program that would include a no-hunting corridor along the proposed Highway. If these mitigation measures were successfully implemented the impacts on moose would be low and insignificant at the local level.

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on moose in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase;
- Minimize disruption of migration patterns due to vehicle traffic; particularly when the barren-ground caribou arrive within the study area for the fall rut and their departure to the calving grounds in the spring;
- Minimize direct mortality due to collisions with vehicles;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage agencies such as the HTCs, WMAC and GNWT Department of Environment and Natural Resources to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-7 presents the mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on moose.

In addition to Project mitigation measures, ENR in consultation with the HTAs and communities should consider the establishment of a no-hunting zone along the proposed Highway. A no-hunting corridor would not only protect moose, as well as other wildlife, but also for human safety concerns that arise from hunting from roadways.

Residual Effects

Table 4.2.7-8 and 4.2.7-9 provides a summary of residual effects on moose and moose habitat in the LSA and RSA respectively.

The amount of lost moose habitat from the proposed Highway and the proposed gravel borrow sources is small. In the context of both the LSA and RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-7: MITIGATION MEASURES FOR MOOSE

Project Activity	Potential Effect	Mitigation Measures
Off-site Activities	Workers walking off-site may disturb moose.	• Workers will not walk off-site onto the land at any time of year, unless there is a specific need (e.g., waste clean-up, emergency). • All workers will be instructed not to disturb any moose observed. • Wildlife monitors will be on-site during construction to monitor potential wildlife issues and manage risks.
Waste Storage	Poorly secured waste can attract predators, which may increase predation pressure on moose in the area.	• All waste products will be properly secured, stored and transported. • Waste removal crews will be sent to areas surrounding each construction site to collect and properly dispose of any waste material that has blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm moose.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage moose from entering the affected area.
Vehicle/ Equipment Use	Vehicular impacts may cause mortality.	• Moose have the right-of-way at all times. • During construction, the presence of moose in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when moose are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of moose mortality due to collisions. • Moose advisory signs will be placed along the Highway, as needed. • Any moose mortalities will be reported to ENR.
Hunting	Hunting may cause moose mortalities	• No hunting by Highway construction and maintenance workers. • Any moose mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

TABLE 4.2.7-8: RESIDUAL EFFECTS ASSESSMENT FOR MOOSE AND MOOSE HABITAT IN THE LSA

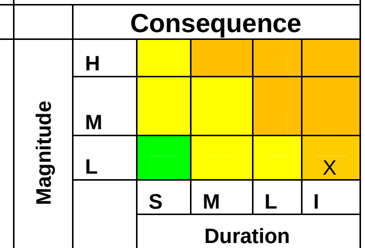
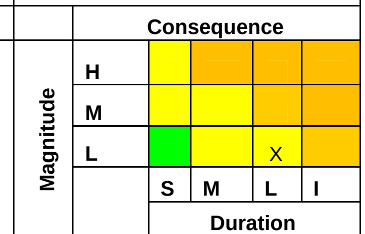
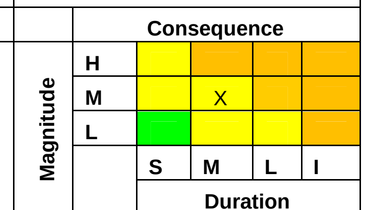
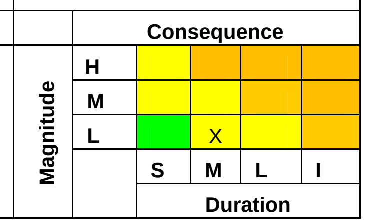
Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

TABLE 4.2.7-9: RESIDUAL EFFECTS ASSESSMENT FOR MOOSE AND MOOSE HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Habitat Loss – Consequence

Magnitude	S	M	L	I
H				
M				
L			X	

Duration

Habitat Degradation – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Disturbance – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Mortality – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

4.2.7.5 Furbearers and Furbearer Habitat

For the purposes of this assessment, furbearers include wolverine, Arctic fox and red fox. Effects on furbearers and their habitats may occur during construction and operation of the proposed Highway. Effects include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on furbearers from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and habitat fragmentation;
- Displacement away from the Highway;
- Increased activity and energy expenditure near the Highway;
- Delayed crossing or failure to cross the Highway;
- Reduced use of habitats adjacent to the Highway;
- Attracted to waste from temporary construction camps;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Habituation to the Highway;
- Disturbance of denning furbearers;
- Injury or death from collisions with vehicles; and
- Increased harvesting of furbearers near the Highway.

Potential effects on furbearers are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

<u>Habitat Loss</u>

The direct effects of development of the proposed Highway and associated borrow sources will include loss of habitat. The footprint is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the proposed Highway (the Primary 2009 Route) is therefore 383 ha, which is 0.1% of the RSA.

The majority of the proposed Highway alignment is situated on upland tundra habitats. Feeding habitat for wolverine and foxes is associated with the occurrence of prey species rather than vegetation types and prey can be found in a variety of habitats. It is anticipated the wolverine and foxes would den in upland tundra sites with suitable features (COSEWIC 2003 and Mueller 1995).

Wolverine dens can be classified as natal or maternal den sites (COSEWIC 2003). Multiple dens may be used in sequence (Copeland 1996) and from year to year (MacDonald 2009; Lee and Niptanatiak 1996). Dens can vary from simple rest beds to complex natal dens with extensive tunnel networks (Pullianinen 1968 and Magoun 1985 as cited in Mulders, 2000). Natal dens are frequently located among boulders, under deadfall, or in snow tunnels (Magoun and Copeland 1998) in tundra habitats (Lee and Niptanatiak 1996). Lee and Niptanatiak (1996) observed a den repeatedly used for three years in the central Arctic, approximately 160 km southeast of Coppermine. This den was situated in a large snowdrift covering a boulder field. Caves, rock crevices, fallen logs and holes in the snow and burrows are also used for shelter (Community of Inuvik et al. 2008).

Fox den sites are usually associated with Arctic ground squirrel den sites (Mueller 1995) which are also a known prey species for both wolverine and foxes (Mulders 2000 and Banfield 1974). Fox denning habitat typically consists of well-drained, stable soils (Martell et al. 1984). Arctic fox den sites include areas that are gently sloping with sandy soil near rivers or lakes or on elevated areas free from permafrost (GNWT ENR 2011).

In general, furbearer denning sites within the study area are similar to sites utilized by grizzly bears. Denning habitat for wolverine and other furbearers is not considered to be limited in the Canadian tundra (Lee and Niptanatiak 1996).

At this time the amount of suitable wolverine and fox denning habitat (slopes with well drained soils) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., different prey availability for furbearers). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For furbearers, this may result in changes to prey species abundance. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that furbearers will not be directly affected by changes to vegetation as a result of dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for wildlife. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. In the event of a spill, cleanup measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

<u>Disturbance</u>

Certain species can be sensitive to disturbance, and displacement from habitat adjacent to roads has been widely reported. Habitat displacement can result in reductions in access to security areas and in the efficiency of foraging strategies (Jalkotzy et al. 1997). Disturbance can affect wildlife within a zone of influence around the source.

In general, there is a paucity of information regarding the effects of linear developments on furbearers. Information on species' disruption is not well-documented in the literature and is typically from southern studies within forested ecosystems. However, in the case of wolverines, a study in Idaho raised the possibility that human disturbance at natal den sites may cause den abandonment (Copeland 1996). Habitat avoidance has been documented to varying degrees for medium sized carnivores. Banci (1994) conducted a review of the wolverine literature in 1994. The majority of references to wolverines in the literature are either anecdotal or refer to incidental observations. The reported anecdotal information on disturbance to wolverines is varied. Wolverines have been reported to be sensitive to human activity (Copeland 1996). Impacts of development activities on wolverines are assumed to be similar to those on grizzly bears: yet in the north where they are more common, some wolverines tolerate civilization to the extent of scavenging at dumps and living adjacent to developments (Jalkotzy et al. 1997).

Construction activities, including borrow excavation activities, are anticipated to generate more intensive disturbance effects than routine traffic. Additionally, during the primary winter construction season there is a risk of disturbing denning furbearers. Foxes are considered a species possessing a high level of adaptability in their ecology (GNWT ENR 2011). Consequently, impacts on these adaptable species are of lesser concern within this Project. However, other species such as wolverines may be more sensitive.

Mortality

Furbearer mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access. Traffic-related mortality can be linked to several factors including traffic density, vehicle speed and/ or road width (Jalkotzy et al. 1997). Any of these factors can directly affect the success of wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely. The Inuvik to Tuktoyaktuk Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day) at most times. Such low levels of traffic would be expected to minimize the potential of traffic-related mortality along the Highway.

Indirect mortality in the form of increased hunting and trapping is a concern for furbearers. The proposed Highway will allow hunters and trappers more ready access to harvesting areas and, consequently, human-induced mortality may potentially increase for furbearers, as well as other wildlife species. The proposed Highway could also assist in providing trappers with access into previously more remote areas along the corridor. Wildlife populations sustain increased mortalities from hunting and trapping as a result of better access (Jalkotzy et al. 1997).

Residents of Tuktoyaktuk have expressed concern that hunting pressure on wildlife may increase as a direct consequence of building the Highway. To protect wildlife, organizations such as the ILA, the HTCs, ITC, WMAC, and GNWT Department of Environment and Natural Resources will need to continue to work together with DOT to develop strategies to reduce impacts on furbearers, after the Highway is constructed. The success of this approach would require a high level of voluntary compliance from the users of the proposed Highway. Additional public education campaigns, such as highway signs, may be necessary to encourage good hunting practises along the corridor.

Project Design and Mitigation Measures

The objectives of furbearer protection activities along the proposed Highway will be to mitigate potentially negative effects on furbearers in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase.
- Identification of active dens in the fall prior to each construction season in order to avoid active areas;
- Minimize direct mortality due to collisions with vehicles;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;

- Ensure Project personnel have appropriate levels of wildlife training and awareness; and,
- Encourage agencies such as the HTCs, WMAC and GNWT ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-10 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on furbearers and furbearer habitat.

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT

Project Activity	Potential Effect	Mitigation Measures
All Activities	Disturbance or injury to furbearers and their habitat.	• Project personnel will be provided with wildlife awareness training.
All Activities	Disturbance of denning furbearers:	• If active wolverine dens are discovered within 500 m of Project sites, ENR will be contacted immediately to determine the appropriate course of action. Activities may be temporarily suspended pending consultation with ENR. • Wildlife monitors will be on-site during construction to monitor wildlife and manage risks. • Personnel are to maintain a minimum distance of 500 m between sighted and/or known wolverine den sites for the duration of the Project and to contact ENR to determine an appropriate course of action. • Workers will not walk off-site onto land at any time of year, unless there is a specific requirement (i.e., waste recovery), and these activities will be scheduled to avoid sensitive furbearer periods. • All workers will receive, at minimum, orientation to the wildlife management plan, and will be instructed not to disturb any furbearers.
All Activities	Wildlife incident or mortality: furbearers may approach sites while workers are present potentially resulting in an incident or mortality.	• Furbearers have the right-of-way at all times. • The wildlife monitor and designated, trained staff will have access to wildlife deterrent materials including bear spray, cracker shells, and a 12 gauge shotgun with plastic slugs. The use of any deterrent method will be reported to ENR. • Snow will be removed around buildings and work areas to increase visibility. • Adequate lighting will be installed in areas where it is essential to detect a wolverine and other wildlife that may be in the vicinity. • Camps and associated infrastructure will be designed to incorporate proper wildlife safety, including installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, and wildlife detection. • No hunting by Highway construction and maintenance workers

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT

Project Activity	Potential Effect	Mitigation Measures
Waste Storage	Wildlife Attraction to Site and Waste Management	• Waste Management that minimizes and disposes of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances will include the following measures: - Minimize and dispose of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances. - Store all food and garbage in either: airtight sealed container, bear proof containers or in an enclosed bear proof area. - Store on-site grease, oils, fuels in bear-proof areas or containers. - No waste will be incinerated on- or off-site. Waste will be transported and disposed of at the Tuktoyaktuk and/or Inuvik municipal solid waste facilities in accordance with the municipalities' terms and conditions for usage of the facilities. The following will be identified: • List of hazardous, non-hazardous waste and any wastes of special concern, if any. • Waste types and volumes expected to be produced • List of storage and transport methods and disposal locations for these wastes. • List of odorous wastes that may attract wildlife, and the identification of its storage and method of transport to prevent wildlife attraction. • Indicate whether odorous waste is stored for the purpose of on- or off-site disposal (i.e. road or air transport).
Waste Storage	Wildlife incident or mortality: poorly secured waste can blow off site and pose risk of mortality to furbearers.	• All waste products will be properly secured, stored and transported. This includes the use of wildlife-proof storage containers that reduce odours at all times. • Waste removal crews will be sent out to areas surrounding each construction site to collect and properly dispose of any waste material that have blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm furbearers.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • All vehicles and equipment will be refueled at least 100 m from waterbodies. • Equipment used in or near water will be clean and free of oil, grease or other deleterious substances. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage furbearers from entering the affected area.

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Mortality	Vehicular impacts and hunting.	• Furbearers have the right-of-way at all times. • During construction, the presence of furbearers in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when furbearers are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of furbearer mortality due to collisions. • Furbearer advisory signs will be placed along the Highway, as needed. • No hunting by Highway construction and maintenance workers. • Any furbearer mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

Residual Effects

Table 4.2.7-11 and 4.2.7-12 provides a summary of residual effects for furbearers and furbearer habitat in the LSA and RSA respectively. The loss of habitat due to the development of the proposed Highway is small (less than 0.1% of the RSA). In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. At this time the amount of suitable wolverine and fox denning habitat (slopes with well drained soils) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

Disturbance from operational activities will be variable depending upon time of year but may influence individual furbearers in proximity to the proposed Highway. Disturbance will reduce habitat effectiveness adjacent to the proposed Highway. This is expected to affect wolverines more than foxes; regardless, the magnitude of habitat disruption is unknown. Disturbance will be limited only to those furbearers with territories adjacent to the construction activity and, to a lesser degree, the proposed Highway during operation.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-11: RESIDUAL EFFECTS ASSESSMENT FOR FURBEARERS AND FURBEARER HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Magnitude	Consequence			
H				
M				
L			X	
	S	M	L	I
	Duration			

Magnitude	Consequence			
H				
M				
L			X	
	S	M	L	I
	Duration			

Magnitude	Consequence			
H				
M		X		
L				
	S	M	L	I
	Duration			

Magnitude	Consequence			
H				
M				
L		X		
	S	M	L	I
	Duration			

TABLE 4.2.7-12: RESIDUAL EFFECTS ASSESSMENT FOR FURBEARERS AND FURBEARER HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	Consequence (1)
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	Consequence (2)
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	Consequence (3)
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	Consequence (4)

Consequence (Habitat Loss)

Magnitude	S	M	L	I
H				
M				
L			X	
	Duration			

Consequence (Habitat Degradation)

Magnitude	S	M	L	I
H				
M				
L		X		
	Duration			

Consequence (Disturbance)

Magnitude	S	M	L	I
H				
M				
L		X		
	Duration			

Consequence (Mortality)

Magnitude	S	M	L	I
H				
M				
L		X		
	Duration			

4.2.7.6 Birds and Bird Habitat

Potential effects and mitigation measures for waterfowl, raptors and upland birds, including the VCs, are described in this section. Bird species identified as VCs, are as follows:

- Waterfowl (Horned Grebe, Tundra Swan, Greater White-fronted Goose, Snow Goose, Canada Goose Mallard, Northern Pintail);
- Raptors (Peregrine Falcon, Short-eared Owl); and
- Upland Birds (Rusty Blackbird, Rock and Willow Ptarmigan).

Effects on birds and their habitats may occur during both construction and operation of the proposed Highway. Effects include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on birds from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Displacement away from the Highway;
- Increased activity and energy expenditure near the Highway;
- Loss of habitat and habitat fragmentation;
- Reduced use of habitats adjacent to the Highway;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Habituation to the Highway;
- Disturbance of nesting birds;
- Injury or death from collisions with vehicles; and
- Increased harvesting of birds (i.e. waterfowl) near the Highway.

Potential effects on furbearers are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

<u>Habitat Loss</u>

The direct effects of development of the proposed Highway and associated borrow sources will include loss of habitat. The footprint is anticipated to be approximately 137 km long by

28 m wide. The amount of habitat lost to the proposed Highway (the Primary 2009 Route) is therefore 383 ha, which is 0.10% of the RSA.

The majority of the proposed Highway alignment is situated on upland habitats (Bryoid, Exposed/Barren Land and Shrub Low habitats). Upland habitats are utilized by passerines, ptarmigan and shorebirds such as golden plovers. The removal of upland habitat along the 2009 Primary Route footprint represents a loss of 261.7 ha. This loss is small compared to the amount of similar habitat available (137,414 ha) within the RSA, of which the Highway footprint represents approximately 0.19% of that habitat type.

Within the RSA the Coniferous, Mixedwood, Broadleaf, Shrub Tall, Wetland-treed, Wetland-herb, Herbs habitats were identified as riparian sites. Lakes, ponds and associated wetlands are utilized by a number of waterfowl and shorebird species. Lakes and ponds also attract waterfowl during the post-breeding moult as these habitats provide security from predators (Ehrlich 1988). Of the four proposed Highway alignment options, the Primary 2009 Route impacted the greatest amount of wetland and shrub riparian habitat (84.14 ha) compared to the amount of similar habitat available (84,227 ha) within the RSA, of which the Highway footprint represents approximately 0.10% of that habitat type.

Borrow excavation activities may cause some localized, temporary habitat loss. Because these activities will be generally limited to the winter period, effects on birds are anticipated to be minimal. Progressive reclamation will occur to ensure that only active areas will be disturbed. Where possible, areas will be recontoured and revegetated, with available native seed mixes to match the surrounding terrain upon completion of excavation activities. In areas where the disturbed habitat is not compatible with native seed mixes then the areas will be recontoured and allowed to revegetate naturally. Exposed areas are exploited by some bird species feeding, nesting and cleaning (dust baths). For example, some passerines commonly feed in areas of exposed gravel, as it is easier to forage for insects and seeds. Other species, such as the Semipalmated Plover seek out gravel exposures for nesting while ptarmigan frequently used gravel sites for dust baths (Ehrlich 1988).

Birds will experience some habitat loss associated with the proposed Highway and associated borrow sources. Of greater consequence, however, is the predicted pattern of snowmelt along the proposed Highway, which is expected to accelerate green-up by 10-14 days in the spring (Walker and Everett 1987, as cited in Truett et al. 1997). This could provide spring foraging opportunities for passerines, waterfowl, and raptors, and advanced nesting for passerines.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., different prey availability for furbearers). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For birds, this may result in changes to food availability. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that birds will not be directly affected by changes to vegetation as a result of dust.

The deposition of dust adjacent to the Highway in the early spring is anticipated to affect snowmelt patterns along the proposed Highway which is expected to accelerate green-up by 10-14 days (Walker and Everett 1987, as cited in Truett et al. 1997). This could provide earlier spring foraging and nesting opportunities for birds attracted to snow-free sites.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for birds. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. In the event of a spill, cleanup measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Displacement associated with disturbance may have physical and physiological effects that can act at the level of individuals, groups, or populations. Birds that are displaced from important habitats may sustain increased energetic costs that can directly influence health and survival of themselves, their offspring, and their population (Diavik 1998). They may also face reduced security and increased predation risk.

During incubation, nesting females draw on fat reserves to sustain themselves throughout the incubation period (Davis and Wiseley 1974). The stress of disturbance could affect the female's energy reserves, leading to mortality of the adult, eggs or nestlings. Disturbance may cause the nesting bird to abandon nest and clutch. The absence of the female from the nest also allows predators access. Some species, such as jaegers (*Stercorarius* spp.) and gulls, have learned to follow humans and prey on the eggs of nesting birds that have been flushed by humans (MacInnes and Misra 1972).

During the summer months birds may encounter some noise during construction of the proposed Highway; however, the majority of the works will occur in the winter when most birds are not present within the study area. Summer-related work will be on a smaller scale and will include compacting and grading of the embankment (Highway surface), installation of certain culverts (to protect fish habitat), or adjustments to culverts installed in the previous winter. Disturbance from the summer activities are anticipated to be relatively minor and will be local and temporary as the construction progresses along the route. Once the proposed Highway has been built, disturbance from passing vehicles is likely to be negligible.

Based on bird surveys and anecdotal observations collected at a tundra diamond mine site between 1995 and 2000, birds typically show little or no detectable responses to stressors and that effects from mining and associated activities are negligible (Smith et al. 2005). Furthermore, despite anthropogenic disturbances, waterfowl (including loons) and shorebirds continued to utilize lakes and wetlands adjacent to roads and infrastructure (Rescan 1999b). Shorebirds such as Red-necked Phalaropes and Least Sandpipers continued to use ponds within the existing footprint. Several pairs of Semipalmated Sandpipers have nested adjacent to developed areas over the years (S. Moore, Wildlife Biologist, EBA, pers. obs.). Raptors, including Peregrines, Gyrfalcons and Rough-legged Hawks, were commonly recorded hunting along roads and within built up areas. Bald and Golden eagles have been observed hunting in the vicinity of the diamond mine and Rough-legged Hawks and Short-eared Owls have been documented hunting within the road system (Rescan 1999b). These observations suggest not all birds are displaced.

At Tuktoyaktuk, Gyrfalcons are regular nesters at an abandoned camp facility adjacent to the town and are commonly seen hunting along the roads and infrastructure associated with town (S. Moore, Wildlife Biologist, EBA, pers. obs.) (Photo 4.2.7-1 and 4.2.7-2). The presence, maintenance and usage of roads and infrastructure, including the airport, in and around Tuktoyaktuk does not appear to disturb raptors, passerines or waterfowl from utilizing adjacent habitats for nesting and rearing offspring (S. Moore, Wildlife Biologist, EBA, pers. obs.) (Photo 4.2.7-3 and 4.2.7-4). Nesting habitat for birds of prey, primarily cliffs, does not exist within the LSA. Any tower or structure erected and standing during the nesting period could be potential habitat. Structures would be designed to minimize or prevent they are not utilized as nesting structures. If nesting occurs they would not be disturbed until after the birds have left the area.

The majority of disturbances to birds will be of a temporary nature. Disturbance effects experienced by birds during construction of the proposed Highway and the physical existence of the proposed Highway afterwards are not anticipated to affect the bird populations at the local or regional level.

Photo 4.2.7 -1:
A pair of Gyrfalcons perched on top of a communication tower at Tuktoyaktuk.
Their nest is just out of view, below the bottom edge of the photo.

Photo 4.2.7-2:
This Gyrfalcon and its mate were observed regularly using
the telephone poles during their hunting activities

Photo 4.2.7-3:
Wilson's Snipe nest with eggs 20 m from active roadway on the edge of Tuktoyaktuk, NWT

Photo 4.2.7-4:
Adult male Red-necked Phalarope on nesting territory adjacent to an active road, Tuktoyaktuk, NWT

Mortality

As with any development, there is always a potential for increased mortality through vehicular collisions and hunting. In the presence of road traffic, the potential exists for birds being injured or killed by colliding with vehicles. The development of roads will also provide access to areas that may not have been previously accessible. There is the potential that people will engage in harvesting geese and ducks along the Highway, putting additional stress on avian populations. These mortality effects can be mitigated with the implementation of appropriate mitigation measures.

Project Design and Mitigation Measures

The objectives of bird protection activities along the proposed Highway will be to mitigate potentially negative effects on birds in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- Survey material deposits in the summer (June-July) to document use by nesting birds, if any, occurring within the LSA and protect any active nest sites from excavation during periods of construction.
- Minimize direct mortality due to collisions with vehicles;
- Minimize attractants at camps through responsible waste management and effective environmental awareness programs;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for nesting birds;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage agencies such as the HTCs, WMAC and GNWT ENR to work together to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-13 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on birds.

In addition to Project mitigation measures, the WMAC, IGC and HTCs, could consider the establishment of a no-hunting zone along the proposed Highway as a public safety consideration to address human safety concerns that arise from hunting from roadways.

TABLE 4.2.7-13: MITIGATION MEASURES FOR BIRDS AND BIRD HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Off-site Activities	Workers walking off-site may disturb nesting songbirds, shorebirds and waterfowl during the breeding season and cause nest abandonment and chick/egg mortality.	• Workers will not walk off-site onto the land at any time of year, unless there is a specific need (e.g., waste clean-up, emergency). • Planned activities will be scheduled to occur outside of peak breeding times. • All workers will be instructed not to disturb any birds or nests observed. • Workers will avoid conducting Project activities within 500 m of an active raptor nest during nesting season. • • Wildlife monitors will be on-site during construction to monitor bird and manage risks. • If a key nesting feature of a Species at Risk is discovered, both ENR and CWS will be contacted. Activities will be temporarily suspended pending consultation with these agencies.
Waste Storage	Poorly secured waste can blow off site and pose risk of mortality to nearby nesting or foraging songbirds, shorebirds and waterfowl.	• All waste products will be properly secured, stored and transported. • Waste removal crews will be sent to areas surrounding each construction site before the arrival of breeding birds in the spring to collect and properly dispose of any waste material that has blown off site.
Workers/ Vehicle/ Equipment Use	Interactions between birds and workers/equipment may cause incidents or mortality.	• During construction, the presence of birds on the proposed Highway is to be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when birds are on the road or near the road, respectively. • Vehicle speeds during construction and post construction in strategic areas will be regulated to reduce the potential of bird mortality due to collisions. • Bird advisory signs will be placed along the Highway, as needed. • No hunting by Highway construction and maintenance workers.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm birds.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • All vehicles and equipment will be refueled at least 100 m from waterbodies. • Equipment used in or near water will be clean and free of oil, grease or other deleterious substances. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage birds from entering the affected area.

TABLE 4.2.7-13: MITIGATION MEASURES FOR BIRDS AND BIRD HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Construction	Structures erected during the nesting period could become potential habitat.	• Structures will be designed to minimize or prevent potential to be utilized as nesting structures. If nesting occurs they would not be disturbed until after the birds have left the area.
Construction	Active birds nests may be destroyed during borrow pit excavation in summer.	• Conduct pre-disturbance bird nest surveys June-July to document use by nesting birds in areas proposed for summer construction work.

Source: Adapted from GNWT DOT (2009).

Table 4.2.7-14 outlines mitigation measures for bird Species at Risk. Species that may occur within the Project corridor that are protected by SARA include the Eskimo curlew (listed as Endangered November 2009) (Government of Canada 2009). The Rusty Blackbird is listed by SARA as Special Concern (Schedule 1) (Government of Canada 2009). Species listed as Special Concern under Schedule 1 do not benefit from full legal protection under the Act. However a management plan for the conservation of the species of Special Concern and its habitat must be prepared within three years. The Short-eared Owl and Peregrine Falcon (*Falco peregrinus tundrius*) are listed by SARA as Special Concern (Schedule 3) and are not afforded protection under SARA (Government of Canada 2009).

Project activities have the potential to adversely affect these species through direct habitat loss, sensory disturbance and accidental mortality. The contractors will be required to employ an adaptive management approach to ensuring sensitive species/ species at risk are adequately protected during all phases of Highway construction and borrow source work. The mitigation measures outlined in Table 4.2.7-14 will be implemented in addition to Table 4.2.7-13 (Mitigation Measures for Birds) to mitigate potential effects on bird Species at Risk.

TABLE 4.2.7-14: SUMMARY OF MITIGATION MEASURES FOR BIRD SPECIES AT RISK		
Bird Species	**Activity/Potential Effect**	**Mitigation Measure**
Eskimo Curlew **Rusty Blackbird** **Short-eared Owl**	Birds may be at risk of mortality from leaks and spills.	•• In the event of a spill, all efforts will be made to properly contain and manage the spill, including bird removal and treatment if necessary.
	Nests may be abandoned due to disturbance from Project activities.	• Appropriate federal (CWS) and territorial (ENR) authorities will be contacted immediately before continuing work if a nest is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).
Peregrine Falcon	Birds can collide with wires, especially during the migration period.	• Guy wires will not be used.

TABLE 4.2.7-14: SUMMARY OF MITIGATION MEASURES FOR BIRD SPECIES AT RISK

Bird Species	Activity/Potential Effect	Mitigation Measure
	Lights can attract birds at night, especially during the migration period, resulting in injury or mortality.	• Lights will be positioned to shine down or fixed with shielding to direct light downward on buildings and other infrastructure sites, wherever possible. Lights will be turned off, whenever possible (e.g., when personnel are not at camps or other facilities).
	Disturbance to Peregrine Falcon nesting during construction or borrow source activities.	• An aerial survey will be conducted along the final route and proposed borrow sources to determine if nests are present. • Appropriate federal (CWS) and territorial (ENR) authorities will be contacted immediately before continuing work if a Peregrine Falcon nest is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).

Residual Effects

Table 4.2.7-15 and 4.2.7-16 provides a summary of residual effects for birds and bird habitat in the LSA and RSA respectively. The loss of bird habitat due to the development of the proposed Highway is small (less than 0.10% of the RSA). In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. Careful planning and design of the Highway corridor to avoid habitats such as wetlands where waterfowl and other wildlife are known to congregate will mitigate impacts on waterfowl populations.

Effects of habitat degradation, which is primarily related to reduction in food and nest site availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

Disturbance from operational activities will be variable depending upon species and time of year but will, regardless, influence bird behaviour and energy budgets. Disturbance will be limited to only those birds immediately adjacent to the proposed Highway and thus a very small fraction of the surrounding population. The net habitat and disturbance effects from the proposed development are expected to apply only to the local individuals and are therefore low in consequence at the local population level with no residual effects.

The majority of construction for the proposed Highway and excavation of the associated borrow sources will occur during the winter period, a time when few birds, are present. Consequently, impacts from construction activities will be mainly temporary and limited.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-15: RESIDUAL EFFECTS ASSESSMENT FOR BIRDS AND BIRD HABITATS IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	Consequence Magnitude H: M: L: X S M L I Duration
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	Consequence Magnitude H: M: L: X S M L I Duration
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate	Consequence Magnitude H: M: X L: S M L I Duration
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	Consequence Magnitude H: M: L: X S M L I Duration

TABLE 4.2.7-16: RESIDUAL EFFECTS ASSESSMENT FOR BIRDS AND BIRD HABITATS IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	Consequence
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	Consequence
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	Consequence
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	Consequence

Habitat Loss – Consequence

Magnitude	S	M	L	I
H				
M				
L			X	
Duration	S	M	L	I

Habitat Degradation – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		
Duration	S	M	L	I

Disturbance – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		
Duration	S	M	L	I

Mortality – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		
Duration	S	M	L	I

4.3 HUMAN ENVIRONMENT COMPONENTS

The purpose of this section is to present the current socio-economic conditions in the communities affected by the Project, and identify potential effects, mitigation measures, and residual effects from the construction and operation of the Inuvik to Tuktoyaktuk Highway. The Highway will be the first all-weather road connecting southern Canada to the Beaufort Sea. It is expected to provide substantial socio-economic benefits at the local, regional and national levels.

The study area for the socio-economic effects assessment is limited to the Town of Inuvik, the Hamlet of Tuktoyaktuk, and the land base between the two communities, including the Husky Lakes area.

The Valued Socio-Economic Components (VSCs) identified for this EIS include:

- Land and resource use by the Inuvialuit;
- Areas of special ecological and cultural importance;
- Land designation areas (as per IFA and CCPs);
- Tourism, commercial and public recreational use; and
- Heritage and archaeological sites.

Table 4.3-1 summarizes the effects identified for the VSCs.

TABLE 4.3-1 VALUED SOCIO-ECONOMIC COMPONENT ASSESSMENT SUMMARY

Valued Socio-Economic Component	Potential Effect	Affected Areas	Duration	Magnitude	Likelihood	Capacity to Manage Effect
Land and Resource Use by the Inuvialuit	Beneficial/ Adverse	Tuktoyaktuk Inuvik ISR	Long-term	Moderate/ Low	Moderate/ Moderate	Territory and ISR partners have the capacity to manage
Areas of Special Ecological and Cultural Importance	Neutral	Tuktoyaktuk Inuvik ISR	Long-term	Low	Moderate	Territory and ISR partners have the capacity to manage
Land Designation Areas (as per IFA and CCPs)	Adverse	Tuktoyaktuk Inuvik ISR	Long-term	Low	Low	Territory and ISR partners have the capacity to manage
Tourism, Commercial and Public Recreational Use	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	High	High	Territory, municipalities and ISR partners have the capacity to manage
Heritage and Archaeological Sites	Neutral	Tuktoyaktuk Inuvik ISR	Short-Term	Negligible	High	Territory, municipalities and ISR partners have the capacity to manage

It was noted that there are both beneficial and adverse effects potentially associated with land and resource use, as a result of the construction of the Highway. Year-round access between communities provides great benefits; however, many people identified during consultation the potential adverse indirect effects related to increased harvesting due to greater access.

Table 4.3-2 summarizes the predicted socio-economic effects for other socio-economic components assessed within the Human Environment section.

TABLE 4.3-2 SOCIO-ECONOMIC ASSESSMENT SUMMARY

Socio-Economic Component	Effect	Affected Areas	Duration	Magnitude	Likelihood	Capacity to Manage Effect
Regional Economy	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	High	High	Territory, municipalities and ISR partners have the capacity to manage
Infrastructure	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	High	Territory, municipalities and ISR partners have the capacity to manage
Individual, Family and Community Wellness	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	High	Territory, municipalities and ISR partners have the capacity to manage
Traditional Cultures	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	Moderate	Territory and ISR partners have the capacity to manage

4.3.1 Demographics

4.3.1.1 Potential Effects

The populations in the Project area are not anticipated to increase to any great extent as a result of the Highway construction and operation. The Developer is committed to hiring local, regional, and NWT residents, where possible, to fill construction and operation positions, and anticipates that the majority of the labour supply will come from the communities of Tuktoyaktuk or Inuvik. In past years, many Inuvialuit have moved away from the ISR to other regions for employment opportunities. During the Tuktoyaktuk to Source 177 Access Road construction, approximately 70% of the workers were from local communities. It is estimated that with additional training, a similar percentage may be achieved for the Inuvik to Tuktoyaktuk Highway.

Many Inuvialuit living in other regions returned to the ISR to work on the Tuktoyaktuk to Source 177 Access Road. Based on this, some in-migration to these communities by returning residents is anticipated, in addition to the reduction in levels of out-migration as more opportunities for local and regional employment become available, particularly during the construction phase.

A limited number of people may move to Tuktoyaktuk or Inuvik to fill indirect and induced employment opportunities in other goods and services sectors during the construction and/or operations phase of the Highway.

The completed Highway will increase accessibility to the Hamlet of Tuktoyaktuk. Although the population of Tuktoyaktuk has been slowly decreasing since 1996, it is possible that once the Highway is established, Tuktoyaktuk could maintain or increase its population (GNWT Bureau of Statistics 2009a).

However, it is also possible for Tuktoyaktuk to experience an increase in out-migration once the Highway is constructed, as residents could seek employment in Inuvik or other communities; however, this is thought to be less likely due to the connection that residents have with their home community. As noted by the school principal, "Kids in Tuk really like Tuk, I don't see many people leaving" (R. Mahnic, Principal, Inuvik Secondary School, pers. comm., January 25, 2011).

In Inuvik, the population has steadily increased since 1996, and is projected to continue to increase in the future (GNWT Bureau of Statistics 2009b). The Highway is not likely to significantly affect Inuvik's projected growth rate. A minimal increase may occur as a result of in-migration of Tuktoyaktuk residents seeking employment, or from a potential increase in attendance at Aurora College by Tuktoyaktuk residents taking advantage of the improved accessibility. "The school (Samuel Hearne Secondary) may gain a couple of new students as a result of an increased number of parents from Tuk attending programs at Aurora College" (R. Mahnic, Principal, Inuvik Secondary School, pers. comm., January 25, 2011).

Project Design and Mitigation Measures

Government agencies and Inuvialuit organizations responsible for education, housing and other infrastructure regularly assess demographic trends in ISR communities. The anticipated changes in population caused by the Highway are anticipated to be minimal. No additional mitigation measures related to possible demographic shifts are required.

Residual Effects

Negligible changes regarding in/out migration are anticipated.

4.3.2 Regional and Local Economies

Economics are considered an important component of this EIS because of the potential effects that the Highway may have on the local and regional economies, quality of life, and future economic development opportunities.

Predicted effects are derived from baseline conditions, discussions with government agencies and Inuvialuit organizations, and an economic analysis commissioned by the GNWT DOT for the construction of the Highway, entitled *Inuvik to Tuktoyaktuk All-Weather Road Economic Analysis* (GNWT DOT 2010a). This report is found in Appendix F.

4.3.2.1 Contribution to Gross Domestic Product and Direct Taxes

Four economic effects of the Highway were assessed in this report:

- Building and maintaining the all-weather Highway;
- Reduction in the cost of living;
- Increase in tourism activity; and
- Impacts on the Mackenzie Gas Project and related natural gas field exploration and development in the Delta Region.

Economic effects may be singular (short term) or annual (long term). The effects of construction activities, for example, are singular as they effectively end when construction is completed. However, the effects of maintenance, cost of living, tourism, and natural gas development may exact annual effects. To convert the annual effects into a single impact value, annual impacts are calculated over a defined lifespan minus a discounted rate (to account for risk and time value). This comparison of future value to today's value is referred to as *Net Present Value*. In this case, the net present value is calculated over a 45-year time-period and discounted at 5% (GNWT DOT 2010a).

The effects of the Highway are anticipated to occur during both the construction and operations phases and to have both direct and indirect significant beneficial effects. *Direct effects* include the employment created and the goods and services required by the Highway's construction. These effects are associated with supplying major Project components and direct capital outlays by construction contractors. *Indirect effects* are the "ripple effect" of secondary employment and purchases. These effects are associated with the companies that supply goods and services to construction contractors. *Induced effects* are tertiary in nature (e.g., the Developer will pay construction employees salaries, which are re-spent in the economy generating further economic activity in sectors such as retail, restaurants etc.).

Highway construction is likely to result in the following categories of effect:

- Employment and revenue;
- Construction;
- Annual maintenance (during the operations phase);
- Loss of annual winter road construction;
- Cost of living;
- Tourism activity; and
- Oil and gas exploration and development.

Although the initial construction of the Highway is expected to cost the Federal and Territorial government about $230 million, after subtracting the increase in government revenues resulting from the existence of the Highway, the net cost to the Federal and Territorial government will be in the order of $183 million ($230 million minus total tax revenues of $47 million). When all of the economic spin-offs (direct, indirect and induced impacts) are accounted for over the 45-year life of the Highway, this capital investment is expected to create about $248 million in net purchases of goods and services (e.g., material inputs) in the NWT and an additional $97 million in the rest of Canada (GNWT DOT 2010a).

The revenues generated from Highway construction will translate into a net increase in gross domestic product (GDP) in the NWT of about $186 million and an increase in GDP in the rest of Canada of about $84 million. Highway construction will create 1,086 one-time jobs in the NWT and another 860 one-time jobs in the rest of Canada. In addition, Highway construction is expected to create 42 long-term jobs in the NWT and another nine in the rest of Canada. Building the Highway is predicted to earn the Federal and Territorial governments almost $36 million from activities in the NWT and an additional $11 million accruing to governments in the rest of Canada (GNWT DOT 2010a).

Table 4.3.2-1 summarizes the total anticipated economic effect (net present value) of the Highway, excluding oil and gas exploration, over an assumed 45-year lifespan.

TABLE 4.3.2-1: TOTAL ECONOMIC EFFECTS OF THE HIGHWAY (EXCLUDING THE MACKENZIE GAS PROJECT)

Total Net Present Value Effects	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$341,073,370	$75,080,810	$70,901,410	**$421,282,220**	$176,496,770
Material Inputs	$166,941,842	$37,690,952	$43,790,746	**$248,423,540**	$96,970,502
GDP	$127,490,287	$35,281,884	$23,240,519	**$186,013,690**	$84,166,547
Employment (construction) (FTE)	668.3	282.0	135.5	**1,085.8**	859.6
Employment (operations) (FTE)	33	7	3	**42**	9
Wages & Salaries	$82,818,283	$20,148,005	$12,654,482	**$115,621,770**	$44,008,660
Benefits	$5,891,974	$1,502,418	$935,318	**$8,658,710**	$5,431,783
Total Gov't Revenues	$24,468,549	$5,373,043	$4,748,718	**$35,590,310**	$10,966,205
Federal	$14,815,632	$2,938,243	$2,424,744	**$20,179,620**	$6,062,648
Net Indirect Income	$2,191,603	$435,667	$560,351	**$3,187,290**	$1,007,001
Personal Income Taxes	$12,626,026	$2,503,908	$1,863,396	**$16,992,330**	$5,056,250
NWT	$9,655,935	$2,443,800	$3,322,955	**$15,412,690**	$4,903,634
Net Indirect Taxes	$3,646,570	$1,404,718	$2,462,493	**$7,513,780**	$2,914,649
Personal Income Taxes	$6,013,360	$1,028,082	$857,468	**$7,898,910**	$1,988,431

Source: GNWT DOT (2010a)

Several spin-off socio-economic effects are anticipated from the Highway construction. These effects are partially the result of increased economies of scale that the Highway will generate. The effects are summarized as follows (GNWT DOT 2010a):

- Increased regional and territorial economic development due to greater efficiency and reliability of the highway network and reduced transportation costs;
- Reduced sense of isolation due to improved connections between Inuvik and Tuktoyaktuk;
- Improved access to government services and employment opportunities;
- Increased opportunities for Northern and Aboriginal training, employment, business development and equity investment;
- Attraction of new investment from outside the area (i.e., companies relocating to a given area);
- Retention of existing companies in area;
- Improvement of the import substitution and export success of companies located in the area by the provision of overland transport links to key markets;
- Enhancement of the competiveness of the regional economy and thereby reducing storage, warehousing and medical travel costs; and
- Increased opportunities for social and cultural interaction and development through reduced isolation, increased mobility, and expanded learning and training opportunities.

Employment and Revenue

Construction

During the construction phase, temporary effects that are significant and beneficial are anticipated. Construction activities create a demand for goods and services that create both direct and indirect impacts. Several studies have been conducted on the economic effects of constructing the Highway, including *Mackenzie Valley All-Weather Road Opportunity Assessment* (Meyers Norris Penny LLP 2007) and *Socio-Economic Literature Review of the Impact of Linear Developments in the Northwest Territories* (Nichols Applied Management and Knopp 2010). While the total value of labour income varies with each study, a significant net gain is predicted in association with Highway construction.

Table 4.3.2-2 summarizes the economic effects of Highway construction, as estimated by GNWT DOT (2010a). While the majority of economic effects will occur in the NWT, the rest of Canada will also be affected. The economic effects of the Highway construction are based on an initial investment of $230 million.

TABLE 4.3.2-2: ECONOMIC EFFECTS OF HIGHWAY CONSTRUCTION

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Direct and Indirect.
Output	$230,000,000	$55,928,500	$49,630,720	**$335,559,220**	$157,787,352
Material Inputs	$138,553,140	$29,545,230	$32,905,170	**$201,003,540**	$84,740,348
GDP	$91,446,860	$26,383,280	$16,725,550	**$134,555,690**	$73,047,004
Employment (FTE)	668.3	282.0	135.5	**1,085.8**	859.6
Wages & Salaries	$61,277,480	$15,012,190	$9,162,100	**$85,451,770**	$37,857,452
Benefits	$4,238,680	$1,089,250	$664,780	**$5,992,710**	$4,667,674
Total Gov't Revenues	$18,701,490	$3,997,460	$4,206,360	**$26,905,640**	$9,522,410
Federal	$11,801,440	$2,226,930	$1,761,250	**$15,789,620**	$5,269,710
Net Indirect Income	$1,622,000	$317,340	$414,950	**$2,354,290**	$893,430
Personal Income Taxes	$10,179,440	$1,909,590	$1,346,300	**$13,435,330**	$4,376,280
NWT	$6,900,050	$1,770,530	$2,445,110	**$11,115,690**	$4,252,700
Net Indirect Taxes	$1,882,650	$976,370	$1,725,760	**$4,684,780**	$2,531,360
Personal Income Taxes	$5,017,400	$794,160	$619,350	**$6,430,910**	$1,721,340

Source: GNWT DOT (2010a)

Maintenance

Ongoing economic effects will occur following Highway construction arising from required annual maintenance. Unlike the economic effects of the construction phase, which are one-time impacts, operations and maintenance effects carry on for the life of the Highway and have a long-term effect on the economy. The annual economic effects of Highway maintenance, as estimated by GNWT DOT (2010a), are summarized in Table 4.3.2-3.

TABLE 4.3.2-3: ANNUAL ECONOMIC EFFECTS OF HIGHWAY MAINTENANCE	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$1,957,500	$569,210	$570,537	$**3,097,247**	$712,682
Material Inputs	$950,195	$376,302	$378,270	$**1,604,767**	$345,788
GDP	$1,007,305	$292,908	$192,272	$**1,492,485**	$366,895
Employment (FTE)	13.6	4.0	1.6	**19.2**	4.9
Wages & Salaries	$620,983	$180,572	$104,037	$**905,592**	$201,242
Benefits	$53,295	$15,497	$8,930	$**77,722**	$24,435
Total Gov't Revenues	$158,006	$45,946	$45,903	$**249,855**	$46,550
Federal	$82,477	$23,983	$19,591	$**126,051**	$25,680
Net Indirect Income	$10,008	$2,910	$4,397	$**17,315**	$2,980
Personal Income Taxes	$72,469	$21,073	$15,194	$**108,736**	$22,700
NWT	$75,529	$21,963	$26,312	$**123,804**	$20,870
Net Indirect Taxes	$47,025	$13,674	$19,349	$**80,048**	$11,940
Personal Income Taxes	$28,504	$8,289	$6,963	$**43,756**	$8,930

Source: GNWT DOT (2010a)

GNWT DOT (2010a) also calculated the net present value of Highway maintenance, based on a 45-year period discounted at 5%. Over this period the total GDP contribution of maintenance activities will be $27 million and government revenues will be $4.4 million to the NWT. The contribution to the rest of Canada will be $6.5 million in GDP and $827,000 in government revenues.

This new transportation infrastructure will make accessing markets in the NWT easier, facilitating regional trade. New business opportunities in harvesting, preparation, packaging and marketing local products could be generated, thereby adding diversity to the local and regional economies (Nichols Applied Management et al. 2010).

Loss of Annual Winter Road Construction

Building the Highway will eliminate the need to construct the winter road to Tuktoyaktuk each year. There will be cost savings and a reduction in economic activity associated with the purchase of goods, services, and the hiring of labour for the annual construction and maintenance of the winter road.

Table 4.3.2-4 summarizes the reduction in annual economic effects created by eliminating winter road construction.

TABLE 4.3.2-4 ANNUAL ECONOMIC EFFECTS FROM LOSS OF INUVIK TO TUKTOYAKTUK WINTER ROAD

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$128,650	$29,988	$26,758	$**185,396**	$91,619
Material Inputs	$78,790	$15,916	$17,740	$**112,446**	$49,326
GDP	$49,860	$14,073	$9,018	$**72,951**	$42,293
Employment (FTE)	0.4	0.1	0.1	**0.6**	0.5
Wages & Salaries	$33,326	$7,886	$4,947	$**46,159**	$21,818
Benefits	$1,951	$560	$351	$**2,862**	$2,693
Total Gov't Revenues	$10,329	$2,119	$2,273	$$**14,721**	$5,260
Federal	$6,514	$1,175	$952	$**8,641**	$2,920
Net Indirect Income	$954	$170	$224	$**1,348**	$390
Personal Income Taxes	$5,560	$1,005	$728	$**7,293**	$2,530
NWT	$3,815	$944	$1,321	$**6,080**	$2,340
Net Indirect Taxes	$3,815	$525	$986	$**2,579**	$1,350
Personal Income Taxes	$2,474	$419	$335	$**3,501**	$990

Source: GNWT DOT (2010a)

Over the assumed 45-year lifespan of the Highway, the net present value losses in the NWT are estimated at $1.3 million to the GDP and $253,000 in government revenues; net present value losses for the rest of Canada are estimated to be $726,000 in GDP and $90,000 in government revenues.

Cost of Living

The Highway is expected to contribute to a reduction in the cost of shipping goods to Tuktoyaktuk. Lower prices mean residents will be able to buy more goods with the same amount of income, thereby effectively increasing their standard of living.

Prices in Tuktoyaktuk are approximately 10% higher than in Inuvik (GNWT Bureau of Statistics 2005, as cited in GNWT DOT 2010a). The Highway would reduce overall prices, reduce the cost of food, increase the variety of goods and services available to Tuktoyaktuk residents, and make those goods and services available year round.

GNWT DOT (2010) estimates that the community of Tuktoyaktuk receives approximately 160,000 lb of food each year, delivered by the federal government-sponsored Food Mail program. At a cost of $3/lb for air delivery between Inuvik and Tuktoyaktuk, it costs approximately $480,000 per year in food delivery costs. With the construction of the Highway, food can be delivered by truck to Tuktoyaktuk from Inuvik at $0.15/lb (or $24,000). Once the Highway is operational, it is assumed that food costs in Tuktoyaktuk will more closely reflect the prices in Inuvik. Food transportation logistics would transition from air cargo and barge to trucks, resulting in the loss of $456,000 in indirect expenditures, and lower food prices in Tuktoyaktuk. The money residents would save on food purchase would increase their disposable income, resulting in an increase in the general standard of living in the hamlet.

With the Highway in place, it is anticipated that some residents of Tuktoyaktuk would drive to Inuvik to shop where more goods and services are available (e.g., medical and dental services, restaurants, etc.). "Inuvik has shopping, some cheaper prices and banking. There is no bank in Tuktoyaktuk. People currently send banking with people going to Inuvik or by mail" (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). GNWT DOT (2010a) calculated an overall savings of $1.0 million to local residents as a result of the Highway being constructed (excluding extra vehicle costs), including savings from the Food Mail Program.

The combined (positive) effects of reduced cost of goods and the (negative) effects related to the possible reduction of the Food Mail program on flight transport are summarized in Table 4.3.2-5.

TABLE 4.3.2-5 NET TUKTOYAKTUK CONSUMER SAVINGS WITH THE HIGHWAY

	NWT				Rest of Canada
	Direct	**Indirect**	**Induced**	**TOTAL**	**Dir. + Indir.**
Output	$1,044,00	-$37,928	$86,231	**$186,903**	-$207,491
Material Inputs	-$148,940	-$54,629	$57,170	**-$146,099**	-$108,409
GDP	$287,240	$16,691	$29,057	**$332,988**	-$99,082
Employment (FTE)	1.2	0.1	0.2	**1.6**	-1.3
Wages & Salaries	$126,622	$574	$16,423	**$153,619**	-$53,719
Benefits	-$1,480	-$942	$643	**-$1,779**	-$7,263
Total Gov't Revenues	$53,865	-$1,309	$7,614	**$60,170**	-$14,360
Federal	$27,661	-$32	$3,196	**$30, 825**	-$7,530
Net Indirect Income	$3,681	$187	$745	**$4,613**	-$1,380
Personal Income Taxes	$23,980	-$219	$2,451	**$26,212**	$-6,830

TABLE 4.3.2-5 NET TUKTOYAKTUK CONSUMER SAVINGS WITH THE HIGHWAY

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
NWT	$26,204	-$1,277	$4,418	**$29,345**	-$6,830
Net Indirect Taxes	$14,055	-$1,106	$3,284	**$16,233**	-$4,410
Personal Income Taxes	$12,149	-$171	$1,134	**$13,112**	-$2,420

Source: GNWT DOT (2010a)

Tourism Opportunities

GNWT DOT (2010) estimates that the total number of tourists to visit the Inuvik-Beaufort-Delta region would increase by about 10% to 5,500 tourists per year with the construction of the Highway. The increased number of visitors is anticipated to spend an additional $1,467,500 in the region.

The average stay per visitor is 4.5 days. With the Highway completed, it is estimated that average visitor days would increase by 1.5 days with easier access to other communities, resulting in an additional 4,125 tourist days per year in the region and additional spending of $1,237,500.

According to Ms. J. Venaas (Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011), some tourists are drawn to Tuktoyaktuk because of the ice road, made popular by the television series “Ice Road Truckers”. The exposure has increased the number of tourist visits to both Aklavik and Tuktoyaktuk. The absence of the ice road to Tuktoyaktuk could result in increased tourism in Aklavik where a winter road would still be in use (J. Venaas, Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011).

Other tourism industries such as air-based travel to Tuktoyaktuk could also be affected by the new Highway. The Highway may reduce flight-based operations as tourists can drive to Tuktoyaktuk in one day from Inuvik. Conversely, “the Highway may open new forms of tourism, more bus-focused than plane” (J. Venaas, Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011).

Inuvik Tourism Coordinator for the Town of Inuvik, Darlene Burden, also noted that the Highway would likely have a positive effect on tourism in the region overall, including Inuvik (pers. comm., February 2, 2011). Table 4.3.2-6 summarizes the projected annual economic effects on tourism.

TABLE 4.3.2-6: ECONOMIC EFFECTS OF INCREASED AND LENGTHENED TOURIST VISITATIONS

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$2,705,000	$424,402	$467,084	$**891,486**	$856,477
Material Inputs	$831,158	$226,864	$309,670	$**1,367,692**	$459,685
GDP	$873,373	$197,538	$157,406	$**1,228,317**	$396,792
Employment (FTE)	18.0	2.7	1.3	**21.9**	5.8
Wages & Salaries	$533,599	$105,942	$85,344	$**724,885**	$221,230
Benefits	$43,997	$8,864	$7,138	$**59,999**	$25,573
Total Gov't Revenues	$138,770	$30,340	$37,204	$**206,314**	$54,410
Federal	$73,782	$15,460	$15,995	$**105,237**	$29,420
Net Indirect Income	$21,015	$3,613	$3,520	$**28,148**	$5,040
Personal Income Taxes	$52,767	$11,847	$12,475	$**77,089**	$24,380
NWT	$64,988	$14,880	$21,209	$**101,077**	$24,990
Net Indirect Taxes	$44,233	$10,220	$15,488	$**69,941**	$15,400
Personal Income Taxes	$20,755	$4,660	$5,721	$**31,136**	$9,590

Source: GNWT DOT (2010a)

Over the life of the Highway, the net present value of economic effects from tourism is estimated at $21 million with $3.5 million in GDP increases and government revenue, for the NWT; the effect on the rest of Canada is expected to be $7 million in GDP and $1 million in government revenues.

Effects Related to the Mackenzie Gas Project

When the GNWT DOT (2010a) conducted an analysis of the proposed Mackenzie Gas Project, they concluded that constructing the Highway would not significantly affect the overall cost of the pipeline but that some savings could be realized in future exploration and development. These savings stem principally from a reduction in logistic costs associated with more efficient use of leased drilling rigs, camps, and related support equipment. There was also a reduction in risk costs by not carrying excess inventory and competing for scarce resources. Concurrently, the existence of an all-weather Highway facilitates the movement of rig equipment from southern Canada during the non-drilling season, rather than storing rig equipment and incurring storage costs and extended rig rental costs.

GNWT DOT (2010a) analysed the economic effects of the Highway on exploration and development savings for the three anchor fields of the Mackenzie Gas Project (Niglingtak, Taglu and Parsons Lake). Using oil and gas industry estimates, this analysis assumed there would be a 5% savings in development costs at Niglingtak and Taglu and 10% savings at Parsons Lake (as it is closer to the proposed Highway and more wells are likely to be developed in this area).

Building the Highway would have financial implications for the Mackenzie Gas Project and broader effects on the NWT economy (i.e., economic effects include GDP, incomes, taxes, and employment).

Table 4.3.2-7 summarizes the total economic effects (net present value) of building the Highway on future exploration and development in the region and the potential financial effects on Mackenzie Gas Project.

TABLE 4.3.2-7: TOTAL ECONOMIC AND FINANCIAL EFFECTS RELATED TO MACKENZIE GAS PROJECT[1]

	NWT	Rest of Canada	Total Canada
	All Effects	Dir. + Indir.	
Mackenzie Gas Project Profits (Increase)	$346,452,555		**$346,452,555**
GDP	$91,553,744	-$80,325,032	**$11,228,712**
Employment (construction)	1,028.6	807.5	**1,836.1**
Employment (operations)	-1,085.1	-3,674,9	**-4,760,0**
Labour Income	$80,715,792	-$58,375,168	**$22,340,623**
Total Gov't Revenues	$34,922,135	$5,431,783	**$40,353,918**
Federal	$28,134,698	-$22,760,477	**$5,374,221**
NWT/Other Provinces	$6,787,436	-$10,278,448	**-$3,491,012**

Source: GNWT DOT (2010a)

Note: 1. Net present value.

Project Design and Mitigation Measures

The *Canadian Environmental Assessment Act* defines mitigation as "the elimination, reduction or control of adverse environmental effects of a project". Mitigation measures are applied to minimize potential negative impacts of an effect and are not generally applied to positive effects.

Although it is anticipated that local and regional suppliers, contractors and residents will be able to provide the majority of construction related services, some may be sourced from outside the region. The Developer is committed to preferential employment opportunities for qualified local residents and contractors. The implementation of focused socio-economic measures will be the responsibility of the Developer and on-site contractors.

Residual Effects

The construction and operation of the Highway is expected to have a net positive economic impact in the region.

Residual effects of the Project are anticipated throughout the construction phase when labour demand, capital expenditure and economic stimulus will be greatest. The increased positive economic effects during construction will be significant over the short term (i.e., primarily limited to the estimated four-year construction period and greatest during winter construction months).

During the operations phase there will be some continued employment opportunities and labour benefits as well as maintenance expenditures. Residual effects of increased tourism and increased standard of living are also likely. These effects will be long term but of lesser magnitude than those of the construction phase.

The negative socio-economic effects of the Project are the result of eliminating the need for constructing and operating the ice road each year from Tuktoyaktuk to Inuvik. The predicted annual GDP loss is anticipated to be around $73,000, with an annual NWT government revenue loss of $15,000. The air transport industry may see a loss of revenue since goods would be increasingly transported by truck once the Highway is constructed.

Overall, no significant adverse economic effects are anticipated because of this Project. Economic effects will generally increase to the benefit of the region with large magnitude and short duration during construction or with small magnitude and long duration during operations.

4.3.2.2 Available Labour Supply, Participation, and Income Assistance

Potential Effects

The number of workers required by occupation or skill will be determined during the detailed design phase of this Project. Typical types of work and skills involved in highway construction include: surveying, environmental and wildlife monitoring, environmental field studies, heavy duty equipment operators, truck drivers, heavy duty mechanics, and camp personnel. Depending on the occupation, work is likely to be seasonal full-time (i.e., heavy duty equipment operator) or on a per project basis (i.e., environmental field studies). Consultants will be retained to complete the engineering design for the Project.

Table 4.3.2-8 describes the potential available labour supply in the Project area (as of 2009). Potential available labour supply is defined as those persons who are of employment age, but are not currently employed, and can be classified according to those willing to do rotational work, gender, ethnicity, or level of schooling (GNWT Bureau of Statistics 2009a,2009b).

TABLE 4.3.2-8: POTENTIAL AVAILABLE LABOUR SUPPLY, 2009		
	Inuvik	Tuktoyaktuk
Number of Unemployed	391	221
% Willing to Do Rotational Work	41.2	62.4
% Male	47.1	61.5
% Aboriginal	84.9	92.8
% Less than High School Diploma	59.3	73.8

Source: GNWT Bureau of Statistics (2009a, 2009b)

During the Tuktoyaktuk to Source 177 Access Road construction, approximately 70% of the workers were from local communities. With additional training, a similar hiring percentage may be achieved for the Inuvik to Tuktoyaktuk Highway based on the available labour pool.

In the ISR, men typically comprise the majority of employees in the construction industry; this is not expected to change with the construction of the Highway. Both females and males participate in the accommodation and food service industries, with female participation being slightly higher; this trend is not expected to change over the life of the Project.

In Tuktoyaktuk, the employment rate is highest among those aged 45 to 54, while in Inuvik it is highest among those aged 35 to 44. Individuals in these age categories will likely benefit most from the employment opportunities generated by construction of the Highway.

Highway construction may increase household incomes and the participation rate of people employed in the community.

Although the Developer could face competition for employees from other potential projects, no other large scale projects are currently planned in the area during the proposed construction timeframe (2012-2016). The outlook for the development of the proposed Mackenzie Gas Project is yet unknown.

Income assistance provides funds to those in need of housing, food, and clothing. Since 2000, the number of income assistance beneficiaries, cases and payments in Tuktoyaktuk has increased, while the numbers have decreased in Inuvik (Figure 3.2.4-24). New employment opportunities in the construction industry may reduce the number of people on income assistance.

Project Design and Mitigation Measures

The Developer is committed to ensuring that the people of Tuktoyaktuk and Inuvik have preferential employment opportunities to provide employment benefits to the region. The IFA guidelines for business operation will apply to this Project, giving priority hiring to companies included on the Inuvialuit Business List. This will help to provide economic stimulus to the Inuvialuit community. Furthermore, employment opportunities will be available to all residents, male or female, and will likely result in increased seasonal employment during construction.

Residual Effects

Employment opportunities associated with Highway construction and operation will provide greater social stability in the region, new skills, and more construction-related experience, possibly resulting in increased incomes and less reliance on income assistance.

4.3.3 Education, Training and Skills

4.3.3.1 Education and Training Participation Levels

Potential Effects

The Aurora College campus in Inuvik offers a variety of programs with different levels of certification, including several trades training programs (see Table 3.2.4-5). The College also offers upgrading programs (grades 8-12) for adults, and entry level safety training courses (A.M. Picek, Registration, Aurora College, January 26, 2011).

The percent of the population with a high school diploma or more in the NWT, Tuktoyaktuk and Inuvik has increased since 1986, as shown previously in Figure 3.2.4-28 (GNWT Bureau of Statistics 2010k and 2010l). In 1986, 31.6% of Tuktoyaktuk's population had completed high school, compared to 46.1% in 2009. In 1986, 58.7% of Inuvik's population had completed high school, compared to 68.6% by 2009 (GNWT Bureau of Statistics 2010k and 2010l).

In anticipation of upcoming construction work, residents seeking employment may enrol in applicable training programs at Aurora College. As well, several training programs were set up specifically for the construction of the Tuktoyaktuk to Source 177 Access Road and similar training programs could be made available in association with this Project. For example, the contractor conducted a successful heavy equipment operator course while the ILA sponsored an environmental monitor training program. Training local residents will benefit the region since it will contribute to an overall improvement in the skills and capabilities of the local workforce. Enrolment in training and employment programs would depend on the level of interest generated from community members.

Training programs related to Highway construction projects in the ISR will likely benefit males and, particularly, Aboriginal males. In the NWT, men typically participate in the construction industry (as shown previously in Figure 3.2.4-9); therefore, it is likely that more men will participate in the training programs than women. Similarly, since Aboriginal people comprise the majority of the population in both Tuktoyaktuk and Inuvik (as described in Section 3.2.2.2), it is likely that a greater proportion of Aboriginal residents will participate in training opportunities.

The proposed Highway will create year-round access from Tuktoyaktuk to the Aurora College campus in Inuvik. Potentially, more Tuktoyaktuk residents will have improved access to post-secondary education and training, which may contribute to a future increase in the level of education for some Tuktoyaktuk residents.

Project Design and Mitigation Measures

The proposed Highway is expected to increase training opportunities in the region. The Highway will also create year-round access for Tuktoyaktuk residents to attend post-secondary education in Inuvik.

Residual Effects

The proposed Highway will enable interested residents of Tuktoyaktuk to access a higher level of education.

4.3.3.2 Language and Literacy Levels

Potential Effects

Use of Aboriginal languages is declining throughout the NWT including in the Beaufort-Delta region (GNWT ECE 2010c). In a study looking at potential effects of linear developments, the Status of Women Council in the NWT expressed concerns that a large influx of southern workers might diminish Aboriginal language use, culture and sense of identity (Nichols Applied Management and Knopp 2010). However, the Developer is committed to hiring workers from Tuktoyaktuk and Inuvik, where possible. Therefore, the construction of the Highway is not expected to affect the use of indigenous languages spoken in the ISR (Siglitun and Uummarmiutun).

Literacy is an individual's ability to listen, speak, read, write, view, represent, compute and solve problems in one or more of the NWT official languages at levels of proficiency necessary to function in the family, in the community and on the job (GNWT ECE 2008). Without literacy, NWT residents may lack the basic skills to fulfill the jobs being created or meet the entrance requirements of job-specific training programs. According to GNWT ECE (2008), 70% of NWT Aboriginal adults lack the literacy skills to fully participate in society, compared to 30% of NWT non-Aboriginals. To address this, in January 2001, the Government of the Northwest Territories (GNWT) approved Towards Literacy: A Strategy Framework (2001-2005), to fund several literacy initiatives in the NWT. Aurora College, offers Adult Basic Education (ABE) or Adult Literacy and Basic Education (ALBE) programs in Tuktoyaktuk and Inuvik (Aurora College 2009). The Northwest Territories Literacy Council works with individuals and families to promote literacy in all of the official languages of the NWT (NWTLC ND).

The Highway will provide Tuktoyaktuk residents with better access to language and literacy classes, higher levels of education, and cultural events taking place in the region.

Project Design and Mitigation Measures

The proposed Highway is not expected to adversely affect language or literacy in the region. Aurora College and Inuvialuit organizations continue to identify, implement and promote literacy programs in the region. No further mitigation measures are anticipated to be required as a result of the Highway.

Residual Effects

The proposed Highway will enable interested residents of Tuktoyaktuk to access language and literacy programs and higher levels of education.

4.3.4 Infrastructure and Institutional Capacity

4.3.4.1 Transportation Infrastructure

Potential Effects

The Project will significantly improve ground transportation infrastructure between Inuvik and Tuktoyaktuk enabling easier year-round transportation of goods, services, and people between communities and throughout the region. The Highway will also facilitate commercial and recreational access to the region and will link the Dempster Highway to the Beaufort Sea coast, thereby enabling travellers to drive between Canada's west, east and north coasts.

The Highway will allow residents of Tuktoyaktuk access to a broader range of services in Inuvik. "Inuvik has shopping, some cheaper prices and banking. There is no bank in Tuktoyaktuk. People currently send banking with people going to Inuvik or by mail" (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

Virtually all fuel for Tuktoyaktuk is brought in by barge once a year, with the exception of fuel that is trucked to the community during winter if supply is low. E. Gruben's Transport (Gruben's) moves approximately 3.2 million litres of fuel and 700,000 litres of gas annually. With an all-season highway, Gruben's expects that the diesel and gas would be transported by trucks on an as-needed basis to create several benefits:

- Avoids the need to pay for the entire annual fuel supply at once;
- Reduces the need for fuel tanks to hold a one-year supply of fuel for the community;
- Reduces the potential for large-scale accidents and malfunctions associated with the fuel tanks;
- Creates opportunity for cost-savings if fuel can be purchased when prices are lower, rather than once per year (R. Newmark, CEO, E. Gruben's Transport Ltd, pers. comm., December 16, 2010).

Although the Highway may reduce the amount of air traffic between Inuvik and Tuktoyaktuk, effects are anticipated to be temporary. The economic stimulus created by a highway to a previously isolated community, such as Tuktoyaktuk, is expected to create more business for the airline and barge service sectors over the long term (GNWT DOT 2010a).

The Project will improve year-round access between all of the communities in the Delta, benefiting Tuktoyaktuk residents needing improved access to health and social services. Additional positive effects are anticipated related to increased tourism, cheaper goods and services, and less need for inventory storage. Although negative effects are anticipated for the airline and barge service industry over the short term, additional business opportunities will likely be created over the long term in these sectors.

Project Design and Mitigation Measures

No further mitigation measures are anticipated to be needed.

Residual Effects

The proposed Highway is anticipated to positively affect the communities of Tuktoyaktuk and Inuvik by creating year-round access between these communities, which ultimately provides cost-savings and other benefits.

4.3.4.2 Emergency Response and Local Law Enforcement Services

Potential Effects

Very few collisions occur on the Inuvik to Tuktoyaktuk winter road (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011). In the past 13 years, the Inuvik Fire Department has responded to two motor vehicle incidents (J. Miller, Deputy Fire Chief, Inuvik Fire Department, pers. comm., January 13, 2011) while Medic North stated that they have responded to one emergency incident in the past three years (M. Cross, Base Manager, Medic North, pers. comm., January 26, 2011).

Emergencies are responded to by Tuktoyaktuk's and Inuvik's Fire Departments and RCMP detachments. There are currently no official geographic boundaries for response on the winter road by either of the fire departments (J. Miller, Deputy Fire Chief, Inuvik Fire Department, pers. comm., January 13, 2011); however, typically the RCMP in Tuktoyaktuk will respond to emergencies up to 70 km from Tuktoyaktuk, and the Inuvik RCMP and Inuvik Fire Department respond to emergencies up to 110 km from Inuvik. Both the Tuktoyaktuk and Inuvik RCMP will respond if there is a large accident or emergency (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

In the northern NWT, Medic North reported that no more than 5-10% of calls are related to highway accidents; most calls are related to accidents involving all-terrain and recreational vehicles (M. Cross, Base Manager, Medic North, pers. comm., January 26, 2011). While a year-round Highway will increase overall traffic volume, which correspondingly may increase the number of emergency incidents, the number of fatal collisions is not anticipated to increase (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

The Highway will require monitoring to enforce speed limits and prevent drinking and driving. When the winter road is open, there are an increase in alcohol-related offenses as people have easier access to alcohol in Inuvik; this may partly be due to the road opening just before Christmas and the holiday season (B. Kershaw, Sergeant, Tuktoyaktuk RCMP, personal conversation, January 25, 2011). Several programs are currently available to prevent or treat alcohol and drug abuse.

Project Design and Mitigation Measures

Year-round operation of the Highway will increase the potential for vehicle crashes to occur. The Inuvik Fire Department is in the process of purchasing a new heavy rescue vehicle specifically for highway response. In Tuktoyaktuk, there is a volunteer Fire Department but no trained emergency technicians or ambulance service. No issues were identified with the level of service available during the winter road operation; however, emergency response levels should be monitored and assessed by GNWT Health and Social Services during the operational phase of the Highway.

The RCMP will patrol the Highway, similar to their responsibilities in other jurisdictions in Canada. The effects on RCMP staffing levels are anticipated to be minimal.

Residual Effects

The Highway is not anticipated to materially affect emergency response and local law enforcement capabilities.

4.3.4.3 Medical and Health Care Infrastructure and Services

Potential Effects

Access to increased health care services is expected to improve with the construction of the Highway. The Highway will provide easier and cheaper access to the primary health center and medical transfers between Tuktoyaktuk and Inuvik.

The Highway is also expected to provide easier access to dental services (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 17 & 18, 2011). There are no permanent dentists in Tuktoyaktuk. Residents can wait for a visiting dentist to come to the community, pay to travel to Inuvik by plane or by winter road to receive immediate treatment, or wait for INAC to authorize travel expenses to Inuvik. The period of time for approval varies and may range from a few days to months.

According to IOL et al. (2004), the most serious threats to health in communities continue to be those posed by substance abuse and derivative accidental or violent injuries. Evidence from Health Canada suggests a link between an individual's health status and the degree of control over health services held by community (Nichols Applied Management et al. 2010). By having better transportation access to regional medical and health services, communities and individuals can be more empowered to seek solutions to medical concerns.

It is not anticipated that the proposed Highway will place significant additional pressures on the Rosie Ovayouk Health Centre in Tuktoyaktuk or Inuvik Regional Hospital. For more information on health effects and mitigation measures, see Section 4.3.5 Human Health and Community Wellness.

Project Design and Mitigation Measures

Comprehensive medical and health programs are provided through Beaufort-Delta Health and Social Services programs in cooperation with Medic North and GNWT programs. The opening of the Highway may cause an initial rise in health care demand in Inuvik, but since it is already a regional medical care hub, it is unlikely to require a significant increase in permanent staff to meet the demand.

Residual Effects

Long term, the health conditions for Tuktoyaktuk residents are likely to improve with year-round access to medical and health care services in Inuvik.

4.3.4.4 Social and Community Support Services

Social and community support services is discussed in Section 4.3.5 Human Health and Community Wellness.

4.3.4.5 Education and Recreational Infrastructure and Services

Potential Effects

Educational attainment in the region is anticipated to be positively affected by the Project due to improved, year-round access to post-secondary education services in Inuvik, which could result in a minor increase in the demand for educational facilities and services.

Year-round travel between the two communities will provide access to recreational opportunities for all residents, and in particular, for regional school and youth teams to meet for tournaments, access recreational facilities, and reduce travel costs. Improved access may affect the existing recreational facilities by having more people use them, but this can be seen as a positive benefit associated with promoting family and community health and well-being, along with increased employment in the recreational services industry.

Project Design and Mitigation Measures

Anticipated Project effects include increased access to post-secondary education facilities and recreational facilities. No mitigation measures are anticipated.

Residual Effects

The residual effect on recreation will likely be increased interactions across the ISR which will strengthen communities and increase participation in recreational activities.

4.3.4.6 Water, Sewage and Waste Disposal Infrastructure

Potential Effects

During the construction phase of the Project, water from local lakes will be used to construct the ice roads during winter months. Water for dust management will be drawn from local lakes and streams during the construction and operations phases during summer months.

Most water used during the construction phase of the Project will be drawn from local lakes. A minimal amount of potable water may be trucked from Inuvik and/or Tuktoyaktuk for the construction camps during the winter construction stages.

Sewage generated at the construction camps will be trucked to community sewage lagoons in Tuktoyaktuk or Inuvik. Both facilities currently have capacity for additional wastewater (Town of Inuvik 2006; Earth Tech 2005).

All other camp-related wastes (i.e., garbage, construction debris, etc.) will be transported and disposed of at the Tuktoyaktuk and/or Inuvik municipal solid waste facilities in accordance with the municipalities' terms and conditions. Both Inuvik and Tuktoyaktuk have solid waste facilities that can accommodate the domestic wastes generated from the construction camps during the construction phase.

Project Design and Mitigation Measures

Water withdrawal will conform to the applicable regulatory guidelines and water licence conditions. For wastewater and solid waste, the Developer will:

- Prior to disposal of waste, provide an estimate of the amount and type of domestic waste to the Town of Inuvik and Hamlet of Tuktoyaktuk; and
- Seek approval from the Town of Inuvik and Hamlet of Tuktoyaktuk to use their sewage lagoon and solid waste disposal facilities.

No negative anticipated effects are anticipated for water, wastewater or waste services.

Residual Effects

No residual effects are anticipated.

4.3.4.7 Quarries and Quarry Materials

Potential Effects

As discussed in Section 2.6, construction of the proposed Highway requires granular materials from select borrow sources in the region. Once operational, the Highway will facilitate future access to these material resources for community use and future development.

Project Design and Mitigation Measures

Borrow pit development plans will conform to the applicable regulatory guidelines related to site conditions, temporary access road design, a defined development approach, mitigation measures to address potential environmental concerns, and operational and reclamation plans. Borrow pits will be closed as soon as they are no longer required and reclaimed according to regulatory standards.

Residual Effects

No residual effects are anticipated.

4.3.4.8 Management of Renewable Resources

Renewable resources, such as wildlife, fish, plants and land, are very important for Tuktoyaktuk and Inuvik residents. Sections 4.3.7 (Harvesting) and 4.3.8 (Land Use) discuss potential effects and mitigation measures related to the management of these resources.

4.3.4.9 Service Industry Capacity

Potential Effects

The Highway will have a positive effect on the movement of goods and services, allowing year-round transportation from Inuvik to Tuktoyaktuk. As discussed in Section 4.3.4 (Infrastructure and Institutional Capacity), it will be possible to transport smaller fuel amounts on a year-round basis to the Hamlet of Tuktoyaktuk by truck, thereby reducing current fuel storage requirements and costs.

Food prices in Tuktoyaktuk are more expensive than Inuvik (GNWT Bureau of Statistics 2004a). Moving smaller shipments more frequently should reduce Tuktoyaktuk's food prices to more closely match food prices in Inuvik (GNWT DOT 2010a) and could likely improve the quality of fresh food.

The Highway will permit Inuvik, Tuktoyaktuk and other regionally-based businesses to compete more effectively for resource-related and government business opportunities. Contract work in Tuktoyaktuk may become more competitive, since more companies in the region will have access to Project work (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., February 2, 2011).

New business opportunities may arise in the private sector, from trucking and fuel service stations to tourism and bus transportation services. Women typically participate more than men in service industry employment. New businesses could be expected to create employment opportunities, which are recognized as critical for young people in the ISR (ICC et al. 2006).

Project Design and Mitigation Measures

Although no direct service industry effects are anticipated, several positive induced effects are anticipated.

Residual Effects

The residual effects are enhanced availability of goods and services, particularly in Tuktoyaktuk, and potential increases in service industry positions as a result of the Highway.

4.3.4.10 Housing

Potential Effects

In Tuktoyaktuk and Inuvik, the percentage of households with more than six people has decreased from 1981 to 2009, as shown in Figure 3.2.2-15. In Tuktoyaktuk, the percentage of households with more than six people has decreased from 42.9% in 1981 to 13.0% in 2009 (GNWT Bureau of Statistics 2010e). Similarly, 10.3% of Inuvik households had more than six people in 1981; by 2009, this percentage had declined to 4.5% (GNWT Bureau of Statistics 2010e).

During the Highway construction period, local workers from Tuktoyaktuk and Inuvik will continue to live in their own houses and will be accommodated at the construction camps during their work schedules. By hiring local workers, the Developer will reduce the potential housing pressures that could otherwise be caused by hiring workers from outside the region. Furthermore, the development of the Highway will facilitate the year-round delivery of house construction materials to the community of Tuktoyaktuk.

Project Design and Mitigation Measures

No effects are anticipated for housing and accommodation due to the construction and operation of the Highway.

Residual Effects

No residual effects are anticipated.

4.3.5 Human Health and Community Wellness

The following section is focused on the possible effects to individual, family, and community wellness during the Project construction phase, with higher levels of employment and income, and during the Project operations phase, with improved year-round mobility between communities.

Overall health conditions are expected to improve, particularly in Tuktoyaktuk, due to the presence of the Highway, which will provide easier, lower-cost, and year-round access to the primary health center in Inuvik.

According to IOL et al. (2004), the most serious threats to health in communities continue to be posed by substance abuse and derivative accidental or violent injuries. The Project is not anticipated to create additional pressure on the capacity of the Rosie Ovayouk Health Centre or Inuvik Regional Hospital.

Potential Effects

During consultation with local health staff, it was clear that there are differing opinions as to how the Highway may affect human health and community wellness. In particular, there are two commonly held views regarding the potential links between increased incomes, substance abuse, and violence. The first view is that increased income from Project employment could potentially contribute to substance abuse-related issues, which correspondingly may create additional burdens on social workers who work in the communities. The second view is that increased individual incomes and overall community wealth may lead to a decrease in social problems by providing opportunities and choices for individuals, which in turn may improve self-esteem, self-worth and self-sufficiency.

The Head Nurse at the Tuktoyaktuk Health Center, Ms. M. Heffel, suggested that family violence would not likely increase as a result of the Highway. It is generally believed that the occurrence of family violence increases with the availability of alcohol. There is a concern that the Highway will make alcohol more accessible to the people of Tuktoyaktuk.

There is also concern that there may be a rise in sexually transmitted diseases (STD) rates when the Highway is built. According to Ms. Heffel (Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011), "I have seen it happen before in other communities." She also suggested that there appears to be a rise in rates of STDs when the winter road is in operation possibly due to increased access to residents in other communities.

As discussed previously, the Highway is predicted to support the improvement of dental health in Tuktoyaktuk through year-round access to dental services in Inuvik. The GNWT HSS runs a program called "Little Teeth are a Big Deal" for children of all ages to learn about tooth and gum care. Adult dental care is currently supported by visiting dentists to Tuktoyaktuk. In the event of a dental emergency, patients must either pay for travel to Inuvik or seek financial assistance for travel through INAC, which may take days or months for approval. The Highway will provide year-round access to dental health care facilities for the people of Tuktoyaktuk (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011).

The Town of Inuvik has a greater number of available community wellness services than Tuktoyaktuk. The Highway will allow Tuktoyaktuk residents to directly access these services in Inuvik, a likely positive effect. The ability to travel year-round between communities will provide new recreational opportunities for all residents, including students and youth teams, which will be able to use the facilities in Inuvik for practices, games and events more frequently and at lower cost due to reduced transportation costs. Increased access may affect the existing recreational facilities by having more people use them, but this may also be a positive benefit associated with promoting family and community interactions.

During consultations with local stakeholders, it was not possible to identify potential effects on the physical, mental and social health of residents of Inuvik due to the Highway, or the perceived changes in residents' quality of life. The health staff stakeholder that Kiggiak-EBA was directed to speak to by several people declined to comment due to discomfort in stating an opinion publicly as it was felt the opinion was biased (Inuvik Public Health Services, pers. comm., January 12, 2011).

In Inuvik, crimes rates typically are highest during the summer months, potentially as a result of the 24 hours of daylight. The RCMP anticipated that crime rates in Inuvik may increase as a result of the Highway. Restrictions in Tuktoyaktuk on the amount of alcohol that residents may possess may cause residents to travel to Inuvik. "Tuktoyaktuk is currently implementing restrictions on the amount of alcohol an individual is permitted to have in possession at one time. The restriction was voted on by the community" (Ben Kershaw, Sergeant, Tuktoyaktuk RCMP, pers. comm. January 12, 2011).

There are specific groups within a community that are more vulnerable to poverty. These groups include: seniors, persons with disabilities, families led by single mothers and single people in general (GNWT ECE 2007). The Highway is anticipated to reduce the cost of living in Tuktoyaktuk, which should positively affect the most vulnerable population and/or slightly reduce the occurrence of poverty in this region.

Attributes of human health and community wellness are related to environmental conditions and food security. As discussed in Sections 4.2.1, 4.2.2 and 4.2.4, the Project is expected to have little or no significant adverse effects on soil, air, or water quality during the construction or operations phases that could induce potentially adverse effects on the health of humans, plants or animals harvested by the local population.

Access to traditional food is not only culturally and nutritionally important, it also plays a fundamental role in food security in the north (Lambden et. al. 2007). The presence of the Highway may increase access to harvesting areas that were previously more difficult to access. The effects from increased access to harvesting areas include increased food security and reduced reliance on store-bought food. Further discussion regarding harvesting and access to harvest areas is found in Section 4.3.7.

Project Design and Mitigation Measures

In general, it is predicted that the Highway will improve the Tuktoyaktuk residents' access for to medical and dental health care facilities in Inuvik.

During the construction phase, when economic activity is higher, violence and criminal behaviour is expected to decrease. Over the long term, the primary concern of stakeholders is that the Highway may increase Tuktoyaktuk residents' access to alcohol. Effects related to alcohol and substance abuse may cause spin-off effects such as increased crime and abuse issues, which in turn may affect social workers and RCMP services in the community. The Hamlet of Tuktoyaktuk, with support from community members, is aware of the issues related to alcohol and substance abuse and has taken steps to reduce this.

In Tuktoyaktuk, the community wellness worker and community support workers provide programs for the prevention of alcohol addiction and abuse (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011).

The GNWT HSS has existing programs and strategies (i.e., the NWT Sexually Transmitted Infections Strategic Directions) to prevent and control sexually transmitted infections in the NWT.

Residual Effects

The Highway will create long-term, year-round access between Inuvik and Tuktoyaktuk. The benefits include increased access to medical and dental facilities; while the potential risk is increased access to unrestricted amounts of alcohol. Several programs are currently in place to prevent or treat substance abuse issues. Increased interaction between residents of the two communities, youth groups and schools is expected to positively benefit the communities.

Over time, the decrease in the cost of living may positively affect those most vulnerable to poverty and poverty-influenced illness.

4.3.6 Socio-cultural Patterns

Potential Effects

During consultation sessions, it was stated that the Highway will help residents get to their cabins, camps and harvesting sites (Kiggiak-EBA 2010). The improved access is expected to reduce costs and foster participation for family members and across communities.

Cultural and spiritual life is demonstrated through speaking traditional languages and participating in cultural events and ceremonies. The Highway will allow the residents of Tuktoyaktuk to have more contact with residents in other ISR communities and, by extension, from the rest of Canada. There will be more opportunities to participate in cultural events and celebrations, from festivals such as the Beluga Jamboree, Muskrat Jamboree and Great Northern Arts Festival to drum dancing, Northern Games and other traditional activities sponsored across the region.

The Highway could have a positive effect on the transference of traditional language skills, and knowledge of and identification with traditional culture. Residents in Tuktoyaktuk could participate more easily in social and cultural resource support programs, such as those offered through the Inuvialuit Cultural Resource Centre. Increased access may also support the implementation of territorial strategic plans related to language, education, culture and employment (GNWT ECE 2009 and 2010a). As well, the anticipated increase in tourists visiting Tuktoyaktuk and Inuvik will provide new and greater opportunities for the community to market their local crafts.

The proposed Highway is expected to strengthen family ties by providing year-round access between the communities. Tuktoyaktuk, until now, has been relatively isolated from other communities for much of the year, with access only by air and water during periods when the winter road is closed. As one participant noted during a consultation meeting, Elders would like to be able to visit their families but the ice road is not open for long and it is rough (Kiggiak-EBA 2010). The Highway will also help to facilitate sharing and mutual aid among family and community members.

The Highway will serve to increase tourism, which in turn could promote cultural awareness of the Inuvialuit and Gwich'in peoples among tourists from other regions, provinces and territories.

Project Design and Mitigation Measures

No adverse effects are anticipated; therefore, no mitigation measures are recommended.

Residual Effects

Residents are anticipated to have better year-round access to cultural and family activities once the Highway is constructed, as well as cultural support systems and programs.

4.3.7 Harvesting

Potential Effects

Wildlife and land resources are of primary importance to the Inuvialuit, and are used for cultural, traditional, and subsistence purposes. The importance of these resources is recognized by the number of people involved in traditional activities and by the number of people who consume country foods, as previously discussed in Section 3.2.

The presence of the Highway will create year-round access to harvesting areas that were previously accessible only during certain seasons. Increased access could result in increased harvesting activities, which may provide increased access to country foods, increased food security, and reduced cost of living through less reliance on store-bought food. The potential effects related to wildlife from increased harvesting are discussed in Section 4.2.7 (Wildlife and Wildlife Habitat).

The *Inuvialuit Final Agreement* provides the Inuvialuit with specific harvesting rights to wildlife in the ISR. Under the *IFA*, harvested resources are managed through a variety of organizations including:

- Wildlife Management Advisory Council (WMAC) - Northwest Territories (NWT) and North Slope (NS) are responsible for advising government ministers and Inuvialuit agencies on all matters relating to wildlife.
- Fisheries Joint Management Committee (FJMC) is responsible for managing marine mammals and marine and freshwater fisheries in the ISR.
- Inuvialuit Game Council (IGC) is responsible for representing the collective Inuvialuit interest in wildlife and also advising the government.
- Hunters and Trappers Committees (HTC) is responsible for resource allocation and promotion of Inuvialuit involvement in conservation, research, management, enforcement and utilization.
- Inuvialuit Land Administration (ILA) is responsible for the management and administration of access to Inuvialuit private lands. The ILA is also responsible for screening the development proposals on private lands.

During the construction and operation of the Highway, the above mentioned parties will continue to manage resources within the ISR.

Harvesting licenses and restrictions are management tools implemented by co-management boards and the GNWT ENR. Harvesting restrictions are currently in place for certain wildlife species in the NWT including barren-ground caribou and grizzly bears.

With year-round access between communities, competition may increase for harvesters from other communities. Husky Lakes is an important harvesting area accessed by harvesters from Tuktoyaktuk and Inuvik. The Highway will create easier access to this area and competition could occur if harvesters from one community travel to the other community to harvest. At present, harvesters from Tuktoyaktuk and Inuvik can travel between communities during the winter months along the winter road or by skidoo.

No evidence of existing competition during this season was identified during consultation. If necessary, issues related to harvesting would likely need to be resolved with the assistance of the Tuktoyaktuk and Inuvik HTCs, the Joint Management agencies, ENR and the ILA.

Hunting restrictions are currently in place to manage caribou populations. These restrictions prevent hunting within certain management areas and within certain seasons. Wildlife populations will continue to be managed by the Wildlife Management Advisory Councils and Fisheries Joint Management Committee, and Highway users will adhere to any hunting restrictions that may be in place. During the construction phase, employees will be restricted from hunting while working on the Highway.

Potential effects related to the abundance and distribution of wildlife, birds, fish and vegetation are discussed in Section 4.2.

Project Design and Mitigation Measures

To protect the environmentally and culturally sensitive Husky Lakes area, the Developer, with input from Inuvialuit interests has attempted to identify routes options that maintain a 1 km setback between the Highway and the Husky Lakes.

Residents of Tuktoyaktuk have expressed concern that hunting pressure on caribou and other wildlife may increase as a direct result of the Highway. Responsible management organizations and government agencies will continue to work together to develop strategies for sustainable harvesting in the region, after the Highway is constructed. The success of this approach will require a high level of voluntary compliance from the users of the proposed Highway.

A public education program and signage related to harvesting, fishing, hunting, and responsible use of the Highway will be installed at appropriate and highly visible locations. Educational material is currently provided for the Dempster Highway and includes information on:

- Harvesting rights for Aboriginal harvesters, and resident and non-resident hunters and fishers;
- Potential restrictions, including areas with restrictions or seasonal closures;
- Hunter responsibilities;
- Minimum safety distance from the highway before shooting may occur; and
- Snowmachine use near the highway.

Management of wildlife and fish populations will continue to be managed by GNWT ENR, the Wildlife Management Advisory Council, the Fisheries Joint Management Committee, and the HTCs.

Residual Effects

The Highway will create year-round access to Tuktoyaktuk, and will increase access to harvesting areas. Harvesting activities are managed by the Wildlife Management Advisory

Council and Fisheries Joint Management Committee, with input from the Inuvialuit Game Council and the HTCs.

Although harvesting patterns may be temporarily disturbed due to Highway construction, harvesting patterns should return to normal upon Project completion. With effective Highway user practices, residual indirect effects related to harvesting wildlife and fish populations are expected to be minimal.

4.3.8 Land Use

The proposed Highway route is located on Inuvialuit 7(1)(a) and 7(1)(b) Lands and Crown Land. The proposed Highway alignment passes through several special management areas. In general, the Highway is located near to or within areas with designated Management Categories "B", "C" and "E" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

According to the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans, the "community supports development where it is compatible with the Conservation Plan's land use and species management priorities" (Community of Tuktoyaktuk et al. 2008, p. 16; Community of Inuvik et al. 2008, p. 17). As well, the stated community values identify that development projects should be scaled to retain opportunities and ensure the most lasting benefit to the local economy, while maintaining air and water quality and the health of the resources.

There are several overlapping management areas between Inuvik and Tuktoyaktuk. The Tuktoyaktuk and Inuvik Inuvialuit CCPs prepared in 2000 identified an "Overlay of all Site Designations in the Tuktoyaktuk and Inuvik Planning Area" (Map 14) that was used during the development of the route options presented in the Project Description Report. According to this map, the proposed Highway routes were located in areas with Management Categories "B" and "C"[10].

In 2008, the Tuktoyaktuk and Inuvik Inuvialuit CCPs were revised and the "All Site Designations in the Tuktoyaktuk and Inuvik Planning Areas" (Map 8) identified that all proposed route options are located within Management Categories "C" and "E". The "E" designation surrounds the Husky Lakes area[11].

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[10] According to Community of Tuktoyaktuk et al. (2000) and Community of Inuvik et al. (2000):

Management Category "B" means that the "lands and waters where there are cultural or renewable resources of some significance and sensitivity but where terms and conditions associated with permits and leases shall assure the conservation of these resources".

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption.

[11] According to Community of Tuktoyaktuk et al. (2008) and Community of Inuvik et al. (2008):

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption."

The following subsections discuss and evaluate the potential effects of the Highway on land use in the region.

4.3.8.1 Potential Effects

The following potential effects of the Project on land uses were considered and evaluated. Effects related to harvesting are discussed in Section 4.3.7. Specific mitigation measures are described in the mitigation measures subsection (Section 4.3.8.2).

Minimal effects are anticipated to occur during both construction and operations phases.

Traditional Use

Traditional use, as it relates to land use, includes activities such as accessing hunting, trapping, fishing areas and conserving and protecting these areas. Effects related to harvesting are identified in Section 4.3.7.

The proposed Highway embankment construction period is scheduled to occur in winter, with some grading, compacting and selective culvert installation/ adjustment activities taking place in spring or summer. As such, the construction activities should have little to no effect on traditional harvesting activities that occur during spring, summer and fall. Access to harvesting areas during winter will not be affected by Highway construction as residents typically access the areas using snowmachines. Access to traditional harvesting areas would continue to be unimpeded during the construction and operations phases.

Summer harvesting activities typically include berry picking. Currently, residents of Tuktoyaktuk have limited areas to pick berries due to the difficulty in traveling on the land during the summer months. In 2010, personal communications between the Project Team and a number of Tuktoyaktuk residents revealed that due to the new all-weather access road between Tuktoyaktuk and Source 177 (which is the north terminus of this Project), the residents were able to pick many berries during the summer months, adding to their traditional food source. The addition of the proposed Highway would allow local residents in Tuktoyaktuk and Inuvik to access additional berry picking areas.

Highway construction may affect the local distribution of some wildlife during the winter months. Wildlife may avoid areas under construction due to human activity and vehicle movement. Similarly, wildlife may avoid the primary winter snowmachine trails that extend from Inuvik to Tuktoyaktuk (Figure 4.3.8-1). During consultations, Tuktoyaktuk residents stated that there is little hunting from Inuvik to Husky Lakes, but that hunting usually occurs near Parsons Lake. According to Mr. J. Pokiak, the harvesting activities that occur during winter months include wolf and wolverine harvesting (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). The effects of the Project on fish, wildlife, and birds are discussed in Sections 4.2.5 and 4.2.7, respectively.

Management Category "E" means that the "lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection."

During consultation, residents stated differing opinions as to whether the proposed Highway would affect fishing. Some residents from Tuktoyaktuk stated that fishing typically occurs further to the east, so the Highway would not affect their fishing areas. Other residents stated that the Highway would allow easier access to fishing areas (Kiggiak-EBA 2008).

Once the Highway is operational, it is expected to provide easier year-round access to harvesting areas and cabins, particularly during the summer months. New access was considered by those consulted as either a positive or a negative effect. Some people expressed concern that the increased access in the summer to berry-picking sites was beneficial, while others were concerned that new access could cause increased harvest pressures on areas typically not harvested.

An additional benefit of the Highway will be that it will provide a single route of effects; that is, during summer and winter months, people will be encouraged, and will likely find it more convenient, to use this main route for travel rather than traveling across the land on new trails. It will serve to localize the effects of travel rather than creating a "spider-web" of effects across the region, such as may currently occur.

Not all residents of Tuktoyaktuk own vehicles that could travel on the Highway (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). For some residents, the preferred mode of winter travel may continue to be by snowmachine using traditional or more direct overland routes to their cabins or harvesting areas.

During the construction phase, construction workers would be required to stay on authorized access roads and the construction area, and not to access the land. During the operations phase, the Developer will work with the appropriate parties to install signage and/or develop educational materials to encourage Highway users to stay on the designated Highway. During the 2009 consultations in Inuvik, participants indicated that the co-management boards will need to decide how to protect wildlife and fish, and that the users will need to be responsible stewards (Appendix B).

Tourism

Air, water and land-based tours are currently offered within the ISR by a variety of business operators. Local residents and tourists travel and camp along the Mackenzie and Dempster Highways. There is also recreational boat traffic on the Mackenzie River, the Mackenzie Delta and the Beaufort Sea. The construction of the Highway would increase tourist accessibility to Tuktoyaktuk during summer months.

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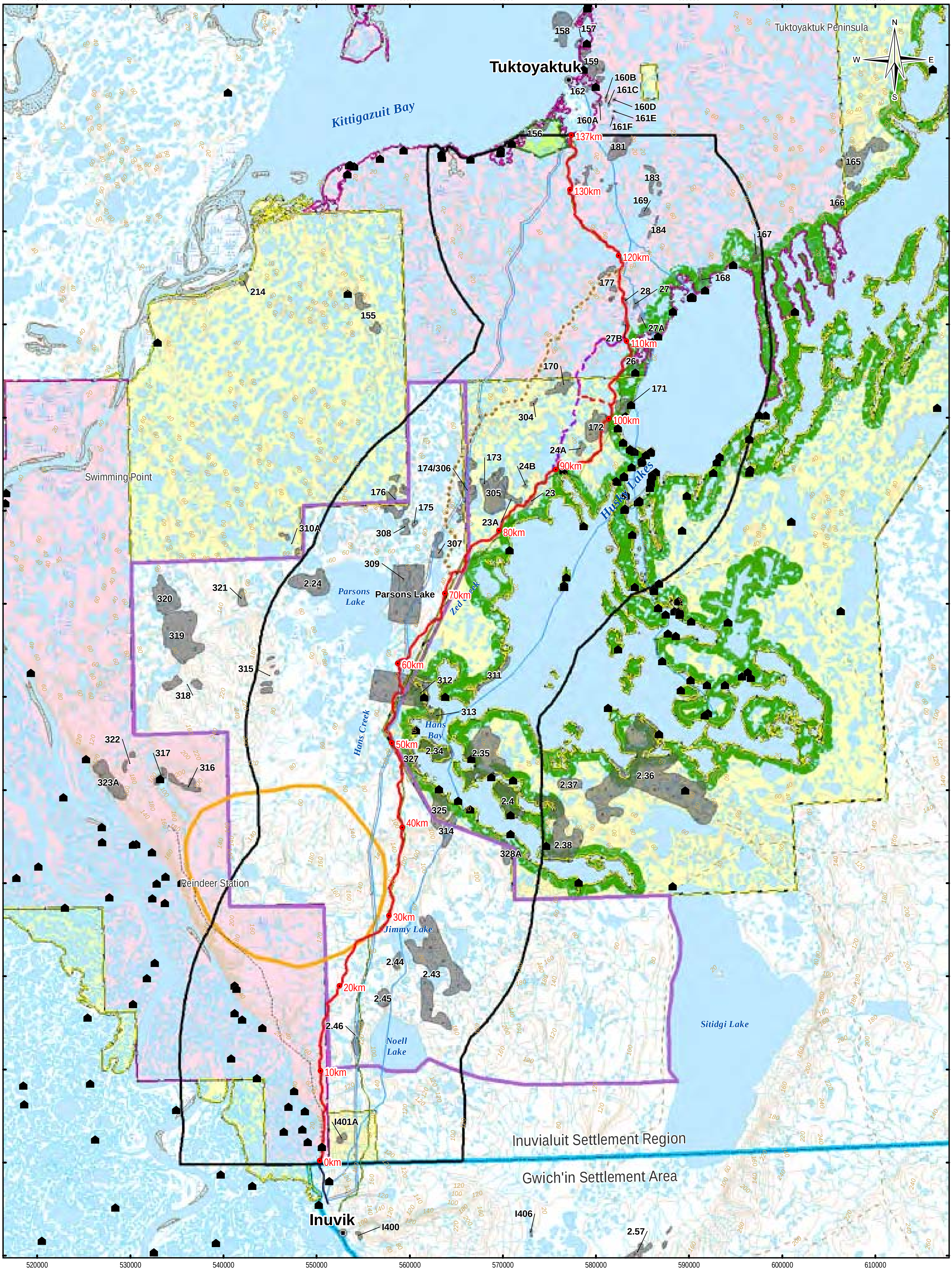

LEGEND

- Residential Leases
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Approximate Winter Reindeer Range
- Approximate Allotment B
- Borrow Sources
- Husky Lakes 1000m Setback
- Former Powerline
- Ikhil Gas Pipeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, Powerline, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Existing Land Uses

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
V23201322_EIS_Map022_CEA_ExistLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 4.3.8-1

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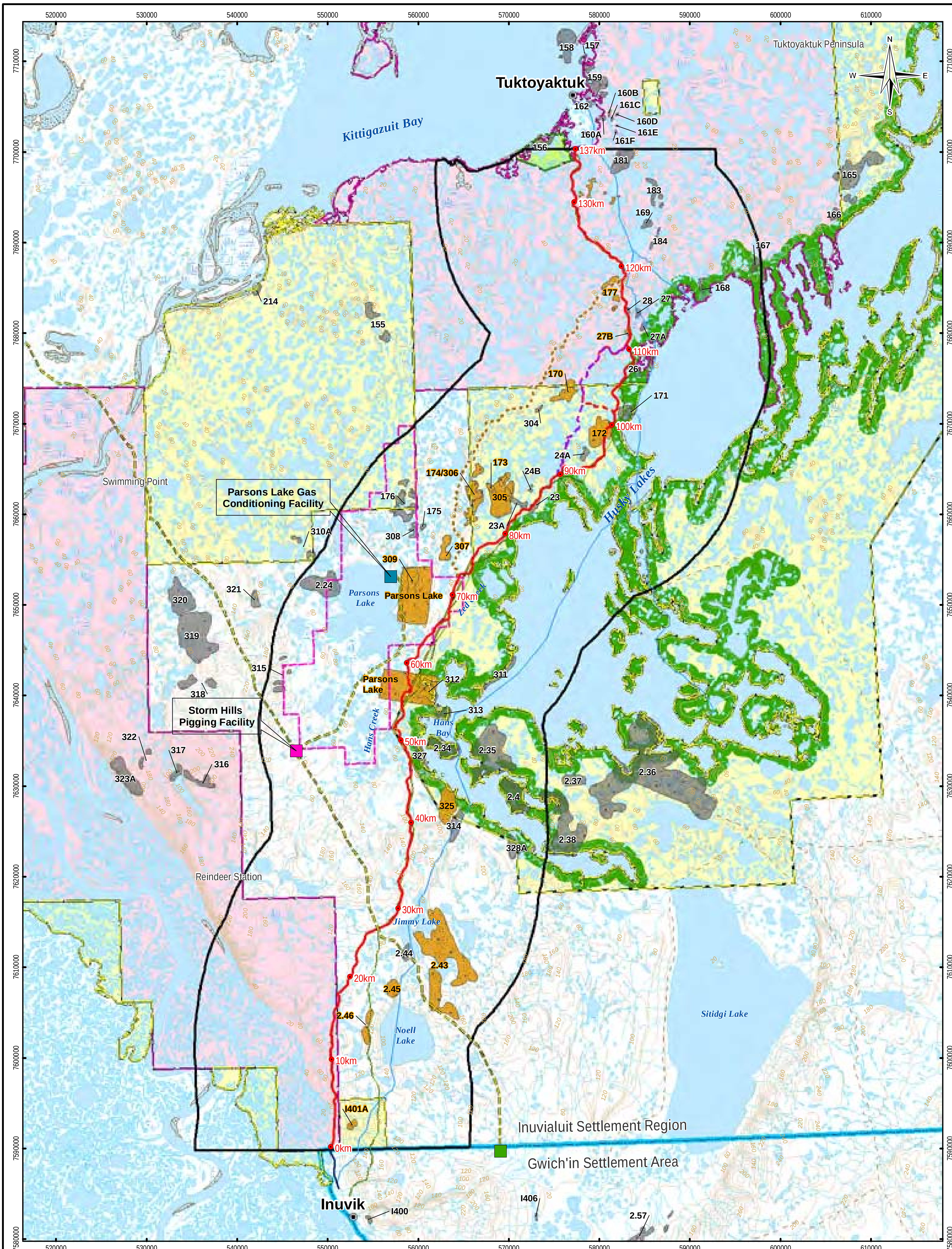

LEGEND

Facility Site	Regional Study Area (15 km buffer)	Inuvialuit 7(1)(a) Lands	Trail
Gas Conditioning Facility	Primary 2009 Route	Inuvialuit 7(1)(b) Lands	Contour
Pigging Facility Site	Alternative 1 (2009 Minor Realignment)	Pingo Park	Watercourse
Route of Gathering Pipelines	Alternative 2 (Upland Route)	Gwich'in / Inuvialuit Boundary	Waterbody
Significant Discovery Licence Area	Alternative 3 (2010 Minor Realignment)	Potential Highway Borrow Sources	Wetland
	PWC 1977	Borrow Sources	Sand
	Navy Road	Husky Lakes 1000m Setback	
	Snowmobile Trails		

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration
Mackenzie Gas Project 2004

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Proposed Future Land Uses

PROJECTION: UTM Zone 8
DATUM: NAD83
Scale: 1:400,000
5 2.5 0 5 10
Kilometres
FILE NO.: V23201322_EIS_Map023_CEA_PropLanduse.mxd
PROJECT NO.: V23201322 | DWN: SL | CKD: TS | REV: 0
OFFICE: EBA-VANC | DATE: May 19, 2011

Figure 4.3.8-2

Currenty, relatively few tourists visit the Project area during winter or summer. Winter Highway construction is not anticipated to affect tourist activities such as snowmobiling or cross-country skiing. The proposed Highway, once constructed, would provide an alternative to air transportation for tourists traveling to or from Tuktoyaktuk.

The proposed Highway will provide all-weather access from southern Canada to the Beaufort Sea, making it possible to travel by car from Canada's west, east and north coasts. New access is expected to attract more tourists to the area, and generate positive economic effects for the existing businesses and commercial activities over the long term. In particular, the hospitality and tourism industries are likely to be positively affected. Increased tourist visits to Tuktoyaktuk and Inuvik will provide new and greater opportunities for the community to market their local crafts.

The construction of the Highway is not anticipated to displace tourists from local accommodations as workers reside in the communities and will be temporarily accommodated at the construction camps during winter, or will be transported to the work site during summer, as necessary.

Industrial Use

The construction of the Project will facilitate year-round access to material resources for community use and for future development. Use of the borrow sources will represent ongoing sources of royalty income for the Inuvialuit.

The Highway will facilitate better access to future onshore and offshore oil and gas exploration and development in the region. According to GNWT DOT (2010a), the Inuvik to Tuktoyaktuk Highway may result in some cost savings for future oil and gas exploration and development. These savings stem principally from a reduction in logistic costs associated with more efficient use of leased drilling rigs, camps, and related support equipment. There is also a reduction in risk costs by not carrying excess inventory and competing for scarce resources. Concurrently, the existence of an all-weather Highway facilitates the movement of rig equipment from southern Canada during the non-drilling season, rather than storing rig equipment and incurring storage costs and extended rig rental costs. Oil and gas companies will need to determine if and how they may choose to benefit from the existence of the proposed Highway.

Commercial Use

The connection of Tuktoyaktuk to Inuvik and the Dempster Highway will provide opportunity for year-round business expansion into the Yukon Territory, and/or potentially reduce overhead transportation costs.

The Highway will open up year-round business opportunities for Tuktoyaktuk businesses and service providers. It will also allow Inuvik and other regionally-based businesses to compete for resource-related and government business opportunities in the area between and within Inuvik and Tuktoyaktuk. An expanding commercial sector will lead to higher quality products and lower cost services for consumers in general, and government, distribution, and resource development organizations.

The construction of the Inuvik to Tuktoyaktuk Highway will also create various spin-off business opportunities for Tuktoyaktuk, Inuvik and other regional businesses such as gas service stations and Highway maintenance services. The increase in tourism and the creation of new business opportunities will also provide important year-round employment and training opportunities for local Inuvik and Tuktoyaktuk residents.

Specific Sites or Features

Specific sites or features within the LSA and/or RSA are identified and discussed in this subsection.

- Gungi – this area located south of Tuktoyaktuk was identified by residents during consultation as an area that would be more accessible for picnicking and berry-picking during summer months following construction of the Highway.
- Caribou migration and feeding areas – Tuktoyaktuk Elders stated that the main feeding and migration areas for caribou are along the shores of Husky Lakes, and not on the higher ground (where the proposed Highway is), as there is not much food available at that elevation.
- Husky Lakes – are an important cultural and spiritual place for the Inuvialuit. The finalized route and all aggregate borrow sources will be a minimum distance of 1 km from the Lakes to avoid affecting the environmental integrity or residents' enjoyment of the Husky Lakes area.

The Inuvialuit Land Administration has developed the draft Husky Lakes Special Cultural Area Criteria: ILMS[12] Special Area Plan (ILA 2010), which identifies the boundary of the Husky Lakes Special Cultural Area, in addition to other Husky Lakes management areas. The criteria are a set of goal-oriented, regulatory standards designed to protect the environment in the Husky Lakes area. If approved, the ILA will employ the use of these criteria to review proposed projects. The Primary 2009 Route, Alternative 1 (2009 Minor Realignment), Alternative 2 (Upland Route), and Alternative 3 (2010 Minor Realignment) which was recommended by Inuvialuit interests, are all partially located within the cultural area. Therefore, if approved, the Developer is committed to addressing the performance criteria and management goals identified in the draft ILMS Special Area Plan.

In addition, under the *Inuvialuit Final Agreement*- Annex D, the Husky Lakes have two management designations, Area 1 and Area 2. Area 1 does not allow dredging or marine development. Similarly, Area 2 does not allow dredging or marine development, in addition to having other terrestrial criteria that must be adhered to. The proposed Highway is not located within Area 1 or Area 2.

[12] ILMS – Inuvialuit Land Management System.

Protected Areas and Special Management Areas

According to the Tuktoyaktuk and Inuvik Inuvialuit CCPs, the proposed Highway alignment passes through several special management areas (Figure 3.2.9-5). The potential interactions with special management areas are discussed. Specific wildlife effects are evaluated and discussed in the wildlife effects section (Section 4.2.7).

Grizzly Bear Denning Areas (322C) – the proposed Highway alignment is located within the expansive grizzly bear denning area. Denning occurs during the winter months when grizzly bears hibernate. The potential effects and mitigation measures are discussed in the wildlife section (Section 4.2.7).

Caribou Hills (702B) – the proposed Highway alignment crosses through the southeast edge of the Caribou Hills area, a management area important for subsistence berry picking and harvesting. According to Figures 3.1.9-11 and 3.1.9-12, Bluenose-West and Cape Bathurst herds are in the portion of the Caribou Hills affected by the Highway between October 8 and November 30, but move away from the area after December, when construction would occur. Residents typically access the area using all-terrain vehicles. The proposed Highway will provide easier access to the area for subsistence harvesters. Direct effects will occur to vegetation under the Project footprint. Indirect effects to vegetation will occur from fugitive dust, which are discussed in the vegetation effects section (Section 4.2.6).

Fish Lakes and Rivers (704C) – the northern portion of the Highway is located within the Fish Lakes and Rivers management area. The area includes the rivers and lakes along the shoreline west of Tuktoyaktuk, inland to their headwaters, including Parsons and Yaya lakes, all of which are used by the residents of Tuktoyaktuk and Inuvik for subsistence harvesting. Mitigation measures implemented during the construction phase will minimize potential effects while the operation of the Highway will allow easier access to these important subsistence harvesting areas. The effects and mitigation measures associated with fish and fish habitat are discussed in the fish effects section (Section 4.2.5).

Husky Lakes (705E) – the route re-alignment options are located outside of the 1 km setback from the Husky Lakes Management Area to avoid encroachment, in accordance with the draft "Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area" (EIRB 2002).

Bluenose-West Caribou Herd Winter Range (701E) – this expansive area encompasses much of the ISR, including Tuktoyaktuk and the area directly north of Inuvik. The proposed Highway alignment is within this area. The effects and mitigation measures associated with this valued component are discussed in the wildlife effects section (Section 4.2.7).

Winter/Spring Caribou Harvesting (315C/302C) – caribou harvesting areas are located throughout the northern portions of the ISR, including Husky Lakes and Inuvik. Caribou are currently protected from harvesting by hunting restrictions. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to declining caribou populations. The effects and mitigation measures associated with this valued component are discussed in the wildlife effects section (Section 4.2.7).

Winter Wolverine Harvesting (314C) – similar to caribou, this expansive area encompasses much of the ISR, including Tuktoyaktuk and the area directly north of Inuvik. The proposed Highway alignment is within this area. The effects and mitigation measures associated with wolverines and wolverine habitat are discussed in the wildlife effects section (Section 4.2.7).

Spring Goose Harvesting (304C) – goose are harvested throughout the ISR. The proposed Highway would cross through portions of this management area. The effects and mitigation measures associated with wildlife and wildlife habitat are discussed in the wildlife effects section (Section 4.2.7).

Winter/Summer/Spring Fish Harvesting (316C/307C/305C) – several fish harvesting locations are identified and managed, particularly near the Husky Lakes region. The proposed Highway would cross through portions of this management area. The effects and mitigation measures associated with fish and fish habitat are discussed in the fish effects section (Section 4.2.5).

The Northwest Territories Protected Area Strategy has been reviewed and considered in the assessment of potential Project effects. The proposed Highway avoids all protected areas identified in the Protected Areas Strategy.

4.3.8.2 Project Design and Mitigation Measures

The construction timing, Highway design, and mitigation measures are intended to minimize potential land use effects. The route re-alignmnet options are located a minimum of 1 km from the Husky Lakes, an area known for its wildlife and cultural values.

The Developer will conform to applicable ambient air quality objectives, by using pollution prevention measures and best management practices.

Other mitigation measures that will be implemented include:

- Ensuring that construction vehicles stay on access roads or the construction site at all times;
- Prohibiting the recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway; and
- Prohibiting the recreational use of the Highway by Project staff during construction.

4.3.8.3 Residual Effects

The residual effect on land use that will remain after implementation of mitigation measures is the footprint of the all-weather Highway across the landscape.

The Highway routing has been designed to avoid or minimize affecting particularly special cultural areas. Access to traditional or special locations will not be restricted by the Highway.

The proposed Highway is a linear development that potentially influences land use at a regional level. It has long-term, low-magnitude, localized residual effects on land use.

4.3.9 Archaeological Resources

Archaeological resources are protected through various federal, territorial and Inuvialuit legislation and regulations. The *Northwest Territories Archaeological Sites Regulations*, pursuant to the *Northwest Territories Act,* applies throughout the Territories and states:

> 4. No person shall search for archaeological sites or archaeological artifacts, or survey an archaeological site, without a Class 1 or Class 2 permit.
>
> 5. No person shall excavate, alter or otherwise disturb an archaeological site, or remove an archaeological artifact from an archaeological site without a Class 2 permit.

Within the Inuvialuit Settlement Region, the *Territorial Land Use Regulations*, pursuant to the *Territorial Lands Act,* applies to federal crown lands. Two sections are relevant to archaeological sites:

> 10(a) No permittee shall, unless expressly authorized in his permit or expressly authorized in writing by an inspector conduct a land use operation within 30 metres of a known monument or a known or suspected archaeological site or burial ground; and
>
> 16 Where, in the course of a land use operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the permittee shall immediately
>
> (a) suspend the land use operation on the site; and
>
> (b) notify the engineer or an inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

On Inuvialuit private lands, the Inuvialuit Lands Administration Rules and Procedures apply. One section is relevant to the protection of archaeological sites:

> 19(9) Where in the course of an operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the Holder shall immediately:
>
> (a) suspend the operation on the site; and
>
> (b) notify the Administrator or an Inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

The *Historical Resources Act* (Territorial) pertains to Commissioner's Land within the ISR. Protection of sites in these areas is afforded by the following Section:

9(1) Whenever, in the opinion of the Commissioner, any prehistoric or historic remains, whether or not designated as an historic place under this ordinance or under the *Historic Sites and Monuments Act* of Canada is threatened with destruction by reason of commercial, industrial, mining, mineral exploration or other activity, the Commissioner may order the persons undertaking the activity to provide for adequate investigation, recording and salvage of prehistoric or historic objects threatened with destruction.

4.3.9.1 Potential Effects

There are twelve previously recorded archaeological sites within a 5 km radius of the proposed Highway. As shown in Figure 3.2.10-1 Archaeological Sites Previously Recorded, none of the sites occur along the Primary 2009 Route. The absence of archaeological sites is consistent with the Historical and Cultural Sites and Burial Sites figures found in the 2006 Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al. 2006).

Of the twelve previously recorded archaeological sites, two are found within borrow sources within the 1 km setback from Husky Lakes. Neither of these sites would be used to source granular materials. One site is located within a known borrow source located further from the route and has not been identified for construction use at this time. Two other sites are found within borrow sources that may be used during construction, which would require mitigation.

Areas with potential to contain unrecorded archaeological sites are identified in Figures 3.2.10-2, 3.2.10-3 Archaeological Potential Areas do occur along the proposed Highway route. Areas with archaeological potential exist along the Primary 2009 Route and Alternative 2 (Upland Route). Alternative 3 (2010 Minor Realignment) which was recommended by Inuvialuit interests in 2010 was not assessed. Areas with the best potential for archaeology include level and dry banks, terraces or benches along major streams or lakes or elevated landforms.

4.3.9.2 Project Design and Mitigation Measures

Further archaeological impact assessments are required prior to Highway construction, once a route is selected. To adequately complete intensive archaeological inventory survey, the Highway route must be finalized within a 100 m wide corridor and boundaries of all associated components such as borrow sources, work staging areas, construction camps must be identified prior to field work.

Initial archaeological reconnaissance identified that no known archaeological sites occur along the proposed Highway alignments. Of the known sites within 5 km of the proposed alignment, only two are located in areas that may be proposed as borrow sources. In assessing these potential borrow sites, mitigation measures would be implemented to resolve any potential effects to these sites. Furthermore, since much of the proposed alignment is located within areas with potential archaeological resources, appropriate mitigation measures will be implemented throughout the duration of the construction process to ensure compliance with heritage resource protection legislation and regulations.

The combination of background documentary data and overview terrain assessment has resulted in the identification of specific areas with sufficient potential for archaeological resources that ground reconnaissance is recommended.

Prior to the annual construction program, intensive archaeological impact assessments will be conducted along the final alignment, including borrow sources, work staging areas, and construction camp locations. A qualified archaeologist will be hired to perform the study. As fieldwork can only be effectively undertaken during the summer months, NWT Archaeologists Permit applications will be applied for during spring, prior to field season.

On the recommendation of the contract archaeologist in the field the Developer shall implement avoidance or mitigation measures to protect archaeological sites or to salvage the information they contain through excavation, analysis, and report writing, subject to the approval by the PNWHC.

An archaeological impact assessment typically consists of two phases of archaeological research, inventory and assessment, focused on the project footprint or study area (PWNHC ND). An inventory is generally conducted once the direct, indirect and perceived geographical areas affected by the project are well defined. Systematic and intensive fieldwork identifies potential effects on archaeological sites from possible and alternate construction components. All archaeological sites must be recorded and submitted on Archaeological Survey of Canada site survey forms. Information is collected from field, library, and archives to identify likely effects and identify any further required studies or mitigations. An NWT Class 2 Archaeological Permit is required.

Following the inventory phase, an assessment is conducted to predict the form and magnitude of the effects. Assessments provide information on the size, volume, complexity, and content of an archaeological site, which is used to rank the values of different sites and to identify mitigation measures or programs (PWNHC ND).

An archaeological site(s) protection plan will be prepared that will facilitate the continued protection and management of archaeological resources during the construction phase of the Project. A typical plan includes detailed procedures for information flow between relevant agencies, how minor route realignments during construction will be assessed for archaeological impacts, and how this information will be communicated in a timely manner.

Mitigation measures will be designed on an individual basis, and require prior approval by the Prince of Wales Northern Heritage Centre. Mitigation measures may include avoidance (the preferred mitigation), temporary site protection, or systematic data recovery. It is expected that most archaeological sites found will be small and could be readily avoided with a minor Project realignment or footprint adjustment. GNWT Department of Transportation and the Hamlet of Tuktoyaktuk, along with the selected contractor, will make every effort to avoid and protect recorded and unrecorded archaeological and heritage resources during the conduct of this Project.

In the unlikely event that Project relocation is not feasible and a site will be impacted, recommended site mitigation will likely comprise detailed mapping, recording and excavation of a sufficient number of units to ensure a representative sample of the site contents is obtained. This ensures that knowledge of that site is available for future generations.

4.3.9.3 Residual Effects

Archaeological impact assessments will be undertaken on an annual basis, prior to the annual construction program, to determine if there are any archaeological resources present. If present, mitigation measures will be designed in collaboration with the Prince of Wales Northern Heritage Centre, to avoid Project effects on archaeological resources.

4.4 ACCIDENTS AND MALFUNCTIONS

Accidents or malfunctions can be associated with any human activities, including those associated with the construction periods projected for the 137 km Inuvik to Tuktoyaktuk Highway. Environmental consequences of potential accidents or malfunctions associated with the Highway and associated aggregate borrow and construction camp activities would be primarily limited to those related to vehicle crashes and fuel storage, transportation and handling system failures.

To minimize risks of accidents or malfunctions occurring and to minimize possible risks to the environment from such potential accidents or malfunctions, a number of preventative and mitigation measures will be employed, including:

- Implementation of best management and industry practices as appropriate to prevent or minimize the occurrence of accidents or malfunctions;
- Ensuring that all on-site contractors have industry-compliant and satisfactory Health, Safety and Environmental (HSE) policies, programs and manuals and that they are successfully implemented throughout the Project;
- Ensuring that the Developer and its contractors have an environmental management plan and spill contingency plan that will address potential accidents and malfunctions for the life of the Project;
- Compliance with ILA and INAC Land Use Permit and Borrow Permit requirements and conditions issued for the construction phase of the Project;
- Conformance with existing applicable GNWT and Workers Compensation Board standards;
- Fuel and other hydrocarbons will be stored in accordance with CCME's (2003) *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities,* and to the extent applicable, and the *CEPA Storage Tank System for Petroleum Products and Allied Petroleum Products Regulations.*
- All vehicles and equipment will be refueled at least 100 m from waterbodies following INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities*;
- Spills will be reported to the 24-hour Spill Report Line (867-920-8130) according to current guidelines; and

- Spill containment and clean-up activities will be implemented in accordance with the site-specific spill contingency plans that will be developed for the Inuvik to Tuktoyaktuk Highway.

In particular, the Developer will ensure that a spill contingency plan is in place that conforms to INAC's (2007) *Guidelines for Spill Contingency Planning* (Appendix E). In particular, the plan will include:

- Descriptions of the type and amount of contaminants stored at the Project location;
- Site map of the location;
- Steps to be taken to report, contain, clean-up and dispose of contaminants in the case of a spill;
- A description of the training provided to employees to respond to a spill;
- An inventory of and the location of response and clean-up equipment available to implement the spill contingency plan.

The key strategy will be to prevent accidents from occurring through education and enforcement. With the application and implementation of the preventative and mitigation measures as outlined, no significant fuel, chemical or other product spills are expected to occur.

The vast majority of the proposed activities will be conducted on the proposed Highway itself and negligible or minor environmental effects are anticipated. The Construction Team will work closely with the ILA environmental and wildlife monitors present when the proposed Highway is being constructed.

4.4.1 Fuel Storage and Spills

Fuel needed for the aggregate borrow and Highway construction activities will be stored in double-walled fuel storage tanks. All fuel will be stored in accordance with CCME's (2003) *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities,* and to the extent applicable, and the *CEPA Storage Tank System for Petroleum Products and Allied Petroleum Products Regulations.*

4.4.2 Refuelling Operation

All vehicles and equipment will be refueled at least 100 m from waterbodies following INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities.*

4.4.3 Waste Management

4.4.3.1 General Waste Management Planning

The Project will have waste management planning in place that will ensure wastes are handled, stored, transported, and disposed of in a manner that will prevent the unauthorized discharge of contaminants, mitigate impacts to air, land, water, and minimize risks of animal attraction, while maintaining health and safety of personnel and wildlife. In order to achieve this, the Developer will develop a Project specific waste management plan for all wastes associated with preconstruction and construction activities. The waste management plan will apply to the Developer and all its Project contractors involved in the generation, treatment, transferring, receiving, and disposal of waste materials for the Project. The Project specific waste management plan will:

- Identify waste sources and related types, including but not limited to liquid, solid, non-hazardous, hazardous and approximate quantities;
- Describe all on-site or remote treatment and disposal methods;
- Describe all waste streams to be transported off-site and final disposal locations;
- Describe the related waste segregation strategies for the identified waste sources and types to accommodate their respective storage, treatment, transport, and disposal; and
- Description of food and food contaminated waste management methods to mitigate animal attraction from source to transport, treatment or disposal.

4.4.3.2 Waste Handling and Separation, Storage and Processing at Source

All Project wastes will be segregated and stored separately as described in Tables 4.4.3-1 and 4.4.3-2. Effective separation of different types of wastes at the source will enable proper handling from waste creation through treatment and/or disposal.

4.4.3.3 Food and Food-Contaminated Waste and Animal Attraction

The Developer recognizes that timely and responsible segregation, storage, and disposal of food and food-contaminated waste, is of critical importance to minimize risks associated with wildlife attraction. To minimize risks of animal attraction to camps and other related activities while maintaining health and safety of personnel, wildlife, and the environment, all food and food contaminated waste will be stored separate to all other wastes, and in airtight sealed container(s), and enclosed in a bear proof container while in bulk storage prior to final transport, treatment or disposal.

4.4.3.4 General Camp Waste and Sewage

The main wastes produced during the construction of the Inuvik to Tuktoyaktuk Highway are those resulting from camps, which is comprised of waste typical and similar to that of municipal solid and liquid waste streams, as described in Table 4.4.3-1.

TABLE 4.4.3-1: CLASSIFICATION OF CAMP WASTE	
Type of Waste	**Description**
Recyclable material	Paper, glass, bottles, cans, metals, certain plastics
Food contaminated	Biodegradable waste, food and kitchen waste, animal and vegetable wastes: typical of restaurants, hotels, markets, etc.
Composite	Waste clothing, non-recyclable plastics, etc.
Human waste	Sewage related, blackwater
Greywater	Kitchen and washing related liquid waste

Standard sanitation collection and disposal methods will be employed at the construction camps. Acceptable practice for sanitary collection treatment will include the use of stationary/ portable sewage collection systems. Sewage will be hauled on a regular basis to either the Inuvik or Tuktoyaktuk sewage lagoons depending on the location of the camps (see Section 4.4.3.7).

4.4.3.5 Industrial Waste

Industrial waste, as described in Table 4.4.3-2, will encompass all other wastes not defined as camp sourced MSW described above.

TABLE 4.4.3-2: CLASSIFICATION OF INDUSTRIAL WASTE	
Type of Waste	**Description**
Recyclable/reusable construction and demolition	• Building materials etc.
Non-recyclable construction and demolition	• Inert material, such as soil and granular material
Hazardous materials	• Contaminated soil/ snow/ water • Waste fuel • Used oil • Other crankcase fluids • Solvents • Glycol • Batteries • Tank, drum, and container rinsings • Empty drums

4.4.3.6 Hazardous Waste

Hazardous waste will be generated during the construction of the Highway will be properly managed. Part of this management includes compliance with GNWT ENR's requirements to track the movement of hazardous waste from registered generators, carriers, to receivers according to the *Guideline for the General Management of Hazardous Waste in the NWT*. Further, the Developers will prepare and adhere to a Project specific waste management plan.

The Developer and its contractors are expected to generate hazardous wastes such as, but not limited to, those described in Table 4.4.3-2. GNWT DOT is currently a registered generator of hazardous waste and is directly responsible for the hazardous waste generated from their operations. Further, GNWT DOT is indirectly responsible for the hazardous waste generated from private contractors on the Project. The Developer is aware that hazardous waste must be disposed of at an approved facility, and that it is not appropriate to dispose hazardous waste in NWT community solid waste facilities.

To mitigate potential adverse environmental effects associated with improper hazardous waste disposal and to further demonstrate that proper hazardous waste management planning is in place, a hazardous waste management plan (HWMP) will be developed and submitted. The HWMP will encompass all pre-construction and construction phases of the Project and will apply to the Developer and all contractors involved in receiving, transferring, and transporting hazardous waste for the Developer's activities on land, water, and air. The HWMP will include, but not be limited to:

- Identifying hazardous waste sources, types, and approximate quantities to be produced (including liquid, solid, dangerous goods and non-dangerous goods);
- Describing waste segregation methods;
- Describing all on-site treatment and disposal methods; and
- Describing hazardous wastes that will be transported to approved receiving facilities.

4.4.3.7 Project Waste Quantities and Disposal Options

The Developer proposes to transport and dispose of segregated, camp-based, solid and liquid waste at the Tuktoyaktuk and Inuvik solid waste facilities and sewage lagoons. Due to construction taking place from the north and south side of the Highway concurrently, it is necessary that waste from the north end of construction be disposed of in Tuktoyaktuk, and similarly, that waste from the south end of construction be disposed of in Inuvik.

In the first year, several 15-20 person camps will be set up and in the second year, at least one camp housing more than 50 people will be set up. The volume and types of waste taken to the Inuvik landfill and sewage lagoon is expected to not represent a significant increase in the existing community sourced amount of waste entering Inuvik.

The Developer has consulted with the communities of Tuktoyaktuk and Inuvik regarding the disposal of camp sourced municipal solid waste. The Developer will ensure:

- Prior to disposal of waste, an estimate of the amount and type of domestic waste is provided to the Town of Inuvik and Hamlet of Tuktoyaktuk, and compared to the facilities' available capacity;
- Approval from the Town of Inuvik and Hamlet of Tuktoyaktuk to use their sewage lagoon and solid waste disposal facilities will be obtained and applicable Licence, Permits, and/or municipal by-laws regarding the use of these facilities will be followed; and

- Records of the amount of domestic waste shipped to the Inuvik and Tuktoyaktuk landfill will be kept by the Developer to confirm and compare the accuracy of waste projections versus the amounts that actually enter the community.

4.4.4 Vehicle Crashes

Safety measures to prevent vehicle accidents on the proposed Highway have been and will continue to be incorporated into the Highway design. According to the GNWT DOT, there were 861 vehicle collisions in 2008, 179 or 21% of which occurred on highways in the NWT, the remaining accidents were in urban centres or involved all-terrain vehicles (GNWT DOT 2009a, 2009b).

Measures to avoid or minimize accidents will include posted speed limits, adequate signage alerting drivers to Highway curves and upcoming bridges. Bridge design will incorporate guardrails to prevent a vehicle from going off the Highway and into a watercourse in the event of an accident.

While it is recognized that a year-round Highway will increase overall traffic volume, which correspondingly may increase the number of emergency incidents, Corporal Doorinbos did not anticipate many fatal collisions on the Highway as there have been very few on the winter road (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

4.4.5 Worst Case Scenario

One of the objectives of the *Inuvialuit Final Agreement* (IFA) is to prevent damage to wildlife and its habitat and to avoid disruption of Inuvialuit harvesting activities by reason of development (IFA Section 13.(1)(a)). As such, when a development is proposed, the EIRB must establish limits of liability for a project proponent or developer. Section 13.(11)(b) of the IFA requires an "estimate of the potential liability of the developer, determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay, and environmental factors." The proposed Highway from Inuvik to Tuktoyaktuk is subject to these terms.

To estimate the potential liability of the developer for impacts of the Highway development, a worst case scenario was identified. Based on consultation and regulatory feedback, it is evident that a worst case scenario would involve environmental damage to the Husky Lakes and effects to traditional activities and harvesting. Therefore, the worst case scenario for the Project would likely be one in which a fuel supply truck crashes on the Highway, in a location nearest the Husky Lakes (e.g., KM 80) and causes a fuel spill of greater than 10,000 L into an open watercourse, which is a direct tributary to the Husky Lakes.

The worst case scenario was further defined to assume that:

- The fuel supply truck crash occurs during spring freshet when water levels, discharge and velocity are at their yearly peak and the potential for the greatest number of available pathways for conveyance downstream to the Husky Lakes is present;

- The spill of diesel fuel into a fish-bearing watercourse and ultimately into Husky Lakes would result in residents avoiding consumption of fish because of the perception that the fuel would taint the fish;
- The fish harvest season from Husky Lakes for that particular year would be lost as a result of the diesel fuel input to Husky Lakes; and
- The fouling of fishing gear would result in replacement costs.

It is recognized that there are strong cultural and traditional values associated with the subsistence fishery within the Husky Lakes (Figure 3.2.8-17 Fish Harvesting Areas Spring, Summer, Fall, and Winter).

The following sections will describe the potential for this type of scenario to occur, the mitigation measures in place to avoid this scenario, and the overall probability of this scenario occurring.

4.4.5.1 Diesel Fuel Transportation

Currently, the vast majority of diesel fuel is transported to Tuktoyaktuk by barge in the summer, via the Mackenzie River, with only very occasional deliveries transported by truck via the winter road (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010). Approximately 3.2 million litres of diesel and 700,000 litres of gas are transported to Tuktoyaktuk for community fuel re-supply, not including that brought in for industrial use. Tuktoyaktuk's fuel tank storage has a capacity of greater than four million litres. Fuel is delivered using the winter road only if fuel prices are low and there is need in the community (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010).

According to E. Gruben's Transport Ltd. (Gruben's), it is expected that in the future, all diesel and gas would be delivered to Tuktoyaktuk via the proposed Highway once it is constructed (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010). Although the cost of delivery by barge or by fuel truck is comparable, the delivery of fuel to Tuktoyaktuk via the Highway would result in overall cost and storage efficiency (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010).

Currently, when the annual resupply is delivered to Tuktoyaktuk in the summer (August) the community has to pay for a full year's supply of fuel at one time. Transporting fuel at regular intervals over the year would allow the community to pay for fuel at intervals instead. Not only is this easier to afford, but it also allows the community to potentially access a discount if fuel is cheaper at different times of the year. For example, if fuel prices in April 2011 are $1.50 per litre, but decrease to $1.45 per litre in November 2011, then the community may realize a cost savings. As well, the Hamlet of Tuktoyaktuk must currently maintain a four million litre fuel tank farm. If fuel was brought to the community on a regular basis, less fuel storage would be required, which would also require less overall cost for maintenance and upkeep and less overall risk to the community.

Based on the annual fuel requirements and given that the average B-Train truck load can hold a volume of 48,000 litres, it is expected that at least 67 truckloads per year will travel via the Highway. Since open water occurs for approximately four months each year (or 33% of the year), it is estimated that approximately 33% (or 22) of the fuel deliveries will occur during this period. Therefore, approximately 67% (or 45) fuel truck deliveries are expected during the winter months when the risk of spill into an open waterway with access to Husky Lakes is negligible.

Winter conditions and frozen waterways exist between October (first ice) and May (spring melt). The risk of a spill into open water is negligible during winter as the spill would occur on snow and ice. In general, spills that occur on ice are the easiest to clean up. Since ice is impermeable, it allows sorbent materials to soak up the spill, while any remaining contaminated ice can be scraped and removed from the ice surface. Trenches and dykes are also effective at containing spills onto ice. Snow acts as a natural sorbent and spills onto snow can also be easily recovered by shovelling contaminated snow into plastic bags or barrels. Again, dykes can be effective in containing fuel spills onto snow and can be used in conjunction with tarps to pool spills within the snow dyke (INAC 2007b). Consequently there is no perceived risk during this period as response, containment and recovery of fuel spilled over snow and ice is typically very effective and therefore, impacts to fish and fish habitat are unlikely.

4.4.5.2 Fate of Fuel in the Environment

Diesel fuel is most often a light, refined petroleum product. According to the National Oceanic and Atmospheric Administration (NOAA), small diesel spills (2,000 L to 20,000 L) will typically evaporate and disperse within a day or less, even in cold water; therefore, seldom is there any fuel on the surface to recover (NOAA 2006). Heavier intermediate fuel oil may persist longer when spilled.

The characteristics of diesel and small diesel spills include:

- Diesel oil has a very low viscosity and is readily dispersed into the water column;
- Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months;
- Diesel oil is much lighter than water (including seawater); it is not possible for this oil to sink and accumulate on the seafloor as pooled or free oil unless it adheres to fine-grained suspended sediments (adsorption), which can settle out and get deposited on the seafloor. This process is not likely to result in measurable sediment contamination for small spills; and
- Diesel oil is not very sticky or viscous, and tends to be washed off by waves and shoreline clean-up is usually not needed (NOAA 2006).

Due to the toxicity of diesel, fish and marine birds that come in direct contact with a diesel spill may be affected. Small spills (<20,000 L) in open water are so rapidly diluted that fish kills have never been reported, except when small spills occur in confined, shallow water

(NOAA 2006). As well, the number of marine birds typically affected is small due to the short amount of time the diesel oil is on the water surface.

To assess the potential likelihood for spill of diesel fuel into an open waterway, data were obtained from the GNWT on hazardous spills and vehicle accidents. It was found that only seven diesel fuel spills of greater than 10,000 L from a transport truck have been reported in the NWT over the last 10 years (GNWT ENR 2010e). These spill reports are shown in Table 4.4.5-1.

TABLE 4.4.5-1: REPORTED DIESEL FUEL SPILLS OF GREATER THAN 10,000 L IN THE NWT

Year	Location	Type of Spill	Volume of Spill
2/20/2000	North Slave Lake	Diesel Fuel	21,500
3/3/2000	North Slave Lake	Diesel Fuel	15,000
2/20/2003	South Slave Lake	Diesel Fuel	10,000
2/24/2003	Sahtu	Diesel P-50	11,000
3/21/2005	Sahtu	Diesel P-50 (cold weather diesel)	14,000
1/14/2006	South Slave Lake	Diesel Fuel	12,000
3/9/2006	North Slave Lake	Diesel Fuel	14,000

The largest spill reported in the Inuvik region occurred on December 22, 2001 when 7,000 litres of diesel fuel leaked from a storage tank. The largest truck spill reported in the Inuvik region was 700 litres on August 16, 2007 and occurred approximately 80 km south of Inuvik (GNWT ENR 2010e). Data in Table 4.4.5-1 and the spills occurring in the Inuvik region suggest that spills as a result of truck accidents are uncommon.

In the event that some of the fuel product (e.g., Arctic diesel) escaped the containment booms, fuel would be expected to begin to move and spread over the local surface of the stream and/or Husky Lakes in the prevailing direction of surface water circulation. Although on-site spill response efforts would continue to attempt to recapture any of this fuel, it is important to note that Arctic diesel and any of the other, lighter fuel products are relatively volatile and rapidly evaporate and disperse, as discussed previously.

To demonstrate this, an oil weathering model available from NOAA's Office of Response and Restoration called ADIOS® 2.0 (Automated Data Inquiry for Oil Spills) was run using typical winter or summer diesel fuels at a nominal temperature of 10°C and light winds. The resultant graph shown in Figure 4.4.5-1, shows that approximately 50% of winter grade arctic diesel would be expected to evaporate within about 24 hours and 80% of this fuel would likely dissipate within about a week. A summer grade of diesel fuel is projected to degrade somewhat more slowly (~ 50% in one week). Winter mix diesel fuel is a lighter mix of diesel used to maintain flow and avoid freezing; it has a pour point of -36°C. Summer mix diesel fuel is a heavier mix that can be used during warmer months; it has a pour point of -7°C. The typical fuel used in Inuvik and Tuktoyaktuk is winter mix diesel.

As a result, the effects of a typical fuel spill that could potentially occur in the vicinity of the Husky Lakes would be expected to be of a generally localized, short-term, low magnitude and rapidly reversible nature.

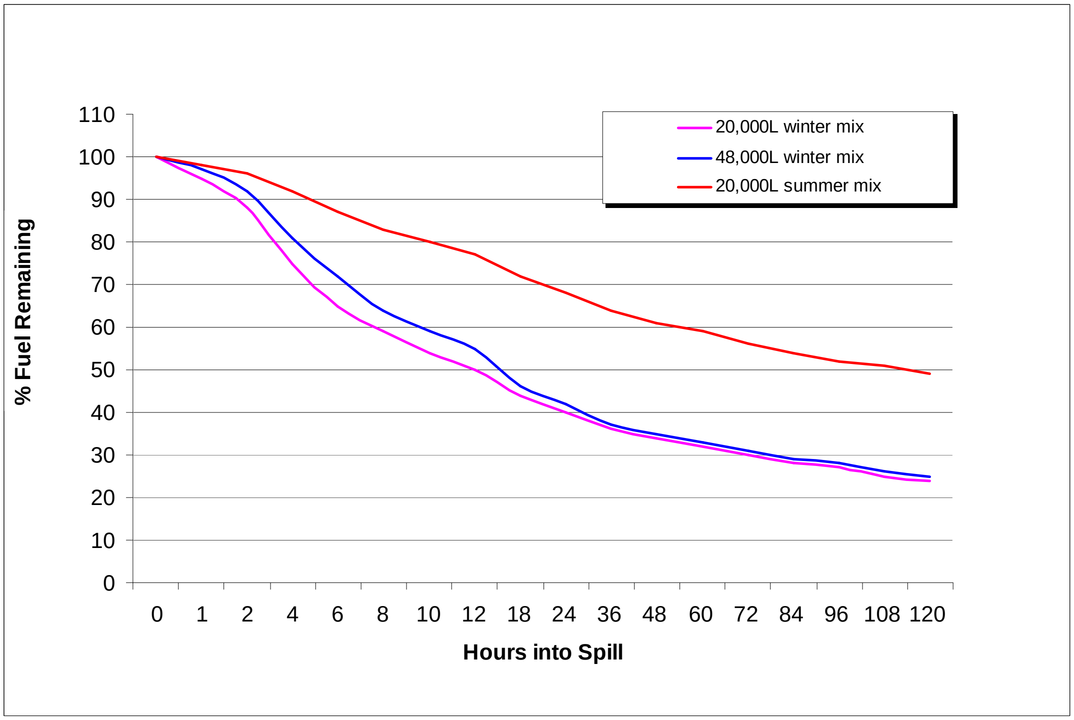

Figure 4.4.5-1.
Dissipation rates of 20,000 L and 48,000L Winter Mix Diesel Spills in Cold Water (10°C) and 20,000 L Summer Mix Fuels in Cold Water (10°C)

Heavier fractions of diesel fuel, found in summer mix fuels, do not evaporate as quickly and therefore persist for a longer period of time in the environment. However, northern fuel mixes are typically winter mixes and do not contain as high a proportion of heavier fractions in order to be usable during cold periods; therefore, the fuel types used in the Inuvik and Tuktoyaktuk communities typically would dissipate faster than the fuels used in more southerly climates.

4.4.5.3 Spill Mitigation

With the application and implementation of the preventative and mitigation measures within the spill contingency plan, no large (i.e. > 1,000 litres) fuel, chemical or other product spills are expected to occur. However, for the purposes of the worst case scenario, a brief description of the spill contingency plan is provided.

The spill contingency plan focuses on response, containment and recovery (INAC 2007, Appendix E). It is noted that response times will vary depending on the severity of crash, ability of the truck operator to respond to the spill (e.g., they may be injured and unable to respond), time it takes for assistance to arrive on the scene, and distance from either Inuvik or Tuktoyaktuk.

The creek crossings with the greatest potential to be affected (due to their location along the Highway) and their ability to convey spilled fuel to the Husky Lakes (due to their close proximity to Husky Lakes and high peak flow rates) include crossings:

- 29a (at KM 55.5);
- 30a (Hans Creek, at KM 56.5);
- 35a (at KM 89.5); and
- 39 (at KM 109).

Hans Creek's average peak discharge rate is approximately 14 m^3/s (Environment Canada 2011). None of these watercourses are within the 1 km setback from Husky Lakes.

According to Canadian Petroleum Association (CPA) and Independent Petroleum Association of Canada (IPAC), fuel in water will move at the same speed as the surface current; therefore, an effort must be made to slow this movement for recovery to be successful (CPA and IPAC 1989). Once spill responders are on the scene, booms would be typically deployed to divert or deflect fuel to an area for containment and recovery. Typically, conventional booms deployed from one shoreline to the other on an angle of 10 to 45 degrees toward a recovery area and integrated with a skimmer will create a system which is reliable under most conditions, even fast moving streams (Exxon 1992; CPA and IPAC 1989). Recovery typically occurs by direct suction of diesel from the surface. Final clean-up and recovery of remaining small amounts of fuel include the use of absorbents to "mop up" diesel soiled stream banks (Exxon 1992; CPA and IPAC 1989).

4.4.5.4 Vehicle Accident Mitigation

According to the GNWT DOT, there were 861 vehicle collisions in 2008, 179 or 21% of which occurred on highways in the NWT, the remaining accidents were in urban centres or involved all-terrain vehicles (GNWT DOT 2009a, 2009b).

Safety measures to prevent vehicle accidents on the proposed Highway have been and will continue to be incorporated into the Highway design. Measures to avoid, or minimize, accidents, particularly those which may occur at or near a watercourse crossing, will include posted speed limits, adequate signage alerting drivers to Highway curves and upcoming bridges. Bridge design will incorporate guardrails to prevent a vehicle from going off the Highway and into a watercourse in the event of an accident.

4.4.5.5 Fishing Effects and Compensation Values

This section identifies the compensation value related to the potential loss of fishing due to a fuel spill.

While it is noted that year-round fishing is of cultural importance to the communities in the region, the risk of environmental damage from an accidental diesel fuel spill is negligible during periods where watercourses and the Husky Lakes area are covered by snow and ice (i.e., between October and May of each year). Fishing during winter and spring are typically done using a hook and lure or gill nets set under the ice (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011; IOL et al. 2004; Joint Secretariat 2003; Roux et al. 2010). Due to the nature of the worst case scenario, fishing information presented here will be specific to harvests occurring during the open water season defined as the period of June to September.

In the open water season from June to September, only a few people use gill nets to fish (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). Data obtained from the Inuvialuit Harvest Study indicated that between 1988 and 1997 there were on average between 3 and 22 Inuvik residents and between 3 and 55 Tuktoyaktuk residents fishing for the period of June to September of any given year throughout the ISR. The differences in the number of people fishing relates to the target species of fish, with more people fishing for broad whitefish, lake whitefish and inconnu and fewer people fishing for burbot and lake trout.

The species selected to determine the value of the summer fish harvest include those mentioned above. They were selected based on their availability during the summer period, their potential to occur within the Husky Lakes, and the available data on past harvest rates. Recent information indicated that summer subsistence fishing using gill nets is typically carried out by one to three residents of Tuktoyaktuk (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

To identify the compensation values related to a loss of fishing, a cost per fish is required. In 1993 and 1997, the cost to purchase a fish was $12.18 (1993) and $12.22 (1997) (IOL et al. 2004). This monetary value of harvested fish was based on a calculation of the cost of replacing harvested fish, based on the Inuvik food price index (IOL et al. 2004). Another assessment of fish value from the public review of the WesternGeco Mackenzie Delta Marine 2D Seismic Program in 2003 stated that $25.00 per fish was acceptable based on the 1987 Wildlife Compensation Agreement between the IGC and Gulf Canada Resources Ltd. (EIRB 2003). Final determination of the estimated value of fish also included information from Mr. J. Pokiak who stated that each fish can be worth between $20 and $50 depending on their size (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). An assumption was made that captures of large fish (valued at $50 per fish) are the exception rather than the norm and the range of all fish values influenced the final determination that the value of $25 per fish was a reasonable replacement cost estimate.

Table 4.4.5-2 identifies average annual harvest from 1988 to 1997 for the open water season defined as June through September (4 months) based on the Inuvialuit Harvest Study for Inuvik and Tuktoyaktuk (Joint Secretariat 2003).

TABLE 4.4.5-2: AVERAGE FISH HARVESTS FROM JUNE TO SEPTEMBER IN INUVIK AND TUKTOYAKTUK (1988-1997)					
		Inuvik		Tuktoyaktuk	
Fish Species	Price per Fish	Average Harvest	Income per species	Average Harvest	Income per species
Burbot	$25	93	$2,325	38	$950
Inconnu	$25	759	$18,975	1,818	$45,450
Lake Trout	$25	49	$1,225	92	$2,300
Broad Whitefish	$25	4,020	$100,500	9,025	$225,625
Lake Whitefish	$25	2,178	$54,450	1,009	$25,225
Total		$177,475		$299,550	

Source: Joint Secretariat (2003)

Based on an average price per fish of $25, as described by Mr. J. Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011) and EIRB (2003), the estimated fish harvesting loss should the worst case scenario occur (i.e., no fish harvested from June to September) would be $477,025 for the residents of Inuvik and Tuktoyaktuk.

Mr. J. Pokiak also indicated that the few residents, on average two or three people, who currently fish the Husky Lakes in the summer period, do so with multiple gill nets, and that gill nets can cost anywhere from $250 to $500 (depending on the net length and mesh size) and average approximately $300 per net (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). Because gill nets are deployed perpendicular to the shoreline with one end above the high water mark and the other submerged, it is assumed that floating diesel would likely contact the shoreline and the exposed portion of each net.

Assuming that each person had all of their nets deployed along the shores of Husky Lakes, the total loss (liability) must also incorporate the replacement value of soiled or tainted nets resulting from the worst case scenario. It is therefore assumed that at least 10 nets per person will be in use and potentially soiled by a diesel spill. At an average cost of $300 per net, the total cost to replace all nets would be ($300/net x 10 nets/person x 3 people) $9,000. Added to the above cost the total potential loss equals $486,025.

The Developer acknowledges, however, that this amount does not account for the possible effects on the psyche, spiritual or cultural values of the people who use and enjoy the Husky Lakes area.

4.4.5.6 Final Worst Case Scenario Determination

In summary, the worst case scenario for the construction and operation of the proposed Highway would involve environmental damage to the Husky Lakes and effects to traditional activities and harvesting, caused by a fuel supply truck crash on the Highway, resulting in a fuel spill of greater than 10,000 litres into an open watercourse, which is a direct tributary to the Husky Lakes.

The worst case scenario was further defined to assume that:

- The fuel supply truck crash occurs during spring freshet when water levels, discharge and velocity are at their yearly peak and the potential for the greatest number of available pathways for conveyance downstream to the Husky Lakes is present;
- The spill of diesel fuel into a fish-bearing watercourse and ultimately into Husky Lakes would result in residents avoiding consumption of fish because of the perception that the fuel would taint the fish;
- The fish harvest season from Husky Lakes would be lost as a result of the diesel fuel input to Husky Lakes; and
- The fouling of fishing gear would result in replacement costs.

Following a detailed analysis of this worst case scenario, the threat of the worst case scenario occurring is considered low due to the short open water period, small number of fuel truck deliveries during the open water season, relatively short duration of persistence of diesel in the environment, mitigation measures such as spill contingency plans employed by transport delivery trucks to avoid spills, and safe Highway and bridge design to reduce the likelihood of accidents.

However, to estimate the potential liability of the developer for impacts of the proposed Highway development as a result of the worst case scenario, the perceived monetary loss of an entire summer season of fishing from the Husky Lakes for all residents involved in fish harvesting was determined to be $486,025. This figure does not, however, account for the possible effects on the psyche, spiritual or cultural values of the people who use and enjoy the Husky Lakes area.

4.5 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

There are potential for effects of the environment on the Project. These effects have been considered during the planning and engineering of the Project to integrate into its environmental surroundings and operate safely and reliably over its life. The potential physical and biological changes in the environment that could have implications for the Project are considered in the following subsections.

4.5.1 Climate Change

During the last half of the twentieth century, meteorological data indicate that mean annual air temperatures in the western Arctic have increased by more than 1.5˚C. This warming trend in the northern high latitudes is anticipated to continue in this century. Many adverse impacts are anticipated, including the degradation of permafrost and its attendant effects (Woo et al. 2007).

The stability of permafrost and the stability of infrastructure built on it depend on maintaining ground temperatures to minimize the thickness of the active layer, and to impede thaw. The proposed Highway is located within the permafrost region and stability of Highway structure will be dependent on maintaining the perennially frozen ground.

To protect the permafrost terrain along the proposed Highway alignment, typical 'cut and fill' techniques commonly employed in southern areas of the Northwest Territories and elsewhere will not be used for this Project. Such traditional construction methods cut into protective layers of surface vegetation and organics, with the possible result of thawing in the permafrost below. Therefore, the current design includes only fills. This approach will protect the permafrost layer below the Highway surface.

The frozen ground has variable proportions of ground ice. When thaw occurs, the excess water is expelled and consolidation produces substantial settlements. The thermal stability of the frozen ground is sensitive to minor changes in heat transfer at the ground surface. These minor changes in heat transfer alter the surface heat balance, initiating thaw and increased active layer thickness. Such heat transfer and potential settlement due to thaw is possible in permafrost regions even without climate warming. Subtle increases in temperature and extreme weather events that result in extreme precipitation and rapid snow melt can contribute to the thaw and accelerate it.

A risk-based approach for incorporating climate change into design of highway infrastructure on permafrost is now recommended practice. The challenge for design and construction over thaw-sensitive permafrost terrain is to assess the capital cost of constructing the Highway and the long term maintenance implications. The design parameters and construction techniques take into account consideration of these risks and provide mitigative approaches in the Highway design. The two most significant elements of the design are the use of non-woven geotextile between the existing ground and the embankment, and maintaining minimum height, based on terrain type, to mitigate heat gain that can result in thawing of the permafrost.

Other risk factors that are related to climate uncertainty are precipitation, including both summer rain and winter snow. Building conservatism into a design to account for climatic warming is more complex than simply projecting air temperature trends into the future. The greatest risk is often associated with extreme events that are now being observed in the northern Canada. Unprecedented warm winters are often followed by rapid and early thaw. High snow cover years are resulting in extreme snow drifting that blankets the downwind sideslopes, insulating the surface and raising the ground temperature under the fringes of the embankment. Standing water against the sideslopes retards winter freezeback of the active layer and can accelerate thaw below the sideslopes.

ey mitigative measures that have been incorporated into the design parameters to manage uncertainty related to future climate trends and extremes in the permafrost region that this Highway will be constructed in include:

- Thick embankments that insulate and stabilize the active layer and the use of non-woven geotextile fabric to assist in maintaining the integrity of the Highway embankment;
- The use of culverts to balance seasonal overland surface flows as necessary; and
- Adoption of construction methods that eliminate cuts and minimize disturbance of the natural vegetation before fill is placed.

Of greater importance is what activities are undertaken after the Highway is put into operation. Given the uncertainty of the events associated with climate change, greater vigilance and effort on the part of maintenance operators will be required including, greater effort for spring culvert clearing and fall protection of culverts and drainage structures, more frequent inspections, and monitoring of the performance of the infrastructure.

4.5.2 Seismic Activity

Geotechnical hazards were reviewed during the planning stage of the Project, including fault zones and active seismic areas. The seismic hazard within the Project area is considered low based on the 2005 Seismic Hazard Map produced by the Geological Survey of Canada (NRC 2010b).

4.5.3 Landslides

Thaw flow slides are characterized by landslides that occur only in ice-rich soils in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and hundreds of these features line the river banks and tundra lakes in the Project area. These landslides are typically relatively small, but over time can retreat some distance back from the rim and from the escarpment. Such a slide could potentially impact the Highway if one were to occur. The likelihood of a retrogressive thaw slide impacting the Highway has been reduced by purposely routing away from existing slides and steeper slopes that would be susceptible to failure. Figure 3.1.1-4 compares the distribution of recorded landslides on the Tuktoyaktuk Peninsula (Aylsworth et al. 2001) to the proposed route options.

4.5.4 Wildfire

Wildfire can affect the permafrost layer by removing the insulating protection provided by the organic layer, without which the rate of permafrost melting increases. Melting of permafrost can result in substantial thaw settlement, the loss of the soil structural integrity, and potentially affect the Highway foundation.

The potential for Project related activities to cause a wildfire is greatly reduced as the majority of the Highway embankment construction will be undertaken during the winter. Summer construction activities will include compacting and grading the Highway embankment, installation of certain culverts (to protect fish habitat) or adjustments to culverts installed in the previous winter. Dust suppression equipment, such as water trucks, will be on site during the summer construction period and if required could be used to combat a wildfire.

Relatively few fires have occurred in the RSA. Figure 3.1.8-5 identifies three fires that have occurred in 1968, 1974, 2003, and 2007, with the largest occurring in 1968, below the treeline, near Inuvik. Figure 3.1.8-3 identifies the post-fire land cover within this area.

Several points of fire ignition from 1988 to 2007 are also identified on Figure 3.1.8-5. The primary cause of ignition is lightning, followed by resident, recreation and unknown. It should be noted that although there are several points of fire ignition shown, these did not become fires. Very few fires have occurred in the RSA, since most of the RSA is located above the treeline and tundra fires are relatively rare.

5.0 CUMULATIVE EFFECTS ASSESSMENT

Cumulative effects are changes to the environment that "are likely to result from the project in combination with other projects or activities that have been or will be carried out" (Canadian Environmental Assessment Agency 2003). Overall cumulative effects are effects of all land or water uses on a Valued Ecosystem Component (VEC) or Valued Socio-economic component (VSC), including effects caused by the Project.

An assessment of cumulative effects provides a more complete understanding of what might happen to VCs beyond the influence of the Project alone. This is useful for regulatory decision-makers and land and resource managers as they review and plan future development. Thus, an assessment of cumulative effects provides a glimpse into environmental and socio-economic conditions now and how they may change in the future with development. This contributes to a better understanding of what might or might not happen if the Project proceeds.

Typically, cumulative effects assessments address effects that:

- Extend over a larger area;
- Are of longer term duration;
- Act in conjunction with other projects/activities on the same VECs; and
- Are reasonably probable, considering possible future projects/activities and impacts.

As noted in the Environmental Effects and Mitigation Measures section of this Environmental Impact Statement (Section 4.0 and 6.0, respectively), it has been determined that, with the application of proposed mitigation measures, for all environmental and socio-economic VCs, the residual environmental effects associated with the construction and future operation of the Inuvik to Tuktoyaktuk Highway are anticipated to be low in magnitude and local in extent.

However, while individually no significant effects are anticipated, the purpose of the cumulative effects assessment (CEA) is to consider the potential additive and synergistic effects of overall residual effects, in combination with past, existing or known planned activities in the vicinity of the proposed Inuvik to Tuktoyaktuk Highway.

In accordance with the EISC/EIRB guide for conducting cumulative effects assessments in the Inuvialuit Settlement Region (Kavik-Axys Inc. 2002), this assessment considers and addresses the following key questions:

- Is the Project likely to have negative environmental effects on VECs in the ISR?
- If so, will the residual negative environmental effects that remain after mitigation combine with the effects of other projects, past, present or future?
- What is the significance of the overall cumulative environmental effects, including the effect of the Project?

- If this Project, in combination with other projects in the area, is likely to create a "significant negative cumulative effect", are there further mitigation measures that could reduce or eliminate the Project's contribution to these effects so that the combined effect does not threaten the VEC?

5.1 SPATIAL BOUNDARIES

For purposes of this cumulative effects assessment (CEA), the spatial boundaries include the portion of the Mackenzie Delta and the Tuktoyaktuk Peninsula in the general vicinity of the proposed Inuvik to Tuktoyaktuk Highway corridor, extending between Inuvik and Tuktoyaktuk, including alternate alignments considered (as shown in Figure 4.3.8-1). The easterly boundary extends from the westerly shores of the Husky Lakes to the westerly boundary, which extends from the eastern side of the Mackenzie River. This general area encompasses the entire proposed Highway, the range of environments that could be impacted by the Highway, and the past, present and future projects that may have a potential to contribute to potential cumulative effects.

The Regional Study Area (RSA) for the Project has been determined as the area within 15 km of the Highway (30 km total width). The Local Study Area (LSA) for the Project has been determined as the area within 0.5 km of the Highway (1 km total width) and the Project footprint is defined as the area directly under the Highway alignment and the area used during borrow source activities (Figure 4.1.3-1).

5.2 TEMPORAL BOUNDARIES

For purposes of this CEA, the temporal (time frame) for the assessment will be the next four (4) to ten (10) years, during which time construction of the proposed Highway is anticipated to be completed and the Highway will have been in operation for up to six (6) years. It remains unknown at this time whether construction of other proposed future projects, in particular, the Mackenzie Gas Project and the Tuktoyaktuk Harbour Project will have commenced or not within this 10 year time-frame.

5.3 OTHER PAST, PRESENT AND FUTURE PROJECTS / ACTIVITIES CONSIDERED

Other potential past, present and future projects/activities that could influence the cumulative effect of the Project are as follows (from IOL et al. 2004):

- Settlements – communities, private land, medical facilities, police facilities and military sites;
- Transportation infrastructure – all weather roads, limited use roads, airstrips, seaplane bases, barge landings, fuel caches, docks and wharves;
- Industry (non-oil and gas) – forestry operations, sawmills, mining, quarries, grazing, herding, power lines, telecommunications lines, outfitting camps, lodges, cabins and camp sites;

- Industry (oil and gas) – exploration leases, significant discovery leases, seismic lines, pipelines, artificial islands, well sites and other facilities;
- Designated areas – bird sanctuaries, national parks, international biophysical program sites, historical sites, points of interest, wildlife sanctuary and other sites.
- Land uses – hunting and fishing, reindeer herding, and tourism and recreation.

These same land uses are applicable to assessing possible cumulative effects for the Inuvik to Tuktoyaktuk Highway (IOL et al. 2004).

During the October 2009 community and regulatory consultations, a number of possible projects and activities were identified that should be considered in the CEA. In addition, several other projects and/or activities warranted consideration based on the Project Team's understanding of past, existing, and potential future projects and activities in the area of interest. The projects and activities considered in this CEA include:

Past and Existing Projects

- Ikhil Gas Development and Pipeline Project
- Tuktoyaktuk to Source 177 Access Road
- Winter Access Trails
- Former Northern Canada Power Commission (NCPC) Power Pole
- Seismic Lines
- Oil and Gas Well Sites

Potential Future Projects/ Activities

- Parsons Lake Gas Field, Associated Infrastructure and Gathering Pipeline
- Mackenzie Gas Project
- Tuktoyaktuk Harbour Project
- Husky Lakes Development

Brief descriptions of each of these past, existing and potential future projects and activities, and to what degree they may contribute to a possible cumulative effect in relation to the proposed construction and operation of the Inuvik to Tuktoyaktuk Highway are provided in the following sections. Figure 4.3.8-1 shows existing land use in the general vicinity of the proposed Highway.

5.3.1 Past and Existing Projects

5.3.1.1 Ikhil Gas Development and Pipeline Project

The Ikhil Gas Development and Pipeline Project consists of two producing gas wells, associated feeder lines, a small gas processing plant and a 50 km (30 miles) long, 168.3 mm (6 inch) diameter buried gas pipeline. The gas production site is located approximately

50 km north of Inuvik in the Caribou Hills, and extends south from there to a pressure regulation and metering facility near the Northwest Territories Power Corporation power plant in Inuvik (Figure 4.3.8-1).

The pipeline component of the project was presented and reviewed by the EISC during the summer of 1997. Their review concluded that the project would not result in significant environmental impacts, and as a result the project was not referred to the EIRB for a more rigorous assessment (North of 60 Engineering 2004).

An environmental screening of the project was also performed by the NEB as mandated under the *Canadian Environmental Assessment Act*. Their review also found the project environmental impact to be small and manageable through the application of appropriate mitigation measures.

The project was developed during the period 1997 to 1999 and is expected to be in service for the foreseeable future.

The pipeline is buried in permafrost and parallels the East Channel of the Mackenzie River for its entire 50 km. Where the pipeline crosses the Douglas Creek Valley, it is supported by piles above ground to avoid disturbance to the slopes on either side of the creek. Since the gas is cooled to below freezing temperatures at the Ikhil production facility, limited melting of the permafrost will occur as the gas passes through the pipeline. Pipeline and right-of-way (ROW) performance has been monitored on an ongoing basis by Inuvik Gas operations personnel (North of 60 Engineering 2004).

Restoration and re-vegetation efforts have been very successful, with hardly any disturbance visible over the ditch centre-line (Photo 5.3.1-1). There are currently no geotechnical or groundwater related issues associated with the operation of the pipeline. The pipeline has performed as designed. Based on visual inspections there has been no significant frost heave or thaw settlement along the line.

The buried gas pipeline approaches the proposed Inuvik to Tuktoyaktuk Highway alignment at KM 5 and then runs parallel to the proposed Highway alignment heading south towards the end of Navy Road in Inuvik. The pipeline is located within an established 30 m wide utility ROW. To ensure that the pipeline will not be disturbed or affected in any way, the proposed Inuvik to Tuktoyaktuk Highway alignment will be located at an appropriate and approved distance from the existing gas pipeline ROW.

The development of the Highway may facilitate access to the portion of the buried gas pipeline that will be located adjacent to the proposed Highway. However, with the application of the planned mitigation measures, there will be no interactions or opportunity for a potentially significant cumulative environmental effect to occur.

Photo 5.3.1-1
Right-of-way at the End of Navy Road

5.3.1.2 Tuktoyaktuk to Source 177 Access Road

The Tuktoyaktuk to Source 177 Access Road is a 19 km long road that is currently under construction. The proposed Highway alignment follows the same general route as originally selected for the northernmost 19 km of the proposed all-weather Highway between Inuvik and Tuktoyaktuk. The alignment is located entirely on Inuvialuit Private Lands.

In January 2009, the EISC concluded that the development, if authorized subject to the environmental terms and conditions recommended by the Screening Committee, would have no significant negative impact on the environment in the Inuvialuit Settlement Region (EISC 2009).

Following receipt of ILA permits, construction of the first 12 km of the access road commenced in February and was completed in April 2009. All aggregate materials used for construction of the road were obtained from Source 177. The road design was developed by FSC Architects and Engineers in accordance with GNWT Department of Transportation design requirements.

Construction of the road was completed in 2010 by an experienced local road construction contractor. The basic road construction sequence included the clearing of snow from the right-of-way, the placement of geotextile fabric directly onto the undisturbed frozen surface, the placement (by end-dumping) of aggregate material in lifts onto the liner and the compacting of the road grade. The second winter of construction will proceed in early 2010. Photos 2.6.3-1, 2.6.3-2 and 2.6.3-3 in Section 2.6 of this Environmental Impact Statement illustrate the construction methods employed and the appearance of portions of the completed road in spring/summer 2009.

Most of the streams crossed by the Tuktoyaktuk to Source 177 Access Road are ephemeral but for potentially fish-bearing streams, the stream crossings were constructed in conformance with DFO Operational Procedures designed to protect fish habitat. Areas with surface runoff were addressed with the installation of standard diameter (800 mm to 2,000 mm) roadway culverts. Follow-up monitoring during the spring/summer of 2009 determined that some areas of ponding occurred and plans were implemented to mitigate these minor issues.

As part of the construction of the Inuvik to Tuktoyaktuk Highway, the current Tuktoyaktuk to Source 177 Access Road will require upgrading to meet the Highway design criteria. During both the October 2009 and January 2010 consultation sessions, several questions were raised regarding what would need to be done to complete this section of the Highway in the future. It was indicated that the current horizontal alignment of the Tuktoyaktuk to Source 177 Access Road would continue to be used for the new Highway. However, there will be a need to build up the road embankment to achieve the Highway design criteria.

The existing Tuktoyaktuk to Source 177 Access Road will represent the northernmost portion of the overall Inuvik to Tuktoyaktuk Highway. However, with the application of the planned mitigation measures there will be no opportunity for a potentially significant cumulative environmental effect to occur.

It is anticipated that the completed Highway will make it easier for people to access the land for their various traditional, recreational and cultural pursuits. To ensure that the environment of the area remains protected, it will be important for the users of the Highway to abide by any management restrictions that may need to be developed for the Highway by the resource management agencies and co-management bodies in consultation with the HTCs and other interested stakeholders.

5.3.1.3 Winter Access Trails

Since the introduction of snowmachines, winter access trails have been developed each winter as needed, to allow residents of Tuktoyaktuk and Inuvik to pursue their traditional recreational, hunting, trapping and other activities on the Tuktoyaktuk Peninsula and in the Mackenzie Delta, including the general area of the proposed Inuvik to Tuktoyaktuk Highway. One of the major winter routes that has become established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figure 4.3.8-1).

The consultations sessions held in October 2009 and January 2010 confirmed that many families have and continue to use the traditional winter routes to the Husky Lakes. The consultations also identified a second, more overland route, which generally followed the alignment of the former Northern Canada Power Commission (NCPC) transmission line ROW that extended from Inuvik to Tuktoyaktuk (Figure 4.3.8-1).

The winter access trails are considered to be of a low impact nature, disappearing with the annual spring snowmelt, and leaving behind minimal evidence that they were ever there. With the development of the Highway, it is anticipated that most north-south traffic will use the Highway, with snowmachines and all-terrain vehicles (ATVs) being towed by trailer to points along the Highway where they would continue to be used to access the adjacent land, as was done previously.

The presence of the Highway will make it easier for people to access the land for their various traditional, recreational and cultural pursuits. To ensure that the environment of the area remains protected, it will be important for the users of the Highway to abide by access controls and limitations that may need to be developed for the Highway by the resource management agencies and co-management bodies in consultation with the HTCs and other interested stakeholders.

With the application of the planned mitigation measures there will be no opportunity for a potentially significant adverse cumulative environmental effect to occur.

5.3.1.4 Former NCPC Power Line

In 1972, a 144 km wood pole transmission line (69 KV) was constructed by the Northern Canada Power Commission from Inuvik to Tuktoyaktuk, the only line of its type in the world north of the Arctic Circle (NTPC 2009b). The route of this former power line is shown in Figure 4.3.8-1.

Due to high maintenance costs, this line was abandoned and salvaged in the late 1980s and replaced with diesel power generation facilities installed at Tuktoyaktuk (A. Martin, NTPC Pers. Com. 2009). Currently the Hamlet of Tuktoyaktuk is serviced by a complement of three diesel generators with a total installed capacity of 2,205 KW. As previously indicated, the former power line ROW was used as a winter trail between Tuktoyaktuk and Inuvik. The power line was used to mark the route and also served to help harvesters on the land to determine their location (G. Colton, NTPC Pers. Com. 2009). Today little physical evidence remains of the former NCPC power line and no significant cumulative environmental effect is expected to occur as a result of this former power line.

5.3.1.5 Seismic Lines

Since the 1960s the most extensive non-traditional land use that has occurred in the Mackenzie Delta, including the area in the vicinity of the proposed Inuvik to Tuktoyaktuk Highway, has been seismic exploration. As an example, in the 41,105 ha Parsons Lake Study Area defined for the Mackenzie Gas Project, approximately 1.5% of that Study Area had been subjected to seismic lines and associated activities (IOL et al. 2004).

In some areas of the Mackenzie Delta, particularly in forested areas near Inuvik, visible evidence of the historic, linear seismic lines remains today. However, on the open tundra of the Tuktoyaktuk Peninsula, very few of the historic seismic lines can be detected at this time. Although from the air the vegetation along the seismic lines sometimes appears to have a different colour, on the ground, little physical evidence remains of these historic seismic programs. As a result, there will be little opportunity for a potentially cumulative environmental effect to occur between the limited residual effects of historic seismic lines and the construction and operation of the proposed Highway.

5.3.1.6 Oil and Gas Well Sites

A number of exploratory oil and gas wells were completed by Imperial Oil near the proposed Highway right-of-way near Tuktoyaktuk on the Tuktoyaktuk Peninsula. For example, 13 wells were drilled in the mid-1980s during Imperial Oil's Tuktoyaktuk Tertiary program. In addition, Gulf drilled a number of exploratory and development wells in the Parsons Lake area in the early 1970s. The number of these wells, compared to the size of the regional study area is considered to be minimal and combined with proposed Project are not expected to result in significant adverse environmental effects.

5.3.2 Potential Future Projects/ Activities

5.3.2.1 Mackenzie Gas Project

Developing a natural gas pipeline from the Mackenzie Delta through the Northwest Territories to southern markets has been contemplated for many years. Various pipeline projects have been proposed during the last 30 years that consider economics, regulatory requirements, socio-economic and environmental conditions, and engineering and geotechnical issues in the decision-making process (IOL et al. 2004).

The proponents of the proposed Mackenzie Gas Project include Imperial Oil Resources Ventures Limited Partnership (IOL), ConocoPhillips Canada (North) Limited (ConocoPhillips), ExxonMobil Canada Properties (ExxonMobil), Shell Canada Limited (Shell) and Mackenzie Valley Aboriginal Pipeline Limited (MVAPL) partnership.

The purpose of the proposed project is to develop three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and to transport natural gas and natural gas liquids (NGLs) by pipeline to market (Figure 4.3.8-2). The main Mackenzie Delta components of the project include:

- The facilities (field development, flow lines, gas conditioning and production facilities and associated infrastructure to be located at each of three anchor fields at Niglintgak, Taglu and Parsons Lake);
- A gathering system including gathering pipelines to transport the natural gas and NGLs from the three anchor fields to a facility to be located near Inuvik;
- A pigging facility at Storm Hills and a gas processing facility and supporting facilities near Inuvik to recover NGLs from the gas stream;
- A pipeline (the NGL pipeline) to transport NGLs south from the Inuvik area facility to Norman Wells, where it will be tied into the existing Enbridge Inc. pipeline; and
- A pipeline to transport natural gas from the Inuvik area facility to the NOVA Gas Transmission Ltd. (NGTL) interconnects near the Northwest Territories-Alberta boundary.

The environmental impact assessment for the Mackenzie Gas Project conducted a comprehensive assessment of the available information, including several years (2001-2004) of additional, new scientific field survey data, the results of community consultations and Traditional Knowledge studies, with detailed descriptions of the importance and value of wildlife and wildlife habitat to the local residents. The potential effects on populations and harvest practices, as determined from the results of harvest studies, were measured against the assessment criteria (IOL et al. 2004).

Based on their assessment, it was determined that the Mackenzie Gas Project would likely have some minor effects on biophysical and socio-economic components, including:

- Wildlife and wildlife habitat at the local level that could last throughout the life of the project, and in some cases beyond. Noise from facilities and flares might also affect wildlife during operations; and
- The economy (including demographics); infrastructure and community services; individual, family and community wellness; non-traditional land and resource use; and heritage resources (IOL et al. 2004).

Their assessment determined that some local wildlife movements might be affected near the project, but no effects on the seasonal movements or migration patterns of wildlife would occur, with the possible exception of the movements of barren-ground caribou from the Cape Bathurst herd in fall and winter. No other possible effects on the seasonal distribution of barren-ground caribou were expected to occur (IOL et al. 2004).

The socio-economic assessment determined that there would be a temporary and marginal increased potential for in-migration of people from outside the study area to the regional and commercial centres. Effects on transportation, recreation, energy or utility, and public wellness, health, and protection service providers are expected to be minor. Use of borrow sites will result in a cumulative reduction in total granular resources and a net increase in the accessible granular resources for use by local communities and other developments (IOL et al. 2004).

The key conclusions of the cumulative effects assessment conducted for the Mackenzie Gas Project (IOL et al. 2004) were as follows:

- The Mackenzie Gas Project would not contribute significant biophysical or socio-economic cumulative effects.
- There were no significant overall cumulative effects.
- The project could contribute to two potential cumulative effects of management concern, direct grizzly bear mortality and competition for qualified northern goods, services and labour[13], which could be addressed with diligent monitoring and management by responsible parties.

[13] Some of the projects identified as competing for qualified northern goods, services and labour are underway or completed at this time and would no longer create competition. Project include: Deh Cho Corporations proposed Mackenzie River bridge at Fort Providence, Devon Canada Corporation's proposed Beaufort Sea Exploration Drilling

- The demand for qualified northern content in projects is expected to use all available northern capacity, which will limit the extent of both potential increased benefit and social costs among northern residents. However, it could marginally increase the temporary attraction of speculative in-migration, and associated social costs in the regional and commercial centres of Inuvik and Norman Wells.
- The project might encourage other development, particularly gas exploration and production in the Northwest Territories; however, information to adequately assess potential cumulative effects contributions from such possible developments are not yet available; and
- Based on the project footprint, the project would disturb a negligible proportion of the regional study area.
- The pattern of any future hydrocarbon development on the land, such as additional production fields, and any effects from such activities would likely be similar to effects predicted for current and reasonably foreseeable land use. Those developments would be subject to their own environmental impact assessment, including cumulative effects.

These conclusions indicated that, despite the size and duration of operations, the contribution to cumulative effects by the Mackenzie Gas Project on the regions and communities of the Northwest Territories were not expected to be significant. These conclusions were based on the assumption that appropriate management and monitoring programs, as outlined in the EIS prepared for the Mackenzie Gas Project would be carried out (IOL et al. 2004).

The project recently received approval from the National Energy Board and the federal cabinet. The Mackenzie Gas Project partners have until December 31, 2013 to decide whether they will go ahead with the construction of the $16.2-billion project. There remains considerable uncertainty as to if and when the Mackenzie Gas Project may in fact proceed. Currently the earliest projections for the possible start of construction of the project suggest the year 2015. However, a number of other critical factors, including economic, market and strategic priority considerations, could potentially result in further delays to the implementation of the Mackenzie Gas Project.

At this time it is more likely that the proposed Inuvik to Tuktoyaktuk Highway will be constructed and be in full operation well before construction of the Mackenzie Gas Project proceeds. On this basis, it is assumed that the one location where the future Mackenzie Gas Project pipeline (Storm Hills Lateral) may interact with the Highway would be in the vicinity of KM 26 of the Highway. At this location it is understood that the pipeline, when constructed, will be buried and would have to be installed beneath what would then be the existing Highway, most likely using horizontal drilling technology. Using this technique, the Highway would remain undisturbed and vehicles could continue to use the Highway in an unimpeded manner.

Program, GNWT Mackenzie winter road bridges between Wrigley and Fort Good Hope, De Beers Snap Lake underground diamond mine.

The development of the Highway may facilitate access to the portion of the buried Mackenzie gas pipeline that would pass under the Highway, but with the application of the planned mitigation measures for the Mackenzie Gas Project, there would be no interactions or opportunity for a potentially significant cumulative environmental effect to occur.

5.3.2.2 Parsons Lake Gas Field, Associated Infrastructure and Gathering Pipeline

The Parsons Lake gas field, currently operated by ConocoPhillips, is located about 55 km southwest of Tuktoyaktuk and 70 km north of Inuvik (Figure 4.3.8-1). The Parsons Lake gas field was discovered in 1972 and defined by two-dimensional (2-D) seismic and other study programs between 1959 and 2001. A major three dimensional (3-D) seismic program was conducted over the Parsons Lake gas field in winter 2001-2002. Between 1971 and 1986, 19 wells were drilled. The Parsons Lake significant discovery licences were granted in 1987. Based on the most recent interpretations of the exploration data obtained, the proponents estimate that the Parsons Lake field could contain about 2.3 Tcf of recoverable raw natural gas and NGLs (ConocoPhillips 2004a and 2004b).

The main production facilities at the Parsons Lake field will be located on two main gravel pads, the most northerly and larger of the two near the northeast shore of Parsons Lake. The north pad, which will accommodate the gas conditioning facility, camp, fuel storage, and other associated infrastructure, is proposed to be built first. The connection to the Mackenzie Gas gathering system will also be located at the north pad. The second, smaller well pad will be constructed about five or six years later and will be located about 14 km from the north pad at a location south of Parsons Lake. An elevated two-phase flow line will transport natural gas from the south pad to the north pad's gas conditioning facility (ConocoPhillips 2004a and 2004b).

The Parsons Lake gathering pipeline (Parsons Lake lateral) will originate from the gas conditioning facility located on the north pad and will head south around Parsons Lake. From there, the buried lateral will continue southwest between West Hans Lake and East Hans Lake to the Storm Hills Junction (Figure 4.3.8-1). The Parsons Lake lateral will be approximately 27 km long and centered in a 30 m wide ROW. At its nearest point, the lateral will be located approximately 1.8 km to the west of the Inuvik to Tuktoyaktuk Highway.

Similar to the status of the rest of the Mackenzie Gas Project, the Parsons Lake gas field component of the overall project is continuing to wait for the outcome of the Joint Panel Review and future regulatory permitting and approvals decisions by a number of regulatory agencies. As indicated earlier, there also remains considerable uncertainty as to if and when the Mackenzie Gas Project may proceed. Currently the earliest projections for the possible start of construction of the overall project suggest the year 2015. However, a number of other critical factors, including economic, market and strategic priority considerations, could potentially result in further delays to the implementation of the entire Mackenzie Gas Project, including the Parsons Lake gas field component of the overall project.

At this time it is more likely that the proposed Inuvik to Tuktoyaktuk Highway will be constructed and be in full operation well before construction of the Parsons Lake gas field component of the overall Mackenzie Gas Project proceeds.

Assuming that this will be the case, it would seem likely that the Highway would be used for the two-way transportation of workers and consumables from Tuktoyaktuk and Inuvik to the Parsons Lake gas field project. Possible use of the Highway for the transportation of large modules to Parsons Lake from the Tuktoyaktuk harbour area would likely also be considered.

In addition, it could be anticipated that the provision of year-round overland Highway access would likely reduce the need for extended-season storage of various critical consumables, including fuel, drilling and production supplies, etc. at the Parsons Lake facility. The existence of the Highway may also influence future industry decisions regarding the need for and nature of an airstrip to support the Parsons Lake gas field project.

Such possible uses of the Highway in support of the Parsons Lake gas field project would increase the overall use of the Highway by oil industry vehicles and equipment for periods of time. The timing of use and traffic controls that would need to be implemented to permit the safe transit of specific equipment (e.g., large modules) and supplies would need to be developed and implemented. However, since the Inuvik to Tuktoyaktuk Highway will be a low volume traffic highway, such possible activities are expected to be manageable and are not likely to create a significant issue for the other users of the Highway.

In addition, the year-round access provided by the Highway may trigger future refinements to the Parsons Lake gas field project that may present environmental benefits. These could include potentially reduced on-site fuel and consumables storage needs and associated reductions in project footprint size and aggregate borrow requirements for infrastructure pad construction.

As a result, it is anticipated that the future existence of the Inuvik to Tuktoyaktuk Highway prior to the implementation of the Parsons Lake gas field project may provide operational and environmental advantages for the development of the Parsons Lake gas field project, but is not expected to contribute to a potentially negative cumulative environmental effect.

5.3.2.3 Tuktoyaktuk Harbour Project

During the October 2009 community consultations, a question was raised about the possible development of Tuktoyaktuk Harbour and how that might impact the development and operation of the proposed Inuvik to Tuktoyaktuk Highway. The harbour at Tuktoyaktuk is the only existing natural and active port along the Canadian Beaufort Sea coastline. Historically it has served as the primary base for offshore oil and gas exploration in the 1970s and 1980s when the oil and gas exploration companies were active in the area.

With the recent renewed interest in Beaufort Sea exploration and the possible development of the Mackenzie Gas Project, Tuktoyaktuk Harbour may again play an important role as an offshore logistics and service centre for the oil and gas industry.

In late 2005, as part of the ongoing Joint Review Panel (JRP) process, the proponents submitted updated information for the Parsons Lake gas field development. A potential option, not previously proposed, was for sea-lift transport of large modules on barges to Tuktoyaktuk Harbour following existing shipping lanes (IOL 2006).

The potential option to bring modules for the Parsons Lake gas field through the Beaufort Sea to Tuktoyaktuk is currently under study by ConocoPhillips. The option involves shipping process modules weighing up to 1,000 tonnes on Series 240 or 400 barges from an offshore assembly location to Tuktoyaktuk, provided that the barges could be brought into Tuktoyaktuk Harbour without the need for dredging. If this was not possible, the modules would be transferred at Kuparuk or Prudhoe Bay, Alaska onto Series 1500 barges, which will accommodate loads of the weight and size of the proposed modules. Series 1500 barges are regularly used by Northern Transportation Company Limited (NTCL) for re-supplying Tuktoyaktuk (IOL 2006).

To date no formal proposal for the development of Tuktoyaktuk Harbour has been put forward. Nevertheless, assuming that Tuktoyaktuk Harbour is used in the future to accommodate further offshore exploration activities and/or the development of the Mackenzie Gas Project, and in particular the Parsons Lake gas field, it would seem likely that the Highway would be used to provide overland logistics and transportation access to the Parsons Lake gas project.

The specific nature of possible uses of the Tuktoyaktuk Harbour and Highway in support of the Parsons Lake gas project cannot be defined with certainty at this time. However, it would seem likely that if the Highway was in operation, it would be used for the two-way transportation of workers and consumables from Tuktoyaktuk and Inuvik to the Parsons Lake gas project. Possible use of the Highway for the transportation of the large modules from Tuktoyaktuk Harbour to Parsons Lake would likely also be considered.

Such possible uses of the Tuktoyaktuk Harbour and the Highway in support of the Parsons Lake gas field project would increase the overall use of the Highway by oil industry vehicles and equipment for periods of time. The timing of use and traffic controls that would need to be implemented to permit the safe transit of specific equipment (e.g. large modules) and supplies would need to be developed and implemented. However, since the Inuvik to Tuktoyaktuk Highway will be a low volume traffic highway, such possible activities are expected to be manageable and are not likely to create a significant issue for the other users of the Highway.

As a result, the possible future development of the Tuktoyaktuk Harbour is not expected to contribute to a potentially negative cumulative environmental effect.

5.3.2.4 Husky Lakes Development

The Husky Lakes Special Management Area (Site No. 705D) is located adjacent to a portion of the proposed alignment of the Inuvik to Tuktoyaktuk Highway. In accordance with anticipated revisions to the Husky Lakes Criteria and associated Management Plan and specific directions received from the ILA, the alignment of the proposed Highway has been re-routed to the extent possible to maintain a minimum setback of at least 1 km from the Husky Lakes Special Management Area.

The Inuvialuit Land Administration has also created a draft Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan (ILA 2010). Although in draft format, this Plan identifies the boundary of the Husky Lakes Special Cultural Area, which is in addition to other Husky Lakes management areas. If approved, the ILA will employ the use of these criteria to review proposed projects. The Primary 2009 Route, Alternative 1 (2009 Minor Realignment), Alternative 2 (Upland Route), and Alternative 3 (2010 Minor Realignment) are all partially located within the cultural area. Therefore, if approved, the Project will be required to address the performance criteria and management goals identified in the draft ILM Special Area Plan.

In addition, under the *Inuvialuit Final Agreement*- Annex D, the Husky Lakes have two management designations, Area 1 and Area 2. Area 1 does not allow dredging or marine development. Area 2 does not allow dredging or marine development, and has other terrestrial criteria that must be conformed to. The proposed Highway is not located within Area 1 or Area 2.

As confirmed during the October 2009 and January 2010 community consultations and previous consultations for the Tuktoyaktuk to Source 177 Access Road, the Project proponents understand fully that the Husky Lakes area is considered by the residents of Tuktoyaktuk and Inuvik to be very important for year-round hunting, trapping, fishing, and recreation and for seasonal berry picking.

As stated in the EIRB's Husky Lakes Criteria (EIRB 2002), the Husky Lakes area is considered by many as one of the best places to hunt and fish in the Inuvialuit Settlement Region. It is an area with abundant plant and animal life, frequented by campers, local hunters and trappers, and visiting sports hunters and fishers. Many go there to relax and enjoy the experience the Husky Lakes area provides.

The Husky Lakes also provide spawning habitat for herring and lake trout. The TCCP (Community of Tuktoyaktuk et al. 2008) reported that fish harvesting has been typically concentrated in the upper parts of Husky Lakes around Saunatuk, Zieman Cabin and Stanley Cabin. Community of Tuktoyaktuk et al. (2000) also suggests that harvesting use has been more limited to the west of Husky Lakes (including the vicinity of the Inuvik to Tuktoyaktuk Highway alignment).

According to ILA records, there are currently about 118 registered leases located throughout the Husky Lakes area with the heaviest concentrations of cabins present in the narrows northwest of Five Hundred Lakes and to a lesser extent around Whale Point and Portage Point at the southern limit of Husky Lakes (see Figure 3.2.9-1 and 3.2.9-2).

The Husky Lakes Integrated Management Planning Study, completed in 2001, suggested that the area was already under pressure and that the local people were concerned about the deterioration of the "specialness" of Husky Lakes due to increased garbage and crowding of Husky Lakes related to the increasing number of cabins and residential leases (Hoyt 2001).

At that time there was already a concern that land use activities may affect the traditional ways of life. As reported in Hoyt (2001), the region was considered to be vital to the community as a place where families could spend time together and pass on the skills and culture of the Inuvialuit.

During the October 2009 community consultation sessions, some people expressed concerns about the proposed Highway being too close to the Husky Lakes area. The main concern was that a highway near the Husky Lakes could result in more people coming into the area and this could subsequently lead to the development of additional cabins, docks, over harvesting, the generation of more garbage, etc. Other people were of the view that the Highway should still be built because it would make it easier for them to get to the Husky Lakes and concerns such as those raised should be managed to ensure that such potential problems would not occur. It was also noted by some people that the relative proximity of the Highway would make it easier for people to transport garbage back to their home communities for more appropriate disposal in established landfill facilities.

During the January 2010 community consultations, community members expressed general satisfaction that the Project Team had employed all reasonable mitigation measures to address the concerns of the community members. In particular, the community members were generally pleased with the Project's efforts to keep the proposed Highway alignment beyond the 1 km setback recommended by the ILA and the latest version of the Husky Lakes Management Plan. Based on the feedback from community members, the Project is unlikely to cause a significant adverse residual effect over and above existing effects.

Representatives of the ILA confirmed that the Hunters and Trappers Committees, the Elders, the Community Corporations, resource management agencies, co-management bodies, the ILA and the proponents of the Inuvik to Tuktoyaktuk Highway should work together to develop the necessary management tools to minimize the potential for such concerns to be realized.

5.4 VALUED COMPONENTS AND THE PROJECT

The valued components for this Project have been identified in Section 4.1 of this EIS. The major VECs which were identified include: terrain, geology, soils, permafrost, air quality, noise, water quality and quantity, fish and fish habitat, vegetation, wildlife and wildlife habitat, birds and bird habitat. The major socio-economic VSCs that were identified include demographics, regional and local economies, education and training, infrastructure and institutional capacity, human health and wellness, socio-cultural patterns, harvesting, land use and archaeological resources.

The cumulative effects assessment focuses only on adverse effects of the Project remaining after the application of mitigation measures. For this Project, residual effects identified in Section 4.2 and 4.3 are carried forward into the cumulative effects assessment, and are summarized in Table 5.4-1.

TABLE 5.4-1: RESIDUAL EFFECTS FOR VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS	
VEC/VSC	**Description of Residual Effect**
Valued Ecosystem Components	
Terrain, Geology, Soil and Permafrost	Residual effects on the terrain are expected as a borrow source will leave some mark on the land. Mitigation measures are intended to minimize the footprint of a single borrow source and minimize the number of borrow sources that are opened for the construction phase.
Noise	Following the implementation of mitigation, residual effects from noise emissions during construction and operations phases are negligible.
Water Quality, Quantity and Hydrological Regime	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on water quality, water quantity, or flow patterns.
Fish and Fish Habitat	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on fish or fish habitat.
Vegetation	Within the LSA, the removal or burial of vegetation types and plant species/groups will occur during construction and the effects will remain so long as the Highway is in place. The effect is considered of high magnitude and of moderate, localized consequence. The effects of borrow source development on vegetation types and plant species/groups during construction results in high magnitude, but reversible effects, with overall low consequence residual effects. The effect of dust, invasive plant species introduction and alteration of local hydrology are considered to be of low magnitude and low consequence. In the context of the regional study area, residual effects have been determined to be negligible.
Wildlife (Caribou)	Residual effects are anticipated to be negligible with the exception of potential vehicular impact and increased hunting. The effects of potential vehicular impact and increased hunting are predicted to be low magnitude effects with a moderate (vehicle collisions) to low (hunting) level of consequence based on duration.
Wildlife (Grizzly Bear)	The net habitat and disturbance effects from the proposed development are expected to be limited to the local grizzly populations and are therefore low in consequence at the local population level. The overall impacts of the proposed Highway and operational activities are considered to be low to moderate within the LSA, and negligible within the RSA.
Wildlife (Moose)	Residual effects are anticipated to be negligible with the exception of potential vehicular impact and increased hunting. The effects of potential vehicular impact and increased hunting are predicted to be low magnitude effects with a moderate (vehicle collisions) to low (hunting) level of consequence based on duration.
Wildlife (Furbearers)	The net habitat and disturbance effects from the proposed development are expected to be limited to the local furbearer populations and are therefore low in consequence at the local population level. The overall impacts of the proposed Highway and operational activities are considered to be low to moderate within the LSA, and negligible within the RSA.
Birds	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on birds and bird habitat.

TABLE 5.4-1: RESIDUAL EFFECTS FOR VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS	
VEC/VSC	**Description of Residual Effect**
Valued Socio-Economic Components	
Harvesting	With effective management of harvesting activities by users of the Highway, residual effects of harvesting on the wildlife and fish populations of the area are expected to be minimal.
Land Use	The Highway, as a linear development, will result in a localized residual effect on land use.
Heritage and Archaeological Resources	Further archaeological impact assessments are required to determine if archaeological resources are present and to prepare site-specific mitigation measures to ensure that effects on archaeological resources will be negligible within the LSA and RSA.

Based on results of the effects assessment completed in Section 4.0, VECs/VSCs that are likely to experience residual *adverse* effects include vegetation, wildlife, harvesting and land use. These specific VECs/VSCs are discussed further in the following subsections.

5.4.1 Significance Determination for the Highway in Relation to Past, Present and Future Projects

The effects assessment or discussion for the each of the past, present and future projects determined that none of those projects are likely to result in residual effects. The effects assessment completed for this Project identified vegetation, wildlife and land use as VEC's/VSC's where residual effects may be a concern.

The EIRB guidance document provides the following guidance on estimating thresholds where they are not readily available from standards, regulations, or directives:

- During consultations with HTCs and community residents, discuss how CCPs and the community's needs and desires can contribute to an evaluation of significance;
- In the absence of established thresholds or standards, use standards and thresholds from other jurisdictions, with the proviso that geographic, ecological and social differences are taken into account;
- Use best professional judgement, including peer review and consensus; and
- Keep up-to-date and informed of ongoing work by industry, government and non-government organizations regarding resource management and cumulative effects.

These recommendations have been incorporated into the significance determination provided in Table 5.4.1-1.

Table 5.4.1-1 is adapted from the EIRB's cumulative effects assessment guide (Kavik-Axys Inc. 2002). The table presents the Project components with residual effects and their potential interaction with past, present and future projects (which were not anticipated to have residual effects on their own).

Table 5.4.1-1 summarizes residual effects that have been identified following the effects assessment completed in Section 4.2 and 4.3. As mentioned previously, the VECs/VSCs identified as having residual effects included vegetation, wildlife and land use. For each of these components the screening matrix looked at what are the key anticipated effects and mitigation measures used to address those effects at a local and regional scale. Mitigation applied at a local scale is often sufficient to address effects at a regional scale as well. Following the application of these mitigation measures, the matrix includes determinations, based on the effects assessment and professional judgement of the possible significance of an effect. The significance determination includes a ranking as Class 1, 2 or 3. These classes are typically based on thresholds but because the VECs/VSCs don't include readily measurable or quantifiable parameters, the Classes are used as a general guideline to rank effects.

Based on the effects identified for each of the VECs/VSCs and the associated mitigation measures and class of effects, the cumulative effects assessment resulted in a determination of no significant effects for all but one component. The magnitude of effects for all components was deemed to be low with the exception of vegetation removal for the right of way which was deemed to be low to moderate. For vegetation and wildlife effects at the local scale and land use at a regional scale, the residual effects are unlikely to result in significant cumulative effect over the long term. Significance was determined for land use at the local scale, as the Highway will affect land use in this area and will provide all weather access to new parts of the region. The land use effect is considered to have both positive and negative aspects, and the benefit of the new Highway will likely overshadow the low magnitude of effects of the Highway on land use.

The developer is committed to participating with other parties in a cumulative effects monitoring program.

Based on this effects assessment and the mitigation measures proposed, the residual effects identified for Vegetation, Wildlife and Land Use may influence the Project area at a local scale but are not expected to have a significant influence or effect at the regional level. No additive or synergistic relationships between the Project and other existing or proposed projects were found to result in a significant cumulative effect on VECs or VSCs.

TABLE 5.4.1-1: SCREENING MATRIX FOR CUMULATIVE EFFECTS TO VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS AT A LOCAL AND REGIONAL SCALE

VEC/VSC	Project Specific Effect	Is there a possible overlap with other projects/activities?		Is there a potential cumulative effect on the VC?	Effects Management		Probable Trends of VEC/ VSC	Effect Type	Magnitude of Effect	Class of Effect	Significance
	Description	Spatial	Temporal		Project Specific	Regional					
Terrain, Geology, Soil and Permafrost	Borrow source activities	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize borrow source footprint -minimize number of borrow sources -follow TAC's guidelines for *Development and Management of Transportation Infrastructure in Permafrost Regions* -conduct progressive remediation of borrow sources	Participate in ISR cumulative effects initiatives	Negative	Project	Low to Moderate	Class 2	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Vegetation	Removal of vegetation for Highway right-of-way	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -reclaim to viable and self-sustaining vegetation types	Participate in ISR cumulative effects initiatives	Negative	Project	Low to Moderate	Class 2	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	Removal of vegetation for borrow sources	No	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -reclaim to viable and self-sustaining vegetation type	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3 (because areas will establish vegetation over time)	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	Dust, invasive species and altered hydrology	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -apply dust suppressants, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998) -ensure machinery and equipment is clean prior to use -Periodic monitoring of roadsides for invasive species -Design tailored appropriately to accommodate unique environmental conditions; -adequate drainage in wet lowland areas through the use of appropriately designed culverts -appropriate spill management	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Wildlife	-potential interaction with caribou and caribou habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-potential interaction with grizzly bear and grizzly bear habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -design route through less sensitive habitats -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes - If active bear dens are discovered within 500 m of Project sites, ENR will be contacted immediately to determine the appropriate course of action. Activities may be temporarily suspended pending consultation with ENR.	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant

TABLE 5.4.1-1: SCREENING MATRIX FOR CUMULATIVE EFFECTS TO VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS AT A LOCAL AND REGIONAL SCALE

VEC/VSC	Project Specific Effect	Is there a possible overlap with other projects/activities?		Is there a potential cumulative effect on the VC?	Effects Management		Probable Trends of VEC/ VSC	Effect Type	Magnitude of Effect	Class of Effect	Significance
	Description	Spatial	Temporal		Project Specific	Regional					
	-potential interaction with moose and moose habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-potential interaction with furbearer and furbearer habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 --minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes - If active dens are discovered within 500 m of Project sites, ENR will be contacted immediately to determine the appropriate course of action. Activities may be temporarily suspended pending consultation with ENR and depending on the species in question	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-wildlife/vehicle interactions over the life of the Project	Yes	Yes	Yes	-relatively minimal (150-200 vehicles per day) traffic reduces the risk of potential traffic-related mortality -Post signage warning of potential wildlife crossings in areas where wildlife are known to frequent (i.e. known migration corridors)	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Land Use	-footprint of all-weather Highway across landscape	Yes	Yes	Yes	-prohibit off-site activities of construction crews -prohibit recreational use of Highway by Project staff during construction	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 2	Significant
							Negative	Regional	Low	Class 3	Not Significant
Harvesting	-temporary disruption of access to harvesting areas during construction and increased access to harvesting areas following construction	Yes	Yes	Yes	-design of route options away from Husky Lakes area -comply with wildlife harvesting regulations -contribute to education program/ signage along Highway for Highway users, in collaboration with wildlife management organizations	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant

Source: Kavik-Axys Inc. (2002)

Class 1 Effect: The predicted trend in the measurable parameter under projected levels of development could threaten the sustainability of the VEC in the study area, and should be considered of management concern. Research, monitoring and/or recovery initiatives should be considered under an integrated resource management framework. Any negative change in VEC value of greater than 25% from benchmark is considered to be a Class 1 effect, regardless of VEC trend at the time of the assessment.

Class 2 Effect: The predicted trend in a measurable parameter under projected levels of development will likely result in a decline in the VEC to lower-than baseline but stable levels in the study area after Project closure and into the foreseeable future. Regional management actions such as research, monitoring and/or recovery initiatives may be required if additional land use activities are proposed for the study area before Project closure.

Class 3 Effect: The predicted trend in the measurable parameter under projected levels of development may result in a decline in the VEC in the study area during the life of the Project, but VEC levels should recover to baseline after Project closure. No immediate management initiatives, other than requirements for responsible industrial operational practices, are required.

6.0 MITIGATION AND REMEDIATION SUMMARY

A goal of the EIRB, as set out in the IFA, is to determine whether potential negative effects to wildlife, wildlife habitat, and wildlife harvesting can be minimized to acceptable levels using mitigative and remedial measures (EIRB 2010). This section of the EIS summarizes mitigative and remedial strategies that will be implemented to avoid or minimize potential effects to the Valued Components (VCs) identified through the environmental assessment process, to ultimately avoid affecting wildlife, wildlife habitat and wildlife harvesting.

Table 6-1 provides a summary description of the proposed mitigation strategies that will be implemented to avoid or minimize potential effects to the Valued Components (VCs) identified for this Project. VCs were selected for this EIS based on a combination of the directions provided in the EIRB Terms of Reference (2010), the Developer's understanding of the biophysical and socio-economic components, traditional knowledge as specified in the CCPs, the *Inuvialuit Final Agreement* and information gathered through consultation. Potential effects have been predicted for each VC, particularly related to the role of the VC in the ecosystem and to the Inuvialuit community. Table 6-1 summarizes the mitigation measures and strategies described in the effects assessment (Sections 4.2 and 4.3) of the EIS. Mitigation strategies for this Project include: Highway design, route location options, construction timing, additional field studies and monitoring, adaptive management, and contingency plans.

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
Noise	Construction and Operations: • Blasting • Heavy equipment • Vehicle traffic	Wildlife Effects: • Sensory disturbance • Behaviour alteration / avoidance	• Construction timing to avoid sensitive periods • Follow noise guidelines • Noise reduction planning, and implementation • Equipment will be properly maintained to ensure noise is minimized	• Based on advice from wildlife experts, the proximity of construction activities may be limited during sensitive periods, in accordance with relevant guidelines • Vehicle movements will be managed to minimize construction traffic • Machinery will be maintained to minimize resulting noise • Borrow sources will be selected to minimize haul distance • Operations will be adaptively managed, in consideration of potential noise effects to VCs	• Project location is remote and construction noise effects will be temporary • Potential effects during construction and operation are expected to be minimal	• DFO (1998) *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* • INAC (2010d) *Northern Land Use Guidelines: Pits and Quarries, and Access Roads and Trails*	• Noise monitoring plan if required	Developer / Contractor
Terrain, Geology, Soil and Permafrost	Construction: • Blasting • Heavy equipment • Borrow source activity • Highway construction Operation: • Borrow pit activity • Highway operation	• Change in drainage and surface hydrology • Thaw slumps • Melting of ice-rich ground • Slope and soil instability • Erosion • Subsidence in permafrost • Permafrost thaw and Differential Settlement	• Winter construction, hauling, and stockpiling • Summer access via embankment • Protect permafrost by Highway alignment, embankment, and borrow pit design • Ensure proper drainage • Use appropriate materials for embankment • Borrow pits will be reclaimed upon decommissioning • Adaptive management	• Construct embankment during winter • Access and haul from borrow sources in winter • Conduct summer activities only where accessible by existing embankment • Stockpile materials on existing embankment • Minimize surface area of open cut • Grade slopes to minimize slumping • Grade storage and work areas to promote drainage • Grade slopes and replace overburden during borrow source reclamation • Design and construct embankments based on terrain type • Design Highway alignment to avoid unfavourable terrain • Install sufficient cross-drainage • Conduct spring and fall drainage inspections	• Similar techniques were used successfully on other road construction projects in the ISR • Vegetation and soil remain intact during construction with ground temperatures maintained; avoiding permafrost melting • Maintain drainage and surface hydrology	• INAC (2010d) *Northern Land Use Guidelines: Pits and Quarries, and Access Roads and Trails* • Transportation Association of Canada (2010) *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions*	• Pit development plans • Environmental monitoring plan	Developer / Contractor
Water Quality and Quantity	Construction: • Borrow source construction • Highway construction Operation: • Borrow pit operation • Highway operation	• Reduced water quality or quantity • Contamination of surface water due to spills, erosion, sedimentation • Reduced water quantity • Changes to surface water flow regimes • Effects to fish and/or fish habitat • Effects on human health	• Construction timing • Highway, and in particular stream crossing, design • Erosion and sediment control strategies • Environmental Management and Spill Contingency Planning • Consultation and direction from DFO regarding fish habitat protection and/or compensation • Environmental monitors during construction • Adaptive management	• Erosion and sediment control measures • Primarily winter construction timing • Dust suppression during construction and operation • Adequate emergency spill planning and personnel training will be implemented • Activities that disturb soil and vegetation will be limited and monitored • Designate areas for refuelling and servicing vehicles and equipment • Environmental monitoring will occur throughout Project construction • Equip all vehicles and equipment with spill kits during construction • Minimize clearing and vegetation removal	• Similar techniques were used successfully on other road construction projects in the ISR	• DFO *Operational Statement for Culvert Maintenance* • DFO *Operations Statement for Temporary Stream Crossings* • DFO (2005) *Protocol for Winter Water Withdrawal in the Northwest Territories* • Conditions of Water License • DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat* • CCME (2007) *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table* • GNWT (1993) *Guideline for Dust Suppression*	• Erosion and sediment control plan • Environmental management plan • Spill contingency plan	Developer / Contractor

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
Changes to Hydrological Regime	Construction: • Culvert installation • Temporary and permanent stream crossings	• Effects on fish and fish habitat • Effects to downstream users • Flooding of habitat • Disrupted, reduced or eliminated flow • Wetland backfilling	• Construction timing • Highway routing and design • Infrastructure design and effectiveness • Monitoring for effects during and after construction • Consultation and direction from DFO regarding fish habitat protection and/or compensation • Environmental monitors during construction • Adaptive management • Regular culvert maintenance during operations, as required	• Design Project to accommodate site hydrology • Avoid sensitive areas during construction • Install and maintain crossing structures • Manage site drainage properly • Select culvert sizes appropriate to conditions, including maximum flow conditions • Monitor culverts after installation, to ensure flow • Select infrastructure to allow fish passage where necessary	• Similar techniques were used successfully on other road construction projects in the ISR	• DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat* • DFO *Operational Statement for Culvert Maintenance* • INAC *Northern Land Use Guidelines for Roads and Trails* (2010c)	• Construction environmental management plan • Post-construction monitoring plan • Habitat monitoring program for fish • Erosion and sediment control plan	Developer / Contractor
Species at Risk and Species of Special Status or Management Concern	Construction: • Highway • Borrow pit • Blasting • Heavy equipment Operation: • Highway • Borrow pit	• Mortality or injury • Sensory disturbance • Displacement • Habituation and attraction • Interference with migration • Population effects • Increased harvest pressure • Habitat loss or degradation	• Project design and planning • Construction timing • Wildlife management plan • Construction environmental management plan • Spill Contingency Plan • Waste management plan • Progressive reclamation of borrow sources • Consultation and direction from regulatory agencies • Adaptive management • Public education • Wildlife monitors during construction	• Conduct field studies prior to construction, as necessary • Monitor for wildlife and birds during construction • Project routing will avoid sensitive locations and periods, where possible • Construction personnel will receive wildlife training • Encourage public education through signage for wildlife crossings and regarding hunting restrictions during operations • Regulation, monitoring and enforcement of harvest will be implemented • Wildlife deterrent mechanisms • Document, report and avoid wildlife and wildlife dens and bird nests during construction • Setbacks will be used to protect sensitive wildlife features • Lighting will be installed and managed, to reduce harm	• Current harvesting restrictions in place • No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4).	• *Species At Risk Act*	• Spill contingency plan • Wildlife management plan • Construction environmental management plan	• Developer/ Contractor • Stakeholders • ILA, HTC, ITC, WMAC, and GNWT ENR
Land and Resource Use by Inuvialuit	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to areas used for hunting and fishing • Potential increased hunting pressure on wildlife • Potential alteration to wildlife distribution patterns	• Cooperation with regulatory agencies • Public education	• Construction crews will be required to stay on authorized access roads and within the construction area at all times • During the operations phase, install signage and educational materials to encourage Highway users to stay on the designated Highway • Minimum 1 km setback from Husky Lakes area	• Results of community consultations • Land and resource use is a valued part of the Inuvialuit identity • Special management areas must be	• Draft *Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan* (ILA 2010) • EIRB (2002) *Husky Lakes Criteria* • *Husky Lakes Integrated Management Planning Study* (2001) • Tuktoyaktuk CCP • Inuvik Inuvialuit CCP	• Wildlife monitoring during construction	• Developer/ Contractor • GNWT ENR, FJMC, IGC, HTC, ILA • Highway Users

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
					managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• *Inuvialuit Final Agreement*		
Areas of Special Ecological and Cultural Importance	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to or near areas of ecological and cultural importance • Potential construction-related effects • Potential effects from Highway users	• Project planning and route selection to avoid areas of importance • Setbacks from areas of importance • Public education • Consultation and guidance from ILA	• Highway is located a minimum of 1 km from the Husky Lakes • Construction vehicles will stay on access roads or the construction site at all times • Recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway will not be permitted • Recreational use of the Highway by Project staff during construction will not be permitted • Signage will be installed encouraging Highway users to stay on the Highway	• Results of community consultations • Special management areas must be managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• Draft *Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan* (ILA 2010) • EIRB's *Husky Lakes Criteria* (EIRB 2002) • *Husky Lakes Integrated Management Planning Study* (2001) • Tuktoyaktuk CCP • Inuvik Inuvialuit CCP • *Inuvialuit Final Agreement*	• Environmental management plan	• Developer/ contractor • ILA • Highway Users
Land Designation Areas (as per IFA and CCPs)	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to special management areas • Potential construction-related effects • Potential effects from Highway users	• Project planning and route selection to avoid areas of importance • Setbacks from areas of importance • Public education • Consultation and guidance from ILA	• Construction vehicles will stay on access roads or the construction site at all times • Recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway will not be permitted • Recreational use of the Highway by Project staff during construction will not be permitted • Signage will be installed encouraging Highway users to stay on the Highway	• Results of community consultations • Special management areas must be managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• Tuktoyaktuk CCP • Inuvik Inuvialuit CCP • *Inuvialuit Final Agreement*	• Environmental management plan	• Developer/ contractor • Highway Users
Tourism, Commercial and Public Recreational Use	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved tourism and recreational use • Increased opportunities for commercial ventures • Potential effects to tourist attractions during	• Project planning and route selection • Setbacks from areas of ecological and cultural importance • Construction timing	• Primarily winter construction • Accommodating winter construction crews in camps and not in tourist accommodations • Hiring northern workers and contractors to support the local economy, without displacing tourists	• Results of community consultations			• Developer/ contractor • Local Communities

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
		construction		• Develop infrastructure for increased access to Tuktoyaktuk for tourists and other uses • Develop infrastructure between Tuktoyaktuk and Inuvik for personal and recreational use				
Heritage and Archaeological Sites	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Increased access to heritage sites • Potential effects to archaeological resources and sites	• Archaeological impact assessment prior to construction • Archaeological sites protection plan • Approved site-specific mitigation measures, as required, by the PNWHC • Route selection and final design • Worker education • Adaptive management plan • Construction environmental management plan	• Identify all known heritage and archaeological sites to be avoided during construction • PNWHC-approved mitigation measures will be implemented throughout the duration of the construction process • Comply with the heritage resource protection legislation and regulations	• Archaeological resources are protected through various federal, territorial and Inuvialuit legislation and regulations.	• The *Northwest Territories Archaeological Sites Regulations*, pursuant to the *Northwest Territories Act* • NWT Archaeologists Permit	• Archaeological site(s) protection plan • Construction environment management plan • Site-specific mitigation plans, as necessary	• Developer/ Contractor • Qualified archaeologist • Prince of Wales Northern Heritage Centre

Note:
1 – detailed mitigation measures are described in the applicable effects sections.

7.0 FOLLOW-UP AND MONITORING

Several monitoring programs will be implemented during the construction and operations phases to monitor biophysical and socio-economic effects and regulatory compliance. This typically involves the collection of repetitive and repeatable measurements of parameters that characterize valued components.

To the extent possible, baseline information was presented in Section 3.0 for use as a baseline or benchmark in setting targets. Because of the scale of the Project, a phased approach to establishing further baseline conditions has been proposed. Prior to each construction season field surveys will be undertaken prior to the construction of that section of Highway. Examples of these surveys include:

- Wildlife surveys (including species at risk);
- Vegetation surveys (including rare plants and ecosystems);
- Wetlands and Aquatic Resources; and
- Archaeological impact assessments.

As discussed in previous sections of the document, environmental management plans will be developed for several Project components. The EMPs will clearly define compliance monitoring requirements, responsibilities, requirements for training, and reporting during construction. Contractors will be required to comply with the EMP.

Monitoring plans generally contain the following information:

- Policy objective – goals, commitments, outcomes to achieve
- Standards to be met – the specifications of a particular activity or process and how it will be carried out.
- Specific measures to be implemented – including equipment, materials, specific schedule or timing requirements
- Responsibility of tasks – clearly identify who is doing the activity
- Scheduling – anticipated length of activity and timing (season)
- Monitoring and reporting requirements – independent monitoring/inspection of activities and reporting mechanisms
- Contingency plans – procedures to be followed in the event accident or malfunction

Examples of a typical construction phase environmental management plan and wildlife management plan are included in Appendix E.

Compliance and effects monitoring activities will be conducted to ensure that the terms and conditions set out in regulatory approvals, licences and permits, and in the commitments are met, and to check the effectiveness of mitigation measures in avoiding or minimizing potential effects. To that end, the Developer will prepare an effects monitoring table and an inspection table prior to construction. The effects monitoring table will describe the indicators and parameters to be monitored and the target or management goal. The inspections table will describe the types of inspections required, the frequency of the inspections, and which phase of the Project the inspection will occur.

Monitoring frequency will vary depending on the activity, the proximity and sensitivity of potentially affected valued components, and occurrence of incidents. Issues may be recorded in daily reports maintained by on-site workers and later reviewed by the environmental monitor.

Compliance monitoring will be carried out to the extent, frequency and duration required by regulators and according to the results of baseline surveys and specific management plans. Generally, compliance monitoring is conducted on a part-time basis unless activities are occurring in a sensitive area. Monitoring frequency will be determined once the EMP is finalized.

An important feature of effective monitoring programs is the concept of "adaptive management". Both natural and social systems are dynamic and complex. While predicted effects are based on similar past projects and probable reactions, the interaction of a community or ecosystem with Project activities is largely unpredictable and the way in which these systems respond to mitigation measures is also unpredictable.

Adaptive management evaluates and adjusts management decisions (i.e., mitigation measures) to reflect the actual interactions. Therefore, management plans must remain flexible and dynamic throughout the entire life of the Project. Management and monitoring will be refined and revised as necessary.

The following subsections describe the Project's biophysical and socio-economic monitoring that will be conducted during construction and operations phases and the responsible parties, and the minimal monitoring overlap between the NWT Cumulative Impacts Monitoring Program and the Highway's monitoring program.

7.1 BIOPHYSICAL MONITORING

7.1.1 Construction

Environmental and wildlife monitoring will be done by third party monitors supplied by the ILA (environmental monitors) and the HTCs (wildlife monitors). The cost of supplying these monitors will be paid by the Developer/ construction contractor, as was done for the Tuktoyaktuk to Source 177 Access Road.

In-stream monitoring in connection with bridge construction and installation of culverts in fish-bearing streams may be required, particularly if a Fisheries Authorization is needed. Monitoring programs will be conducted during bridge and culvert installations, and conducted by professional consultants working on behalf of the Developer/ construction contractor.

7.1.2 Operations

Long-term monitoring of environmental conditions in the Mackenzie Delta are and will remain the responsibility of the natural resource management agencies including GNWT ENR, DFO, Environment Canada, WMAC, and FJMC. The Developer is willing to cooperate with these agencies in their monitoring activities.

7.2 SOCIO-ECONOMIC MONITORING

7.2.1 Construction

The Developer will require the contractor(s) to report on various parameters related to their activities. Parameters include:

- ISR hiring/contract preferences;
- Employment:
  - Number of workers employed;
  - Employee gender;
  - Location of employee residence; and
  - Wages paid.
- Training:
  - Types of training provided;
  - Number of employees trained;
  - Employee gender; and
  - Location of employee residence.

The Developer is willing to provide this information to related monitoring programs, upon request.

7.2.2 Operations (Long-term)

Long-term socio-economic monitoring is the responsibility of social development agencies, including IRC agencies, NWT Bureau of Statistics, GNWT ITI, GNWT MACA, and GNWT ECE.

7.3 NWT CUMULATIVE IMPACT MONITORING PROGRAM (CIMP)

The Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP) identifies thirteen valued components of the biophysical environment that are regularly monitored. Table 7.3-1 provides a comparison of the NWT CIMP VCs and the VCs in this EIS. The NWT CIMP focuses on the biophysical environment while the Project assessment also identifies potential effects to valued socio-economic components. There is some overlap between the CIMP VCs and the Project's valued ecological components.

TABLE 7.3-1: COMPARISON OF NWT CIMP COMPONENTS AND PROJECT VALUED COMPONENTS

NWT CIMP Valued Components	Project Valued Components
Snow, Permafrost and Ground Ice	Terrain, Geology, Soils and Permafrost
Water Quantity	Water Quality and Quantity Changes to Hydrological Regime
Water and Sediment Quality	
Fish Habitat, Population and Harvest	
Fish Quality	-
Moose	Species of Concern, Special Status or Management
Caribou	
Terrestrial Mammals	
Avian Wildlife	
Marine Mammals	-
Vegetation	-
Climate	-
Air Quality	Air Quality
-	Noise
Human Environment Components	
-	Land and Resource Use by the Inuvialuit
-	Land Designation Areas (CCPs and IFA)
-	Tourism, Commercial and Public Recreational Use
-	Heritage and Archaeological Sites

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