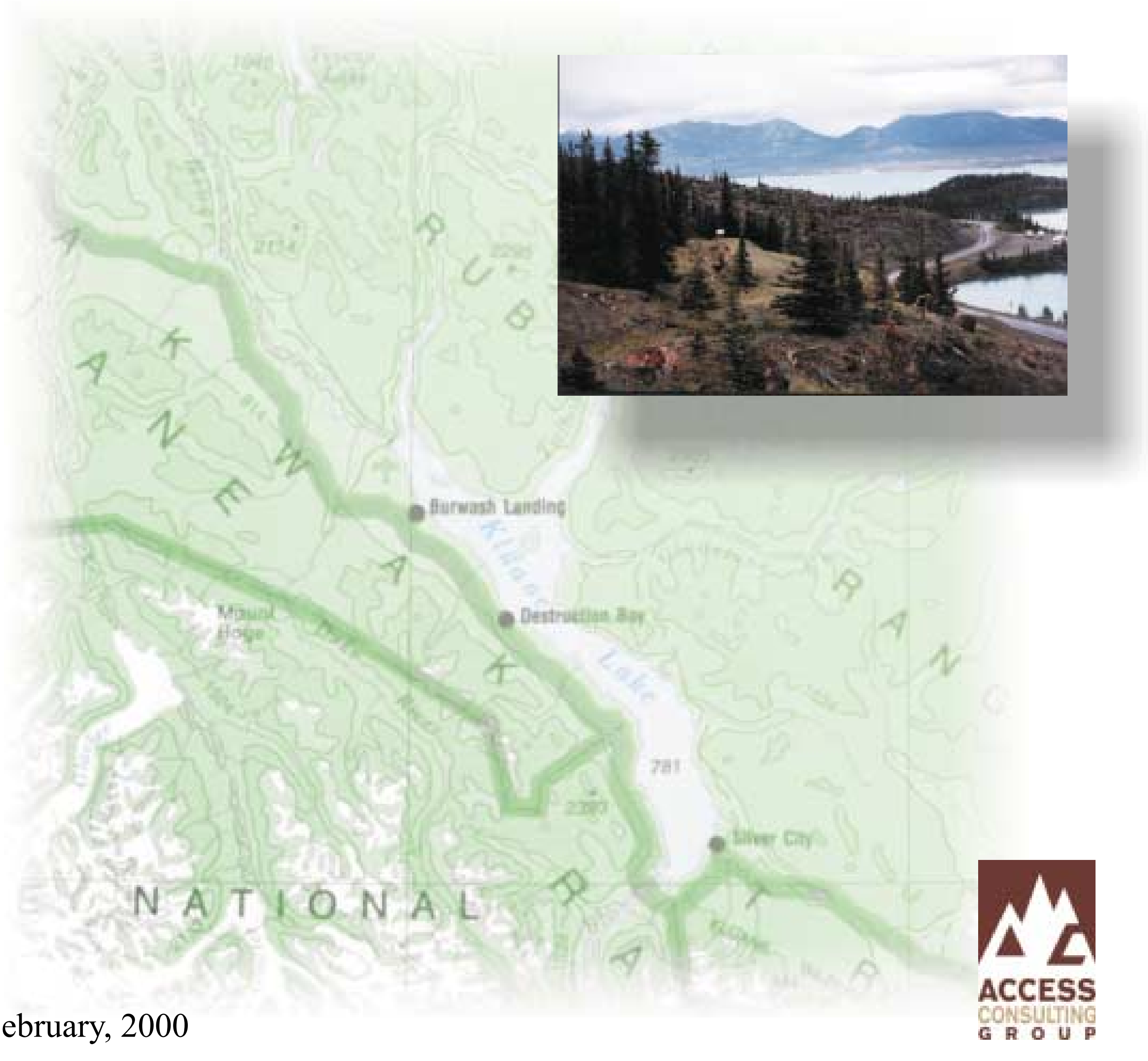
Yukon

Community and Transportation Services
Transportation Engineering Branch

Shakwak Highway Project
Environmental Assessment Update
Km 1664.5 - 1788.5 Alaska Highway #1

Volume I, Main Report & Technical Appendices



February, 2000

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SHAKWAK HIGHWAY PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

VOLUME I – MAIN REPORT & TECHNICAL APPENDICES

February 2000

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EXECUTIVE SUMMARY

Background

The Shakwak Highway Project is a long-term phased project to reconstruct and pave the Haines Road from the Alaska/British Columbia border (km 71) through to Haines Junction (km 246), and the Alaska Highway to the Yukon/Alaska border (km 1966), a distance of approximately 520 kilometres. The project involves reconstruction of horizontal and vertical alignments, road widening, and paving to improve highway safety and enhance driving conditions.

The Shakwak Project is funded by the American Government through the Federal Highways Administration, and administered by Public Works and Government Services Canada. Responsibility for the design and construction of the Shakwak Project rests with the Yukon Government, Department of Community & Transportation Services, Transportation Engineering Branch.

An Environmental Assessment and Review Process Guidelines Order (EARPGO) Panel in 1977/1978 reviewed the Shakwak Project and a Panel Report was completed in June 1978. The original Environmental Impact Statement (EIS) identified data gaps and required further areas of study.

The purpose of this report is to complete an environmental assessment update for the Shakwak Project, between the Jarvis River (km 1664.5) and Quill Creek (km 1788.5), Alaska Highway #1 Yukon. See Figures 1-1 and 1-2 for the general location map and the study area overview map.

Scope

The study objectives for this environmental assessment update included:

- Identification and description of environment conditions within the proposed highway reconstruction study area;
- Identification of resources and areas that are particularly sensitive to the reconstruction process; and
- Identification of potential impacts and mitigation requirements to be addressed prior to highway reconstruction.

The scope of work for this project included the following discipline specific study components:

- archaeological and traditional use;
- current land use;
- wildlife and waterfowl;
- hydrology;
- vegetation;
- aesthetics; and,
- socio-economic.

Each discipline specific study generally involved literature reviews and compilation of historic and current data, consultations and interviews with knowledgeable persons regarding the study area, field surveys as necessary to compliment existing data or to address data gaps, and report compilation. The results of the discipline specific studies with accompanying technical appendices are presented in Volume I Main Report & Technical Appendices.

A series of base maps were developed at 1:60,000 scale to describe the 124 kilometer linear study area, and present the various reconstruction highway alignment options, potential borrow sources, and construction field camp locations. These base maps were then used to describe pertinent discipline specific study results. Study maps were prepared for archaeological and traditional use, current land use, wildlife and waterfowl, hydrology, vegetation and aesthetics and are presented in Volume II, Study Maps.

Pertinent results from the various discipline specific studies are discussed below.

Archaeological and Traditional Use

The main objective for the archaeological and traditional use studies was the creation of a detailed Heritage Inventory and comprehensive archaeological/traditional use impact assessment on the study region. The impact assessment covered the immediate impact zone of the proposed new highway alignment (200-300 meters) as well as the locations of potential borrow pits and potential field camps. It is recognized that most heritage impacts are mitigative, and an emphasis was placed on site-specific mitigation and sound management practices during highway construction.

Extensive field investigations were completed along with interviews with Champagne Aishihik and Kluane First Nations elders. Previously identified archaeological sites were re-visited, and traditional use and historic sites inspected and documented.

Key findings of the archaeological and traditional use studies included the identification of fifty-seven heritage resource sites. See Figures 2-1 to 2-6, Volume II for the location of the various heritage resource sites. All sites were documented, potential impacts identified, and mitigation measures proposed. A total of twenty-one known archaeological sites were identified in the study area with most sites revisited. Seven new archaeological sites were documented. Twenty-nine traditional and historic sites were documented in the study area.

Of the identified heritage resources sites, only sixteen locations required mitigation measures to address potential impacts resulting from highway reconstruction. Key heritage resources sites included:

- A new archaeological site (HR 12) located near an unnamed lake near Christmas Creek at km 1684+200 is located within the highway right-of-way. Archaeological salvage is recommended for this site.

- An existing archaeological site HR 27 (JgVp-3) is located within the highway right-of-way near Goose Bay (km 1723+400). Archaeological salvage is recommended for this site.
- A new archaeological site (HR 12) located near an unnamed lake near Christmas Creek at km 1684+200 is located within the highway right-of-way. Archaeological salvage is recommended for this site.
- New archaeological sites were also identified near Sakiw Creek. Site HR 51 (km 1783+500) is located near a potential borrow and field camp area, and Site HR 56 (km 1783+800) is located on the margins of the highway right-of-way. If the sites cannot be avoided, then salvage would be required.
- Within the study area a number of traditional trials were identified crossing the highway at varying points. No specific mitigation measures where identified to address potential impacts, except for mapping the trails existence and ensuring that First Nations are consulted regarding ways to acknowledge the trails in the study area.
- Historic sites of significance within the study area included Silver City (HR 16 at km 1694+600), the Fisher (Fromme) Cabin and Grave (HR19) at km 1704+100 and a Survey Platform (HR 26) at km 1716+100.

Current Land Use

The main objective for the current land use study was the documentation of all current land tenure and use activities in the study area. Potential impacts to current and potential land users were described and mitigation measures identified. All known waste disposal sites and contaminated sites within the study area were also identified and documented. Current land tenure and land use highway access points were inspected and documented with information presented in a series of maps. See Figures 3-1 through to 3-8 in Volume II for the locations of the current land use highway access points.

Key findings resulting from the current land use study included:

- Mapping and geo-reference of all current land tenure and land uses.

- Present and historic current land uses in the study area included tourism, mining, forestry, agriculture, trapping and outfitting, residential/commercial land uses, recreational uses, traditional and cultural uses, hunting and fishing.
- A total of eleven waste sites were identified within or near the highway right-of-way. Ten of these site were previously listed on the Department of Indian Affairs and Northern Development, Arctic Environmental Strategy Waste Inventory. One new waste site was identified as part of the archaeological investigations. This site (HR 50) is located near Sakiw Creek at highway chainage 1783+300. No waste sites were identified as posing a significant environmental risk; however, if the waste sites are disturbed as a result of reconstruction activities then additional investigations may be warranted.

The main impacts associated with current land tenure and use is retention of continued access to existing business, private residences, local land uses and recreational highway access points. The current land use maps (Figures 3-1 to 3-6 in Volume II) identify highway access points and recommends potential highway access standards for each. The Transportation Association of Canada (TAC) personal residence, or TAC commercial standards, are recommended for the various highway access points. During the course of the current land use study, many local residents and First Nations requested that land use highway access points be designated as a TAC personal residence standard to deter overuse by tourists or unwanted visitors.

Wildlife and Waterfowl

The major objectives of the wildlife and waterfowl studies included providing a general wildlife resource description, summarizing species occurrence, habitats, and the relative ecological importance for the key species in the study area. These species or guilds included: the Kluane Caribou herd; Dall sheep, Birds of Prey, Sharp tail grouse, and Waterbirds. Other species including Grizzly bears, moose, ground squirrels and porcupine were given cursory attention. Current and historic movement corridors, winter ranges, key habitats and frequency of use for the valued ecosystem components were delineated and mapped. Figures 4-1 through to 4-13 in Volume II present the mapping results of the wildlife and waterfowl studies. Measures to mitigate or avoid potential adverse impacts resulting from construction, operation, and maintenance activities were provided. Specific mitigation guidelines were developed for the key species or guild.

The wildlife and waterfowl studies involved the compilation of historic and current literature as well as interviews with knowledgeable persons and First Nation elders. Field studies were specifically conducted for birds of prey, Sharp tail grouse and waterfowl due to identified data gaps for these species or guilds.

The key findings from the wildlife and waterfowl studies included the following:

- The Kluane Caribou herd is a guild identified as a priority concern for highway reconstruction. Current and historic information was used to document seasonal movement patterns and highway crossing area. Mitigation measures are proposed to address potential concerns with highway reconstruction and operation and maintenance activities. These mitigation options include highway signage and crossing identification, limiting the highway as a perceptual barrier for crossing areas, limiting the extent of right-of-way clearing near identified crossing areas, construction timing windows near crossing areas, limiting camp and borrow site near crossing areas, revegetation seed mixtures that distract animal forage and herd monitoring within the study area.

- As previously identified in the original environmental impact statement, Dall sheep are a key species of concern and a focal point for many visitors to Kluane National Park. No specific field studies were undertaken as the Dall sheep population, habitats, movement patterns and mineral licks have been well documented. Mitigation guidelines were developed for potential impacts resulting from highway reconstruction. The focus of these measures is directed as precautionary with special attention to indirect impacts. These measures include construction timing windows, limiting camp and borrow sites within the movement corridors, avoidance of mineral licks, highway signage and crossing identification, providing escape terrain, limiting recreational encounters, and revegetating disturbed areas with poor forage species.

- As a result of the Birds of Prey corridor study undertaken to confirm area usage, Boreal owls, Gyrfalcon, Peregrine and Golden Eagle were identified as the main species of concern. Potential impacts to Birds of Prey species resulting from highway reconstruction and operation and maintenance activities were identified. General mitigation guidelines are provided for birds of prey species. Mitigation measures include the provision of construction buffer zones and construction timing windows, limiting camp and borrow site location away from active nesting areas, installation of nest cavities outside of the highway right-of-way for Boreal owls, brush clearing highway right-of-way, and keeping historic and active nests sites confidential.

- A Sharp tail grouse lekking field survey was conducted to verify previous documentation and to determine current area usage patterns. Two potential lekking areas were identified, Duke River Meadows and Copper Joe Creek. General mitigation guidelines were developed for this species.

- A series of waterbirds surveys were completed for the study area to address data gaps. The surveys included a spring staging/migration survey, a summer brooding survey, and a fall staging/migration survey. Key waterbird habitat areas identified as a result of the studies included Sulphur Lake, and the Kluane lakeshore between Topham Creek and the Slims River. Potential impacts were identified and mitigation measures proposed to address these impacts. These measures include the provision of buffer zones and construction timing windows and the installation of culverts along the Slims River causeways to ensure habitat is not lost.

Hydrology

The major objectives of the hydrology study included a review of all available regional streamflow data and literature to enable an estimate of 50-year and 100-year return period peak events for watercourse crossing design. Preliminary hydrological and morphological characteristics for all major watercourses were provided along with an assessment and description of the potential impacts to the hydrologic regime of these major watercourses. The major watercourses in the study areas that were assessed include Christmas Creek, Silver Creek, Slims River, Williscroft Creek, Congdon Creek, Nines Creek, Mines Creek, Bocks Brook, Lewis Creek, Copper Joe Creek, the Duke River, Burwash Creek, and Sakiw Creek. The location of these watercourses and their drainage areas are mapped on Figures 5-1 through to 5-7 in Volume II. A field survey was conducted at each major watercourse crossing to describe hydrological and morphological characteristics. Mitigation measures and options were presented to address potential impacts.

The key findings from the hydrological studies included the following:

- Revised flood flow prediction and estimates for each major watercourse crossing. The recommended estimates include a provision for standard error for structural design.

- A historic review of the Silver Creek hydrological processes was undertaken. Based on this review, a number of mitigation options were developed to address potential downstream impacts to historic, residential and commercial properties. These options include: continuing with the existing stream maintenance practices; creation of sediment traps both upstream and downstream of the existing stream crossing with associated granular removal; removal of the existing stream diversion and the highway crossing and redirection of the creek towards Topham Creek, split the creek flow into another separate channel, divide the stream flow into two channels and create a new channel.

- Potential hydrological impacts and mitigation measures, complete with various options, were identified for each major watercourse crossing. Of particular concern are the potential channel avulsions associated with the glacial fed streams or “Kluane Creeks” and impacts to the highway. Continued maintenance of existing diversions and stream banks and installation of emergency overflow culverts are recommended.

- The construction of causeways across the Slims River delta area was also assessed. Many of the potential impacts on Kluane Lake, such as lake isolation or loss of fish habitat, could be avoided or minimized if the existing highway alignment is kept. However, other potential concerns such as improved highway safety and wildlife collisions are not adequately addressed. Mitigation measures are recommended to address new causeway construction in the Slims River delta area.

Vegetation

Major objectives of the vegetation study included the description and characterization of vegetation communities in the study area, and a determination of the communities in terms of sensitivity to disturbance. All vegetation communities within the study area highway corridor were identified and mapped. Rare plant species were identified and the locations noted. A number of field surveys were conducted to ground truth vegetation communities, identify rare plant species, and confirm vegetation community maps. Vegetation maps for the study area are presented in Figures 6-1 through to 6-7 in Volume II. Potential impacts resulting from highway reconstruction activities were identified, and mitigation measures were developed to reduce impacts. A revegetation plan for various segments of the reconstructed highway was prepared to assist with reconstruction reclamation.

The key findings of the vegetation study included the following:

- A total of eighteen major vegetation communities were documented within the study corridor and presented on the vegetation maps. No potential borrow or field camp areas were identified as sensitive to reconstruction activities.

- Twelve rare plant species were identified within the study area, with most species occurring in the Slims River delta, Sheep Mountain and Kluane lakeshore areas.

- The *Dryus drummondi* plant community located near the Silver Creek floodplain was considered aesthetically pleasing to many locals and visitors.

- Various revegetation seed and fertilizers mixtures were recommended for various highway segments. Of particular concern is revegetation with non-indigenous plant species in the Kluane National Park area. Similar concerns were raised with the use of legume seed mixtures in areas associated with caribou crossings. Revegetation mixtures were specifically designed to address these potential concerns.

Mitigation measures to address potential impacts associated with highway reconstruction and operations and maintenance activities include minimizing off road construction traffic, continued use of disturbed areas for potential borrow sources and field camp locations, identification, salvage and transplantation of rare plant species, minimizing disturbance and maintenance of natural drainage courses, and revegetation seed mixtures tailored to address particular corridor concerns (e.g. introduction of non- indigenous plant species and use of legumes near wildlife crossing areas).

Aesthetics

The major objectives for the aesthetics study included documentation of specific or potential viewpoints or tourist pullouts for preservation and the identification of vulnerable areas particularly sensitive to highway reconstruction. All potential borrow pit and camp locations were assessed for potential aesthetics impacts. The study involved meetings and site visits with various stakeholders to identify candidate viewpoints or tourist sites. The results from the other discipline specific studies were also integrated into the aesthetics study to determine vulnerable areas. Potential viewpoints, tourist pullout and vulnerable areas were mapped and appear on Figures 7-1 through 7-6 in Volume II. Mitigation measures were developed to address potential aesthetics impacts.

Key findings of the aesthetics study included the following:

- Many of the existing tourist pullouts and viewpoints should be reconstructed and maintained. Consideration should be given to upgrading public rest stop facilities at key locations along the highway such as the Kluane Lake overlook.

- As noted in the previous environmental impact statement, the Slims River Delta, Sheep Mountain area and Duke River Meadows are considered ecologically sensitive areas. Results from the various discipline specific studies confirm the uniqueness of these areas. Other vulnerable areas include Sulphur Lake, Silver Creek floodplain, and the Goose Bay area. Specific mitigation strategies are recommended for these vulnerable areas.

- A review of the potential borrow sources and field camps indicated that some locations may need to be modified due to potential conflicts with wildlife, archaeological and First Nations concerns, particularly in the Sakiw Creek area. However, many sites could easily be developed following current granular resource management practices. Streambed borrow source development in glacial fed streams may address many aesthetic issues and long term maintenance, as well as providing sources for highway granular material.

Socio-economics

Major study objectives for the socio-economic component included the preparation of socio-economic profiles for the communities of Haines Junction, Destruction Bay, Burwash Landing and Beaver Creek. Potential positive and negative economic impacts as a result of highway reconstruction and maintenance activities were assessed. A comprehensive and accurate understanding of local residents, businesses, First Nations, recreational users and tourists was undertaken through extensive interviews and questionnaires. Both potential positive and negative economic and social impacts were identified and mitigation measures presented.

The key findings of the socio-economic study included the following:

- Interviews conducted with local First Nations, residents and businesses indicated that locals had concerns with construction camp locations, construction related dust, pilot car operations, business loss due to piloting and construction camp locations, the length of construction segments, and the impediments to local businesses as a result of highway reconstruction. Mitigation measures were recommended to address potential impacts.
- Based on the review of economic conditions, it was determined that highway construction benefits to the Yukon are considerable. However, local residents and businesses expressed concerned over the accessibility to construction related contract opportunities.
- Very little impacts to mining, forestry and fishing industries were identified as a result of highway reconstruction. Generally, highway reconstruction will improve or help these economic sectors.
- One local trapper is potentially impacted as a result of highway reconstruction. However reconstruction activities are typically undertaken during spring, summer, and fall months, which are considered off-season for the trapper.

Mitigation Strategy

On the basis of the individual discipline specific study results, an overall mitigation strategy was developed that summarized the potential environmental impacts to various study components with mitigation measures proposed to address those impacts.

A general mitigation plan was developed that provided guidelines applicable to highway reconstruction and operations. Areas sensitive to reconstruction activities were noted and mitigation summarized. Current environmental management practices presently undertaken by Yukon Government, Community & Transportation Services, will adequately address many of the identified impacts associated with highway reconstruction. In areas where unique or vulnerable features or sensitive environmental resources were identified, a prominent features mitigation strategy was developed. Specific areas where an integrated mitigation strategy was required included Silver Creek floodplain, Sakiw Creek caribou crossings, Destruction Bay, Duke River Meadows, and the internationally renowned Slims River Delta and Sheep Mountain area. Implementation of the various mitigation measures should ensure that environmental sensitive resources are not impacted as a result of reconstruction of the Shakwak Highway Project.

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1.0 INTRODUCTION

This document presents the results of an environmental assessment update for the Shakwak Highway Project, km 1664.5 to km 1788.5, Alaska Highway #1 Yukon. The environmental assessment update was completed by Access Consulting Group by request from Yukon Government, Community & Transportation Services, Transportation Engineering Branch.

1.1 PROJECT SCOPE

The Shakwak Highway Project is a long-term phased project to reconstruct and pave approximately 520 kilometres of highway starting at the Haines Road - Alaska/British Columbia border (km 71) to Haines Junction (km 246), and continuing north along the Alaska Highway at Haines Junction (km 1635) to the Yukon/Alaska border (km 1966). The project involves reconstruction of horizontal and vertical alignments, road widening, and paving to improve highway safety and enhance driving conditions.

The Shakwak Highway Project was reviewed by an Environmental Assessment and Review Process Guidelines Order (EARPGO) Panel in 1977/1978, according to established guidelines and a Panel Report was completed in June 1978 (FEARO and Environment Canada, 1979). Studies of baseline environmental conditions were undertaken, and an assessment of impacts provided in an Environment Impact Statement (EIS) prepared by the Department of Public Works, Canada and the U.S. Federal Highway Administration for the Shakwak Highway Improvement Project in December 1977 (DPW, 1978 and 1979).

The EARPGO Panel provided 35 recommendations to address potential impacts specifically to project management, physical and engineering, ecological and socio economic, and unique area issues. The Panel's overall conclusion was "…*that it will be possible to carry out the project without significant adverse environmental or socio impact if appropriate procedures are followed and certain conditions are met…*" Specific commitments were made as part of the EIS report by the proponent to implement various mitigation measures, and undertake detailed studies to address data gaps in the original EIS.

The discipline specific studies presented within this document represent a follow up study to the original EIS) and are designed to address data gaps in the EIS and follow up on recommendations made by the EARPGO Panel respecting the need for further study. The scope of work for this project includes the following components between Jarvis River (km 1664.5) and Quill Creek (km 1788.5) of the Alaska Highway:

- archaeological and traditional use;
- current land use;
- wildlife and waterfowl;
- hydrology;
- vegetation;
- aesthetics; and,
- socio-economic.

For each study area, the level of knowledge has been updated to reflect present conditions. Potential environmental impacts related to each study components are described, and a series of mitigation options are presented to address potential impacts. Detailed mapping is used to describe study features and locations.

It is expected that the results of this study will be used by Yukon Government, Community & Transportation Services, to assist with the following:

- updating environmental conditions and information within the study area;
- road reconstruction design and alignment selections;
- borrow pit and field camp site selection;
- identification of environmental components requiring mitigation as a result of road reconstruction and operation and maintenance activities;
- development and implementation of mitigation options to address potential impacts; and
- providing supporting documentation for various permit applications and environmental screenings.

1.2 PROJECT STUDY AREA

The project study area is located within the Shakwak Trench in south western Yukon (Figure 1-1), and extends from km 1664.4 (Jarvis River) to km 1788.5 (Quill Creek). Figure 1-2 illustrates the 124 km linear section of the highway that is slated for highway reconstruction.

Of particular interest and concern for the Shakwak Highway Project development is the recognition and protection of two unique ecologically important areas within this section of the highway. The Sheep Mountain/Slims River Delta area, a focal point for Kluane National Park, and ecological reserve under the International Biological Program, is unique in its importance as an ecological sensitive area for Dall Sheep, raptors and plant communities. The Duke River Meadows is similarly important as an ecologically sensitive area, particularly for the Kluane First Nation community of Burwash Landing.

The study area has been subdivided into a series of seven base maps. The base maps and their linear coverage are listed below:

- Base Map 1 (Figure 1-3, Volume II) extends from km 1664.5 to km 1684;
- Base Map 2 (Figure 1-4, Volume II) extends from km 1683 to km 1713;
- Base Map 3 (Figure 1-5, Volume II) extends from km 1700 to km 1725;
- Base Map 4 (Figure 1-6, Volume II) extends from km 1727 to km 1747;
- Base Map 5 (Figure 1-7, Volume II) extends from km 1749 to km 1770;
- Base Map 6 (Figure 1-8, Volume II) extends from km 1770 to km 1788.5;
- Base Map 7 (Figure 1-9, Volume II) extends from km 1700 to km 1709 (Slims River/Sheep Mountain).

Volume II – Study Maps presents a complete set of all the base maps and study maps used for the report. For ease of presentation of geographical information, Volume I, Main Report & Technical Appendices should be read in conjunction with Volume II – Study Maps.

The base maps discussed above have been subsequently used for the various discipline specific studies, and are provided as a complete set in Volume II – Study Maps.

All base maps and study maps include potential borrow sites and field camp locations. These sites are numbered sequentially starting from Jarvis River (km 1664.5). The numerical designation also indicates whether the site is a potential borrow source ("B") or potential field camp ("C") location. As no detailed field inspection and geotechnical information has been collected from these sites, they were considered potential areas for investigation for the purpose of the various discipline specific studies.

Base and study maps provide highway kilometer locations with specific reference to the reconstructed highway alignment. These highway chainages are based on the reconstructed highway alignment center line, with the Center Line route option used (see Volume II, Figure 1-9).

As noted on the base maps, various highway center line alignment options exist, particularly in the vicinity of the Slims River Delta. Volume II, Figure 1-9 outlines the existing highway alignment and the four other highway reconstruction center line alignment options (A1, A2, B1, and Center Line), as identified by Yukon Government, Community & Transportation Services, Transportation Engineering Branch.

Highway chainage equations for reconstruction survey purposes are shown on Figures 1-6 and 1-8, Volume II.

1.3 PROJECT COMPONENTS AND MAJOR OBJECTIVES

As noted previously, the overall intent of this study was to address data gaps in the original Shakwak Highway EIS, specifically to the Alaska Highway between existing kilometres 1664.5 and 1788.5. The objectives of this report are to:

- Identify and describe environment conditions within the proposed highway reconstruction study area;
- Identify resources and areas that are particularly sensitive to the reconstruction process; and,
- Identify potential impacts and mitigation requirements to be addressed prior to highway reconstruction.

Specific studies undertaken to address data gaps and study objectives follow.

ARCHAEOLOGICAL AND TRADITIONAL USE

Major study objectives include:

- Gain a thorough understanding of the archaeological resources and potential of the study area;
- Conduct a systematic archaeological field survey for prehistoric/traditional/historic sites (or Heritage Sites) between km 1664.5 (Jarvis River) to 1788.5 (Quill Creek), to relocate and assess the condition of previously identified heritage sites, and to determine the location and condition of additional unknown heritage sites within the region;
- Gain a thorough understanding of the ethnographic information on traditional land use within the study area and Kluane region;
- Precisely locate and describe all traditional use sites, known and unknown, within the study area, based on interviews with members of Kluane First Nation (KFN) and Champagne Aishihik First Nation;
- Create a detailed Heritage Inventory of the study area, and to identify measures to avoid impacts to sites of archaeological and traditional use importance, and to provide recommendations on mitigative measures where impacts are unavoidable;
- Prepare a comprehensive Archaeological Impact Assessment and Traditional Land Use Impact Assessment on the study region.

CURRENT LAND USE

Major study objectives include:

- Preparation of accurate documentation of all current land use activities in the study area;
- Compilation of complete land tenure information database;
- Description of impacts to current and potential land uses in the study area resulting from construction, operation and maintenance, and recommend measures to mitigate those impacts;

- Identify and document all known waste disposal sites and contaminated sites within the study area.

WILDLIFE AND WATERFOWL

Major study objectives include:

- Provide a general resource description for the study area which will summarize the occurrence of different species and habitats, and the relative ecological importance of these ecosystem components to the broader ecosystem, and to the Yukon;
- Delineate known movement corridors, winter ranges, and other key habitats of the Kluane Caribou Herd; Dall sheep, Birds of Prey, Sharp tail grouse and waterbirds;
- Determine historic range use patterns and delineate key habitats, including late winter, calving, post-calving, and rutting areas, migration corridors, and mineral licks;
- Determine current range use patterns and delineate key habitats, including late winter, calving, post-calving, and rutting areas, migration corridors, and mineral licks;
- Determine frequency of use (over successive years) of key habitats within the study corridor;
- Delineate areas to determine raptor nesting sites, including frequency of use;
- Determine known nesting sites and key winter roosts in the study corridor;
- Determine the significance and extent of waterbird habitat in the study area, and quantify the use of the habitat by waterbirds during spring and fall staging, breeding and molting;
- Recommend measures to mitigate or avoid adverse impacts resulting from construction, operation, and maintenance activities;
- Identify potential adverse impacts of linear developments, including (a) the risk and outcome of temporary and permanent displacement (functional loss of habitat), (b) loss of habitat, change in habitat use, or fragmentation of habitat, (c) the interruption of movements (such as barriers or changes in snow conditions), (d) the risk of traffic accidents involving animals, (e) the change in activity budgets which may influence energetics and productivity, (f) the consequence of greater stress and increased vigilance;
- Consider the indirect consequences of road upgrading and re-routing, such as the risk of greater levels of off-road vehicle and pedestrian traffic, increased hunting pressure, and

changes in distribution of other mammals that may influence distribution or activity pattern;

- Predict the impacts of roadside clearing, seeding, fertilization, and the use of road salts, as possible factors influencing habitat use, and the risk of traffic kills or hunting losses.

HYDROLOGY

Major study objectives include:

- Assess and review all available regional streamflow data and analyses;
- Site familiarization, preliminary hydrological and morphological characteristics for all major watercourses in the study area;
- Estimate 50-year and 100-year return period peak flows for all major watercourses;
- Assess and describe potential impacts to the hydrologic regime of all major watercourses, particularly Silver Creek, Slims River delta and causeway, and Kluane Lake shoreline;
- Recommend mitigation measures to minimize impacts.

VEGETATION

Major study objectives include:

- Collate existing sources of knowledge regarding vegetation in, and adjacent to, the study area to use as a guide to focus investigation;
- Finalize and describe vegetation communities in the study area, including the Slims River delta;
- Characterize communities in terms of sensitivity to disturbance;
- Identify and map known locations of rare plant species;
- Identify mitigation measures to reduce impacts;
- Develop a revegetation plan for the realignment project.

AESTHETICS

Major study objectives include:

- Document specific or potential elements or views which should be preserved;
- Identify areas which are most vulnerable to aesthetic damage due to construction activities;
- Review potential borrow pit and camp locations to determine the most effective method to minimize aesthetic impacts resulting from construction, operation, and maintenance;
- Develop recommendations on suitable locations for the development of tourist pullouts and rest stops with input from Kluane First Nation (KFN), Champagne Aishihik First Nation (CAFN), Kluane National Park staff, YTG Tourism, and YTG Highways Maintenance Branch.

SOCIO-ECONOMICS

Major study objectives include:

- Prepare a socio-economic profile of the study area, its communities and people;
- Provide an assessment of potential positive and negative, local, regional and Yukon wide economic impacts;
- Develop a comprehensive and accurate understanding of the concerns of local residents, businesses, First Nations, recreational users and tourists;
- Describe potential positive and negative economic and social impacts.

On the basis of the individual discipline specific study results, a mitigation plan was developed that summarized potential environmental impacts and proposed mitigation measures.

1.4 CONSULTATIONS

During the course of the various studies, a number of individuals, organizations and agencies were directly contacted and consulted to ensure that discipline specific study information was made available for the report. This information was used to address study data gaps, and to assist with achieving various study objectives.

Generally, consultations involved an explanation of the overall project (environmental assessment update) and proposed highway reconstruction alignment options. Where possible, airphotos and maps were used to assist with consultations.

For the discipline specific studies, team members contacted pertinent people or organizations and agencies for specific study information. Potential study component concerns or impacts were noted, and possible mitigation measures were discussed. This information was then used as part of each study component. Appendix I provides a list of contacts and their affiliation for the project.

1.5 DOCUMENT ORGANIZATION

This report is presented in two volumes. The main report and technical appendices “Shakwak Highway Project Environmental Assessment Update km 1664.5 – 1788.5 Alaska Highway #1,” is presented in Volume I, with the supporting base and discipline specific study maps presented in Volume II “Study Maps”.

The various sections of the main report are organized by the various discipline specific studies. Each study section is accompanied by supporting tables and figures. Individual study maps for the various studies are presented in Volume II.

Section 1 of this document introduces the project scope, setting, objectives, and discusses the various discipline specific studies undertaken. Information is provided on study consultations, and key participants are acknowledged.

Section 2 presents the archaeological and traditional land use study component. Details of the field surveys are provided, and potential impacts assessed, and mitigation measures recommended. This section of the report will also be produced as a separate stand-alone report, and filed with appropriate agencies.

Section 3 provides a discussion of the current land use in the study area. Potential impacts are assessed, and mitigation measures recommended. Detailed mapping is used to document the specific road accesses off the highway that are required.

Section 4 discusses important wildlife or valued ecosystem component species within the study area. Included are discussions of the Kluane Caribou Herd, Dall sheep, Birds of Prey, Sharp tail grouse, and waterbirds. Potential impacts on these species are assessed, and mitigation measures recommended.

Section 5 presents the results of the hydrological study and site investigations. Hydrological impacts are assessed, and mitigative options presented.

Section 6 presents the results of the vegetation study and resultant vegetation community mapping. Potential impacts are assessed, and mitigation measure recommended. Discussions regarding revegetation seed and fertilizers mixtures are provided for various sections of the highway.

Section 7 discusses the aesthetic study component. Existing viewpoints are examined and vulnerable areas assessed. All proposed borrow sources and field camp locations were assessed for potential impacts. Mitigative measures are presented to address potential aesthetics impacts.

Section 8 provides a description of the socio-economic profiles of communities in the area, and discusses potential positive and negative socio-economic impacts associated with highway reconstruction and operations. Mitigation measures are recommended as necessary.

Section 9 integrates the results of the various discipline specific studies to provide an overall mitigation strategy for the study area. Both general and prominent feature mitigation strategies are presented.

Section 10 provides the various references used for the report. The references have been organized by general as well as discipline specific studies.

Various technical appendices follow the main report. These appendices provide supporting documentation for the various discipline specific studies.

Volume II, Study Maps, presents the base and study maps used throughout the main report. The study maps should be used in conjunction with the main report.

1.6 ACKNOWLEDGEMENTS

For this project, Access Consulting Group assembled a project team of specialists to undertake and complete the discipline specific studies. Individual project team members included:

- T.J. Hammer – archaeological and traditional land use studies, with assistance from Ty Heffner, Derek Johnson, and Stephen Reid.
- Norm Barichello, Grant Lortie and Dave Petkovich – Wildlife and Waterfowl, with assistance from David Mossop and Peter Wright.
- Peter McCreath – hydrological studies.
- Stuart Withers – vegetation studies.
- Rob Harvey- aesthetics studies.
- Nick Poushinsky – socio-economic studies with assistance from Math'ieya Alatini, Luigi Zanasi, and Malcolm Taggart.

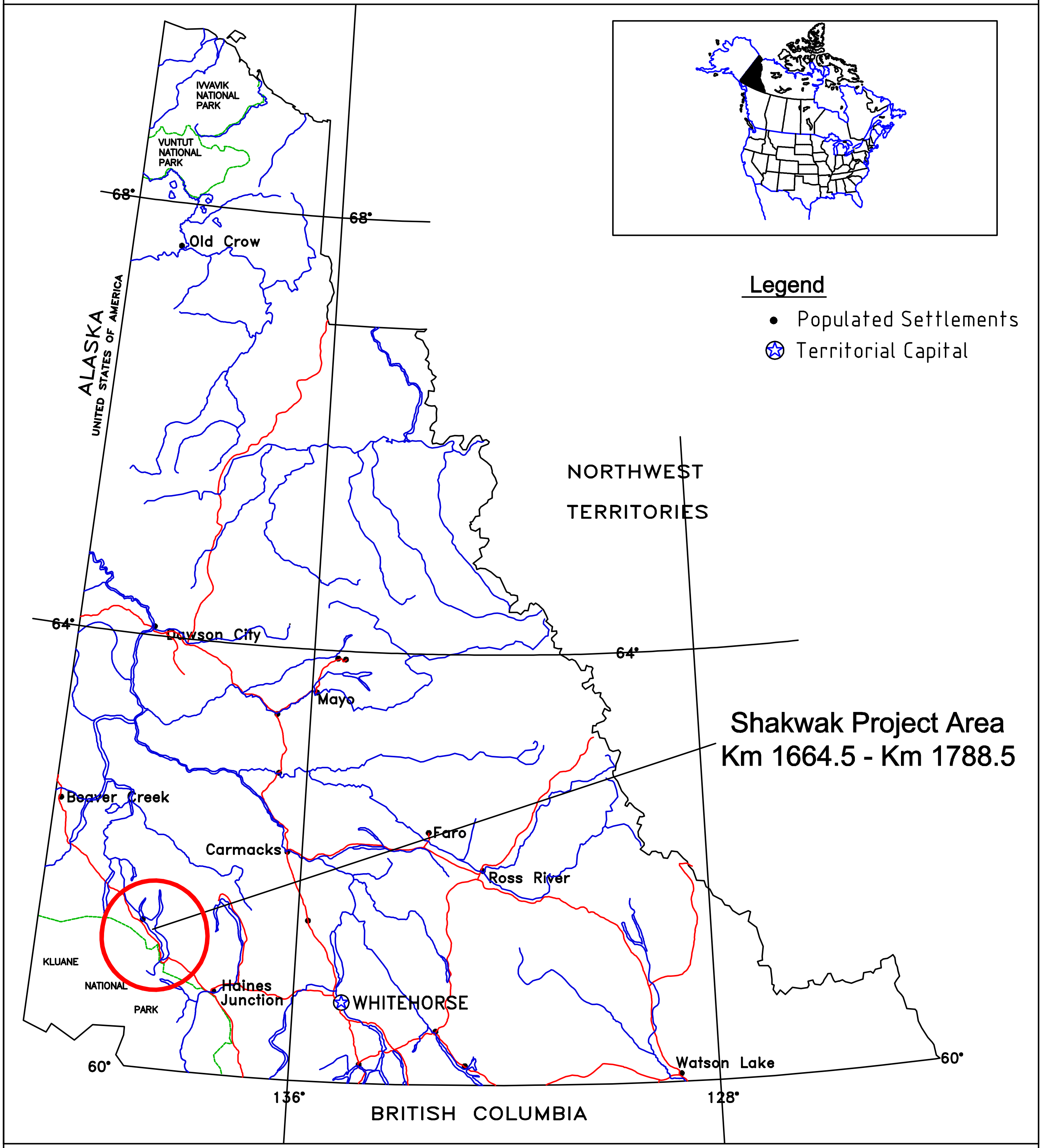
Access Consulting Group's core team undertook overall project management, administrative, research, and mapping components, and included Dan Cornett, Rob McIntyre, Colette MacMillan, Travis Ritchie and Lee Randell. The overall report was compiled by Access Consulting Group.

Project team members benefited from the assistance of James Allan and Ron Chambers and their local knowledge of the study area.

Without the assistance and input from a number of local residents, First Nations and other government agencies, it would have been impossible to achieve the accuracy and clarity for which the project team has striven. The team wishes to express its appreciation to those individuals listed in Appendix I.

We greatly acknowledge the solid support, assistance and advice of Allan Nixon, Environmental Coordinator, and Paul Knysh, Shakwak Program Manager, of the Transportation Engineering Branch, Department of Community & Transportation Services, Yukon Government, throughout the project.

Yukon Territory



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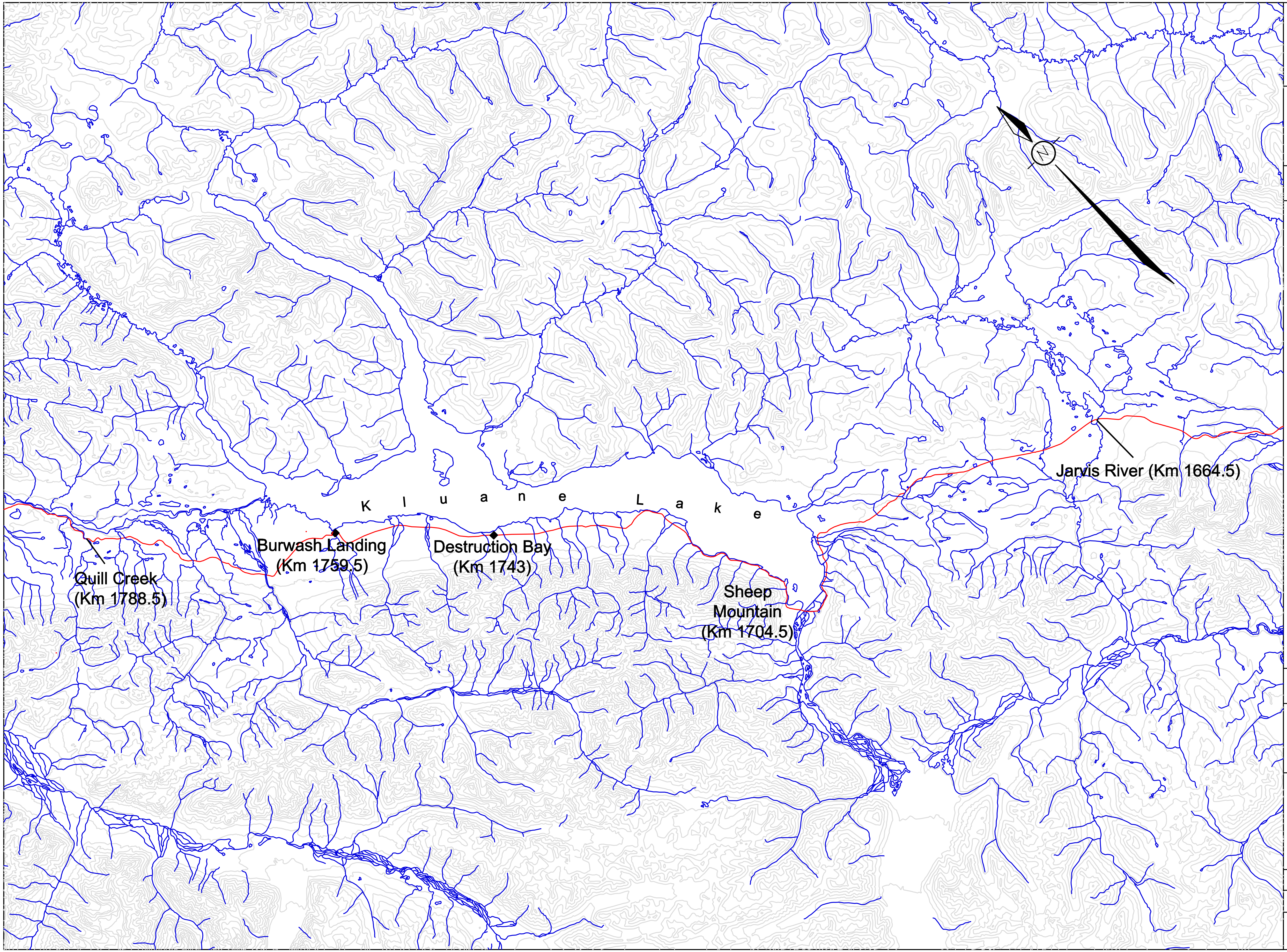
Yukon
Community and Transportation Services
Transportation Engineering Branch

0 100 200 300
KILOMETRES
Lambert Conformal Conic Projection
with Standard Parallels at 49°N and 77°N

Shakwak Project Environmental Assessment
Update 1999 Km 1664.5 - Km 1788.5

General Location Map (Map of Yukon)

DRAWN BY: LDR	CHECKED BY: DDC	Figure 1-1
DATE: 16/02/2000	Scale 1: 6,000,000	



Shakwak Project
Environmental
Assessment Update 1999
Km 1664.5- 1788.5 Km

Yukon
Community and Transportation Services
Transportation Engineering Branch

Legend

Existing Alaska Highway
Contours at 500ft intervals
Watercourse

STUDY AREA OVERVIEW

Scale 1:360,000
10Km 20Km

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DRAWN BY: LDR
CHECKED BY: DDC
DATE: 17/02/2000

Fig. No. 1-2

2.0 ARCHAEOLOGICAL & TRADITIONAL LAND USE

General

The goal of the archaeological and traditional land use investigations, carried out in the summer and fall of 1999, was to address data gaps in the original 1977 Shakwak Highway Improvement Environmental Impact Statement (EIS) as it pertained to km 1664.5 (Jarvis River) through to km 1788.5 (Quill Creek) on the Alaska Highway. The study area lies within the Champagne and Aishihik First Nation (CAFN) and the Kluane First Nation (KFN) traditional territories. The objectives of the investigations were to carry out a systematic archaeological and traditional land use impact assessment within the defined study area. The impact assessment covered the immediate impact zone of the proposed new highway alignment (200-300 meters) as well as the locations of potential borrow pits and potential field camps. It is recognized that most heritage impacts are mitigable, and an emphasis is placed on site-specific mitigation and sound management practices during highway construction.

The archaeological and traditional site identification fieldwork was carried out in May of 1999 by T.J. Hammer, Project Archaeologist, Ty Heffner, Archaeological Field Technician, of the University of Alberta, and field assistants Derek Johnson of KFN and Steven Reid of CAFN. A total of 112 localities along the realignment were investigated. This included revisiting known archaeological and traditional sites. In addition, seven new archaeological sites were documented (see Appendix II-1).

The traditional land use fieldwork was carried out between May and August 1999. Six First Nation elders were interviewed. Two elders, Mrs. Bessie Allen and Mr. Thomas Joe, were interviewed from CAFN, and four elders, Mrs. Grace Chambers, Mrs. Agnes Johnson, Mr. Peter Johnson and Mr. Edward Johnson were interviewed from the KFN. T.J. Hammer, who was assisted by Mrs. Agnes Johnson, Mr. James Allen and Mr. Ron Chambers, carried out elder interviews.

This section reports on the archaeological and traditional land use investigations carried out between the Jarvis River and Quill Creek for the proposed Alaska Highway realignment activities. The following sections detail the background of the study area, methodology used during the investigations, findings as a result of the investigations, and recommended mitigation measures for heritage resources that will be impacted.

2.1 BACKGROUND OF THE STUDY AREA

2.1.1 Study Area Setting

The study area lies within the Shakwak Trench within the Ruby Range Ecoregion, southwestern Yukon, as defined by Oswalt and Senyk (1977: 40-43). The entire area was glaciated prior to 12,500 before present (BP) (Rampton, 1981). As a result of glaciation, the surficial deposits are glacial and peri-glacial in origin, consisting of morainal and glaciofluvial materials and loess deposits. In poorly drained areas, black spruce and bogs dominate; whereas, in better drained areas, white spruce are predominate. Permafrost is widespread and most common in more closed forested areas and north facing slopes. The common understory vegetation consists of willow, shrub birch, alder, various berries, and ericaceous shrubs. In poorly drained areas, sedge tussocks fields occur while in well drained areas grass meadows are prevalent.

2.1.2 Paleoenvironment

In southwestern Yukon the modern vegetation was established ca. 4,500 years BP when the temperatures are believed to have stabilized during the mid-Holocene (Cwynar 1988; Cwynar and Spear 1991; Wang and Geurts 1991). Data recovered from Jenny Lake, Long Last Lake, Two Horseman Pond and Kettlehole Pond are used for the following reconstruction of Holocene vegetation history for the southwestern Yukon.

Cwynar (1988) describes the vegetation between 10,000 BP to 8,500 BP in southwestern Yukon as being Populus (Poplar) woodland with an understory of soapberry in gallery forests concentrated near streams and rivers, with open areas of grassland and shrub vegetation. Spruce appears in the palynological record around 8,500 BP. A marginal boreal forest-like environment dominated by white spruce was present in the area by 8,000 BP, and lasted until 6,000 BP. (Cwynar 1988; Cwynar and Spear 1991). Extensive stands of white spruce, trembling aspen, and balsam popular, with an understory of juniper and soapberry, characterized well-drained slopes during this period. Between 6,000 BP and 4,500 BP, frequencies of white spruce and black spruce varied in dominance, but as temperatures stabilized towards the end of this period, the modern day boreal forest was established (Cwynar 1988).

It is likely that by 8,000 BP the fauna in southwestern Yukon resembled the fauna in the area during this century. The frequencies of different fauna and their distribution over the landscape probably varied over the past 8,000 years, more than likely correlating with the changing vegetational environment. One exception is that bison were native to the region up until the more recent past. Bison (*Bison bison athabascae*) was recovered at the Canyon Site and dated to 7,195 ± 130 BP and in the Carcross Road area *Bison bison athabascae* was dated to 930 ± 90 BP.

The important species, as related to human occupation, that exist in the area include moose, caribou, mountain sheep and goat constituting the large game animals. Muskrat, ground squirrels, and hare are the important small game animals, and foxes, wolverines, lynx, marten, and beaver are the important fur bearing animals. Both Grizzly and black bears are common in the area (McClellan 1981). Migratory water fowl such as ducks, geese and swans were important species occupying the small lakes and ponds within the study area, most notably being Kluane and Sulphur Lake. Kluane Lake supports a variety of fish with trout, white fish, grayling and pike being the most important for subsistence (Kluane First Nation n.d.). Pike and grayling also occur in a number of the streams and small lakes within the study area; the Jarvis River, Sakiw Creek and the mouth of Quill Creek at the Kluane River being the most important. Salmon do occur in the area. Small runs of King and Chum salmon are documented in a number of tributaries of the Kluane River (Ibid.).

Two geological events occurred within the Kluane area that likely had an affect on First Nation settlement patterns. The hypsithermal, which marks an increased warming event, had a profound impact on Kluane Lake. At approximately 8,700 BP, a marked warming trend began and with it the Kaskawulsh Glacier at the head of the Slims River began to retreat. The retreat of the glacier allowed Kluane Lake to drain via the Slims and Kaskawulsh Rivers, which lowered the lake level just over 12 m (Bostock 1967; Rampton 1981). This drainage pattern continued until the onset of the neoglaciation ca. 2,800 BP. The lowering of the lake level would have opened up a great deal more shoreline than is present today, and it is likely that some archaeological sites dating between 8,700 BP and 2,800 BP are submerged.

The second geological event is evident throughout the southwestern Yukon and central Yukon and Alaska border. These areas were blanketed by volcanic ash after two violent eruptions occurred in the White River area between 1,800 to 1,250 BP (Workman 1978). The eruptions were separated in time by approximately 500 years. Much of the White River ash in the study area originated in the later eruption, the eastern lobe, dated 1,260 BP (Clague et al. 1995). The northern limits of the study area appear to have both the eastern lobe and the northern lobe or earlier ash deposit. Definitive conclusions have yet to be made regarding how severe the ash falls impacted the resident population; however, these ash falls do provide a time marker aiding the relative dating of archaeological sites.

2.1.3 Pre-contact Period

The study area is in the southwestern Yukon, Kluane-Aishihik Region. This area of southwestern Yukon has been subjected to intensive archaeological study. Workman's (1978) culture history of the southwestern Yukon is used as a comparison and a general framework for chronology and cultural affiliations of the archaeological sites within the study area.

Workman's research focused primarily within the Aishihik-Kluane region and built on the work carried out by MacNeish (1964). The culture historic framework he developed was based on excavations at the Chimi Site, JjVi-7, the Otter Falls Site, JgVf-2, the Canyon Creek Site, JfVg-1, the Little Arm Site, JiVs-1 and the Taye Lake Site, JfVb-4. Because of the study area's geographical proximity to these sites, there should be direct chronological and archaeological similarities with them.

Four archaeological phases covering a span of +8,000 years divide southwestern Yukon prehistory:

1) the Bennett Lake phase - ca. Protohistoric to 200 BP;

2) the Aishihik phase - ca. 200 to 1,260 BP;
3) the Taye Lake Phase - ca. 1,250 to 5,000 BP; and,
4) the Little Arm phase - ca. 5,000 to 8,000 BP.

Gotthardt (1990), Clark (1992) and Hare (1995) add to Workman's sequence of the northern Cordilleran tradition, ca. 7,500 to 10,000 BP characterized by large blades and lanceolate points and the Annie Lake Complex, within the Taye Lake phase, ca. 4,500 to 5,000 BP. Northern Cordilleran sites in southwestern Yukon include the basal layer of the Annie Lake site and the Canyon Site, as well as certain localities at Fish Lake near Whitehorse.

The Little Arm phase is the earliest technological phase to be defined by Workman (1978) in southwestern Yukon. Microblades struck from tabular and wedge-shaped cores, a variety of burins, and an emphasis on large round-based points characterize this phase. The Little Arm phase is an early manifestation within southwestern Yukon related to the Paleoarctic tradition of the Western Subarctic (Clark 1991; Gotthardt 1990; Hare 1995; Workman 1978).

The Northern Archaic tradition is represented in southwestern Yukon by the Taye Lake phase. Microblade and burin technology are generally absent from this phase and it is at this time that notched points make their first appearance. Other tools include large bifaces, angular endscrapers, notched cobble net sinkers, stone wedges and boulder spalls (Workman, 1978). It is in this phase that camps become larger suggesting an established seasonal round (Workman, 1978).

The Aishihik phase, or the Late Prehistoric period, is represented by all archaeological material above the White River ash–dated ca. 1,260 BP–but lacking historic materials (Workman, 1978). Diminutive stemmed and notched points are abundant during this phase; however, its lack of abundance in preceding phases may be the result of preservation factors. The use of native copper for implements is also a hallmark of the Late Prehistoric period.

The last phase is the Bennett Lake phase, or protohistoric period, and is a continuation of the Aishihik phase accompanied by the introduction of historic trade goods (Workman, 1978). There is cultural continuation between the Taye Lake phase and the later phases, and some evidence suggests that there was cultural continuity from initial population of the area until present (Clark, 1978; Workman, 1978).

2.1.4 Ethnographic Baseline

The study area falls within the traditional area of the CAFN and the KFN. Both groups are Athapaskan and are Southern Tutchone speakers. Today the Slims River marks the transition zone between the two First Nations. It marks the northern border for the CAFN and the southern border for the KFN. McClellan (1975: 25-31) identifies four bands in the general area that would have used the study area at one time or another during the year: the Champagne Band; the Aishihik Band; the Kloo Lake Band, which constitute the CAFN; and, the Burwash Band or the KFN.

The names of the bands, as identified by McClellan, are associated with different geographical locations; however, their seasonal rounds brought them into the study area for trade, subsistence and social gatherings. For the bands constituting the CAFN Nesketaheen, Klukshu and Nuquik, located in the southwestern most territory of the CAFN traditional territory were important salmon fisheries. All bands hunted in the ridges by Kluane Lake for sheep and within the area in general for caribou (McClellan, 1975). The Aishihik Band used Tincup Lake, the Duke River and the Kluane River. The Burwash Band, who were only situated at Burwash Landing after 1904, used the area around Kluane Lake north to the White River Drainage. The Kluane River and its tributaries, such as Quill Creek at its confluence with the Kluane River, did provide KFN people with access to salmon from the Yukon River drainages.

The seasonal round for the inhabitants of the study area is typical for Northern Athapaskans. During the summer families would gather at rivers, streams and lakes to catch either salmon or fresh water fish. Important fresh water species include grayling, trout and whitefish. Fish were dried and cached in preparation for the winter months (McClellan, 1975: 97). During late summer, groups would then usually split into three or four families and move upland to hunt sheep, caribou, moose and ground squirrels. Surplus meat was dried and stored in caches. Berries also ripened during this time of the year and were picked and stored as well. During the winter, families would at first stay together at winter fish camps on principal fish lakes to fish and use up stored surpluses from the summer and fall caches (Ibid.). When stored food ran out, groups further split to hunt. It was not until late spring that families gathered again at summer fish camps to replenish the caches for the next long winter.

Each group used similar hunting techniques and technologies (McClellan, 1975, 1981). In the fall caribou moved between alpine areas and valleys. Fences were sometimes constructed to guide them for harvesting. Snares were not only used to catch caribou at fence intervals, but also aided for capturing game such as moose, sheep and goats along well used game trails. Waterfowl, beaver and other fur bearers were also captured by the use of the snare. Dead falls captured large game including the occasional bear (McClellan, 1981). In general, spears and bows and arrows were used for stalking game, and bunting tips were used to acquire smaller game and birds. The fishing technology used consisted of weirs, gaffs, leisters and nets.

2.1.5 European Settlement

The first significant European incursion into the Kluane area did not occur until 1891. At this time, American Lieutenant F. Schwatka and Charles Willard Hayes entered the area for a climbing expedition in the St. Elias Mountains, and journalist E. Glave and J. Dalton entered the general area over the traditional route used by the coastal Tlingits.

Permanent non-native settlement of the area began ca. 1903 with the onset of the Kluane Gold Rush and the establishment of a roadhouse at the site of Silver City by R. Lamb at the terminus of the Whitehorse-Kluane trail. After the fever of the Klondike Gold Rush subsided, independent prospectors began to seek other areas in the Yukon that were potentially rich in minerals. The Kluane region was one of these areas. In July of 1903, Skookum Jim and Dawson Charlie were prospecting in the region and made the first gold discovery at Forth of July Creek (Dobrowolsky, 1983; Stevenson, 1980: 2; Wright, n.d.: 117). Their discovery initiated the Kluane Gold Rush and shortly after 500-600 prospectors moved into the immediate area.

By March of 1904 there were more than 300 prospectors in the Kluane area, and over 2000 claims were reported. At the end of May of the same year there were over 1200 individuals reported to be in the region (Stevenson, 1980: 2). Several other gold bearing streams in Kluane were prospected during this time, and mining camps, such as Bullion, Sheep and Ruby camps, quickly arose near the Creeks.

As a result of the influx of miners and the rise of various mining camps in the Kluane area, the Territorial Government up-graded the Whitehorse-Kluane trail into a wagon road. The wagon road began in Whitehorse and terminated at Christmas Bay. Several roadhouses were established along this road. At the southern end of Kluane Lake, before turning east to Christmas Bay, the Wagon Road spurred to a rising settlement and transportation hub known as Kluane or Silver City. Goods to furnish the gold miners in the region were moved along this trail to Christmas Bay and Silver City, where they would then be off-loaded and taken to points along the shores of Kluane Lake such as the Jaquot trading post. In 1904, the Jaquot Brothers, Louis and Eugene, established a trading post at the spot now known as Burwash Landing. From Burwash Landing to the White River area, the Kluane-White River Trail, which began near Silver City crossing the Slims River at Sheep Creek, and running on the west side of Kluane Lake, was used to move goods as well. Mrs. Grace Chambers tells of First Nations using this trail for travelling, hunting and moving horses prior to the establishment of the Alaska Highway. (G. Chambers, Pers. Comm., 1999).

With the trail’s up-grade to a wagon road, Silver City became the distribution point for incoming goods destined to reach the miners on the creeks. In 1904 the North-West Mounted Police established a temporary post at the settlement. It became permanent with the construction of a new barracks and compound in 1905. Also in 1905, the Kluane area was designated a separate mining district and Lachlin Burwash, the mining inspector, established a Mining Recorder’s Office at Silver City. The small service settlement also had a post office, which was likely associated at first with the North-West Mounted Police or Royal North-West Mounted Police after 1905 since they were the ones who carried the mail into the region.

Despite the enthusiasm of the first year of the rush, the Kluane Gold Rush was short lived, lasting three years. Only 20,000 dollars worth of gold was taken out of the Kluane District in 1904, but successive finds in new streams kept the enthusiasm for gold high. This enthusiasm, however, only lasted a couple of years and the population of prospectors in the area had decreased from 1400 in 1904, to 40 in late 1906 (Stevenson, 1980). The area had a brief resurgence with the onset of the 1913 Chisana Gold Rush in Alaska that saw the extensive use of the Whitehorse-Kluane Wagon Road and the Kluane-White River trail.

The time between the Kluane Gold Rush and the building of the Alaska highway saw no significant non-First Nation settlement. Trapping, fur farming and outfitting, in which First Nations played a major role, were the main economic mainstays of the region.

The building of the Alaska Highway and the CANOL (for Canadian Oil) pipeline project, during World War II, were the next events that significantly changed the course of settlement and economic history of the area (EIS, 1977: 3.9-8). The United States Military Eighteenth Engineers Regiment oversaw the construction of the Alaska Highway from Whitehorse to White River. Six highway camps were located within the study area located near Kloo Lake, Sulphur Lake, Silver City, Slims River, near Horseshoe Bay, Destruction Bay, and near the Duke River (Ibid.). By the end of 1943, the all weather road was completed, with Canada taking over the road in April of 1946. This permanently opened the Kluane area for non-First Nation encroachment.

2.1.6 Summary

The above brief chronicle of the natural and human history of the general area provides a historical and chronological framework in which the material culture remains encountered during the survey can be placed. The following framework is used for the purposes of this study:

1) Prehistoric Period (+8,000 - 1700s)
    a) Paleoarctic or Little Arm Phase (+8,000 to 4,500 BP)
    b) Northern Archaic - Taye Lake Phase (4,500 - 1,260 BP)
    c) Late Prehistoric Period - Aishihik and Bennett Phases (1,260 BP contact).
2) Traditional Period (contact - present)
3) Historic Period (1890s to WWII)
    a) Exploration (1890s)
    b) Kluane Gold Rush (1903-1906)
    c) Later Historic - Game outfitting, trapping, fur farming (1906 to present)
    d) Building of the Alaska Highway, WWII (1940s-1950s).

2.2 METHODOLOGY

The investigations undertaken regarding the heritage resources of the study area consisted of three primary components. A background literature search was undertaken focussing on previous archaeological investigations carried out within the study area. Meetings were held with the CAFN and the KFN to determine their heritage priorities within the study area as well as their suggestions for potential elders to be interviewed for the traditional land used component. Consultations also were held with C&TS Transportation Engineering Branch to further refine realignment activities. YTG Heritage Branch was also consulted. The third component, the traditional land use and archaeological field investigations, were carried out in late May and August of 1999. The following discussion details the methodology carried out to arrive at the result presented within this section.

2.2.1 Background Research

The objective of the background research was to gain a thorough understanding of the archaeological resources and potential within the study area. Included in this research was a search of databases for archaeological sites, a review of the published literature on Kluane regional prehistory, archaeological resources and physical and natural history, which is summarized in Section 2.1. A review of the unpublished archaeological/ethnographical reports on the Kluane region was undertaken including previous Shakwak archaeological reports and a review of the topographical maps and air photos pertaining to the study area. This work was carried out prior to the field investigations.

A review was conducted of the archaeological site database held by YTG Heritage Branch. The search was done by Borden Block, and those sites within or in the vicinity of the study area were marked for potential revisits. Table 2-1 lists the 21 archaeological sites that are in the vicinity of the highway realignment. All but two of the sites were revisited and both sites not revisited were out of the new highway realignment.

The search of the archaeological database also pointed the way to the published and unpublished literature pertaining to investigations carried out within the study area. Johnson and Raup (1964) carried out the earliest archaeological survey within the study area shortly after the highway was constructed. During their survey they covered the segment that constitutes the study area relocating a number of prehistoric sites (see Table 2-1).

Table 2-1 Summary of Known Archaeological Sites and Sites Revisited during Investigations

Site	Location	Investigator	Revisited
JfVl-1	Jarvis River	Van Dyke	Yes
JfVl-2	Jarvis River	Van Dyke	Yes
JfVl-3	Sulphur Lake	Van Dyke	Yes
JfVo-10	Site located on a terrace overlooking an abandoned segment of the Alaska Highway leading to the settlement of Silver City.	Van Dyke	Yes
JgVp-2/JgVp-1	Horseshoe bay.	Van Dyke	Yes
JgVp-4	Goose Bay	Van Dyke	Yes
JgVp-3	Goose Bay	Van Dyke	Yes
JhVP-1	Dutch Harbour	Johnson	Yes
JhVq-3	Mouth of Rocks Creek	Johnson	No
JhVr-1 & 1a	On a high bluff edge north of the telephone right-of-way and also northern of MP 1085 of the Alaska Highway. Site located on the road leading to the borrow pit.	Van Dyke/MacNeish	Yes
JhVr-3	Copper Joe Creek	Van Dyke	Yes
JhVr-4	Mouth of Lewis Creek	Johnson	Yes
JiVr-1	1.5 km east of Burwash Landing, on a terrace above Kluane Lake, just west of a small cove formed by a stubby sand spit	Johnson	No
JiVs-3	Burwash Landing	Johnson/McNiesh	Yes
JiVr-3	Burwash Landing	Reeves	Yes
JiVs-4	Burwash Landing	Cairnes	Yes
JiVs-6	Burwash Landing	Johnson	Yes
JiVs-7	On ridge northwest of Burwash, north of the airstrip.	Johnson	Yes
JiVs-8	West of Burwash on road to airstrip, near junction of access road and Alaska Highway	Johnson	Yes
JiVs-9	South of Duke Meadows and west of Burwash Landing Airfield	Van Dyke	Yes
JiVs-0	Duke Meadows	Johnson & Raup	Yes

S. MacNeish (1964) was the next to carry out investigations in the general area. He did do some archaeological reconnaissance within the study area, but primarily focused on the east side of Kluane Lake. In 1977 B. Reeves conducted a Traditional and Archaeological survey as part of the environmental protection measures for the Shakwak Highway Improvement Project (Reeves, 1978). The section of the study area Reeves investigated started at the Jarvis River and ended at Burwash Landing. Reeves documented both traditional sites and known archaeological sites. S. Van Dyke (1979, 1980, 1981, 1982) surveyed the region during his investigations of sections of the Alaska Highway Pipeline Project during 1976 and 1977. Van Dyke relocated a number of previously unknown archaeological sites within the present study area where the pipeline right-of-way came close to the highway. Rounding out the studies directly related to the study area is the “Environmental Impact Statement: Shakwak Highway Improvement British Columbia and Yukon, Canada” (1979). This work provided valuable maps marking heritage sites along the segment of Alaska Highway under this current study.

Other documents relevant to the study include the “Greater Kluane Regional Land Use Plan” (1991), which provided place name information between Kloo Lake and Kluane Lake. As well, the Council for Yukon Indians commissioned a survey of extant First Nation structures and camps all along the Alaska Highway.

2.2.2 Stakeholder Consultations

Prior to entering the field, consultations with stakeholders were carried out. YTG C&TS Transportation Engineering Branch, the CAFN, the KFN and YTG Heritage Branch, Department of Archaeology, were met with in order to address their concerns regarding the investigations to take place.

Meetings with YTG C&TS Transportation Engineering Branch were held in March 1999. During these meetings, potential borrow pit and field camp locations were identified on air-photographs of the study area. Discussion also focused on the immediate impact zone where heritage sites would be adversely affected. As a result of the conversations held, it was determined that a 200 to 300 m right-of-way, 100-150 m on each side of the centre line, was adequate to ensure the protection of heritage resources from construction activities.

The archaeological field methodology and traditional land use methodology was discussed with Ms. Sara Gaunt and Ms. Diane Strand of the CAFN Heritage Office. CAFN expressed its interest in acquiring more documentation about traditional use of Kloo Lake, Silver City and the Slims River. Overall, the CAFN had no serious concerns regarding the methodology to be used and the proposed route of the realignment. Discussion by the CAFN field assistant also took place. A second half day was spent at CAFN Heritage offices conducting summary research of their files.

Ms. Geraldine Pope and Mr. Gerald Dickson were the principal contacts for the KFN. The same procedure followed that as with the CAFN. The KFN identified traditional trails as their priority as well as known traditional sites at Duke River and areas south of Sakiw Creek. Arrangements were made to hire a KFN field assistant as well as acquiring the services of Mrs. Agnes Johnson, a KFN elder, to aid with elder interviews.

Several discussions about the project and field methodology were held with YTG Heritage Branch Archaeologists Dr. Ruth Gotthardt and Greg Hare. They provided access to the Heritage Branch archaeological data base, archaeological site maps, their knowledge and experience with the archaeological and traditional resources in and around the study area, the Heritage legislation and other source materials.

The data gathered through the above sources provided baseline data on which to base the archaeological and traditional land use fieldwork and traditional interviews within the study area. Maps were created to use in the field including air-photographs.

2.2.3 Traditional Interviews

Six elders were interviewed during the investigations. The CAFN's traditional territory makes up approximately one-third of the study area with the KFN traditional territory the remaining two-thirds. Therefore, of the six interviewed, two were CAFN elders – Mr. Thomas Joe and Mrs. Bessie Allen–and four were KFN elders–Mrs. Grace Chambers, Mrs. Agnes Johnson, Mr. Peter Johnson and Mr. Edward Johnson.

Mr. Ron Chambers, Mr. James Allen and Mrs. Agnes Johnson assisted with the elder interviews. Prior to the interviews a list of questions were drawn up by the Access specialist team that were to act as a guide for acquiring traditional knowledge regarding their area of specialty. Furthermore, elders were asked to identify known sites of use and locations of old traditional camps. Three of the interviews were conducted while driving the segment of Alaska Highway under study, and the other three were carried out in Burwash with maps. Interviews were informal and ranged in length of time between one to three hours. All interviews were taped for transcription and summarization.

Three of the interviews were carried out prior to field investigations in May. The remaining three were carried out in August before three additional field days were carried out in order to investigate sites identified by the elders.

2.2.4 Traditional Land Use and Archaeological Fieldwork

The traditional land use and archaeological fieldwork was carried out concurrently between May 20th to May 31st, 1999. Three additional days of field investigations were conducted in late August and early September in order to close any remaining data gaps. The field crew consisted of the Access Project Archaeologist, an archaeological technician and two field assistants hired from the CAFN and the KFN.

Prior to entering the field, air photographs and topographical maps were studied to divide the study area into high, moderate and low potential areas. This was done based on the traditional land use and archaeological data, geomorphology and general geography of the study area. The results of the above compilation created a research design intended to get the best coverage of the realignment right-of-way.

The 125 km linear study is separated into four general areas and are as follows:

1. Section 1: Jarvis River to Kluane Lake;
2. Section 2: Kluane Lake shore;
3. Section 3: Burwash Landing to Duke River;
4. Section 4: Duke River to Quill Creek.

Areas where known traditional and archaeological sites were documented were automatically rated as high potential. Based on the previous coverage of the study area and the distribution of known traditional and archaeological sites, the four sections of the study area were deemed to have low to moderate archaeological potential except where lakes and streams crossed the realignment. These points, depending on the geomorphology, such as dry eskers, stream and lake terraces and ridges, were determined to have moderate to high potential. Stream crossings and lakes without terraces were considered medium and those with such features were considered to have high potential.

The field survey consisted of a thorough coverage of the immediate impact zone (100-150 m right-of-way on each side of the highway) of the realignment. In areas where the realignment deviated from view of the highway pedestrian survey took place. High potential areas within the study area were determined during the actual field survey.

Areas determined to have high archaeological potential were subjected to rigorous investigation. Transects were established at these areas and shovel testing, spaced 10-15m apart, was carried out with crew members spaced 5-15 m apart. Shovel testing was staggered by transect in a checker board-like fashion. Medium potential areas were covered by transects spaced 15-25 m apart with shovel testing occurring 15-25 m apart in a staggered fashion. In areas of low potential a cursory surface survey of the area was carried out, checking exposures, and shovel testing, if warranted, was judgmental.

All shovel tested areas were excavated with the aid of shovels and trowels. The resulting divots and back-dirt were sifted through ¼ in. mesh. Artifacts recovered were bagged according to the unit and stratum from which they came. Where stratigraphy was not clearly defined 5 cm vertical arbitrary levels were established. The stratigraphic profile for positive test units was documented with vertical measurements taken from the surface of the test pit. Once documentation was complete all shovel tests were back-filled.

New archaeological sites were given a field number (Stop No.) and its location was determined by a hand held GPS. A shovel testing program was implemented to determine the horizontal and vertical extent of the site and to recover a sample of material culture as an indicator of the nature of occupation and cultural affiliation. Documentation of the new site was carried out on pre-made site forms that included the natural and physical setting, access, vegetation, major body of water or drainage, elevation, soil matrix, number of cultural strata, features present and other remarks. A pace map was drawn and the site was then photographed. This data was sent to the Archaeological Survey of Canada for site Bordenization (site inventory logging).

In cases of new and revisited sites the site condition was documented. Sites were determined to be intact, have low disturbance, high disturbance or destroyed. Sites determined to have high disturbance were subjected to intensive exposure survey to collect any significant cultural material. The level of disturbance coupled with the types of artifacts retrieved were heavily weighted when decisions of whether or not further investigation of the site was considered.

2.3 RESULTS

The traditional land use and archaeological investigations resulted in the documentation of new sites and an assessment of previously known sites. All of the sites documented were placed within the three main categories as outlined in Section 2.1.5 as follows:

1) archaeological sites–prehistoric sites;
2) traditional sites; and,
3) historic sites–sites dating up to 1940s.

This section is primarily a description of the sites documented during the survey (see select photos in Appendix II-2 and select site maps in Appendix II-3). For convenience the sites are separated based on the categories in which they fall. Each category is discussed separately. Although the survey was conducted from north to south, Quill Creek to Jarvis River, they are presented from south to north. Figure 2-1 to 2-6, Volume II document archaeological sites and traditional use areas. Archaeological and traditional use site designations are denoted with “HR” (Heritage Resource) on the various heritage resources maps.

2.3.1 Archaeological Sites

JfVl-1 (Map 1, HR-5)

JfVl-1 is an archaeological site located on a vehicle trail north of the Alaska Highway and east of the Jarvis River. It is about 25-30 m west of a barbed wire fence. Van Dyke (1977) collected one obsidian scraper from a road cut and characterizes the site as an isolated find and that no further work was required. No artifacts were observed during site revisit. This site falls out of the realignment right-of-way.

JfVl-2 (Map 1, HR-2)

This archaeological site is situated on a rise west of the Jarvis River south of the Alaska Highway overlooking the remains of the old Alaska Highway Jarvis River Bridge. It skirts the north side of a former borrow pit and the old Alaska Highway road cut. Van Dyke (1977) collected one obsidian flake and characterizes it as an isolated find. At one time it was likely a larger site, however, extensive borrow pit use and construction of the original Alaska Highway has obliterated any traces.

No further archaeological remains were observed during the reconnaissance of this site. It is located in the right-of-way of the new realignment; however, no further investigations of this site are required.

JfVl-3 (Map 1, HR-10)

Debitage from stone tool manufacturing was collected by Van Dyke (1980) at JfVl-3. The site over looks a beaver pond at the southwest end of Sulphur Lake. The terrain is undulating with good exposures and is likely the location of a traditional fish trapping area (Reeves, 1979).

During the site revisit is was clear that the exposure from which Van Dyke recovered cultural material had slumped into the beaver pond. The area was surface surveyed and five shovel tests were excavated all proving negative. Therefore, it is determined that the lithic scatter was indeed an isolated find and no further work is required at this site.

Site 12 (Map 2, HR-12)

Site 12, which was designated Stop 51 during the fieldwork, is located 30 m west of the present day Alaska Highway and is in the realignment right-of-way. It is located on a terrace that skirts the northern west end of a unnamed lake that drains into Christmas Creek. Aspen, small white spruce, kinnikinick and grasses characterize the vegetation. The site is partially intact, having its top layer removed (humus/ash). There are intact cultural deposits within a red brunisol horizon.

Surface flakes were documented on the initial surface survey of the site. Flakes were confined to a small flattened rise in the terrace at the northwest end of the lake (lat. 61° 00’ 17.4”; long. 138° 12’ 01.8”; NTS Map 115G/F) and is approximately 20m x 20m. Surface flakes were used to determine site size in order to leave the site as intact as possible for future investigations. A total of six tests were carried out in order to demarcate the limits of the site. Cultural material in the form of lithic debitage and two stone tools were recovered on the surface and in the first 7-20 cm below the surface in the red brunisol.

Table 2-2 summarizes the collection recovered from the site. The material recovered appears to come from 7-15 cm below surface (BS). Ash was documented in other areas along the terrace above the red brunisol. Therefore the occupation of this site occurs below the ash, which makes the site older that 1,260 BP. A total of 26 lithic fragments were collected all appearing to originate from the same raw material.

Table 2-2 Summary of Artifacts Recovered from Site 12

Artifact Type	Unit No.	Depth BS	Size	Raw Material	Count
Complete Biface	TP-4	9-15cm	99.9mm Max. Length 60.9mm Max. Width 13.3mm Max. Thickness	Grey Chert	1
Flake	TP-4	7cm BS	30mm	Grey Chert	1
End Scraper Fragment	Surface	0cm	30.8mm Max. Width	Grey Chert	1
Utilized Flakes	Surface	0cm	20-70mm	Grey Chert	5
Biface Thinning flake	Surface	0cm	20-30mm	Grey Chert	1
Flake fragments	Surface	0cm	5mm-50mm	Grey Chert	14
Block shatter/core fragments	Surface	0cm	30-50mm	Grey Chert	3
Total					**26**

Flake attributes and size suggest that primary as well as tertiary lithic reduction activities were being carried out at the site. One *in situ* complete biface and one end scraper from the surface are included within the collection. The biface was likely discarded because of a manufacturing mistake and the end scraper is a distal fragment likely broken during manufacture. As a result of the remains collected it appears that the main activity occurring at the site was stone tool manufacture. The quality and quantity of the material remains so far collected warrant further investigation of this site. If the site is to be impacted mitigation is necessary.

Site 14 (Map 2, HR-14a)

Site 14 is a new site located on knoll forming part of an esker complex northeast of an active borrow pit on the Silver City access Road (old Alaska Highway) (lat. 61° 01' 31." long. 138° 19' 49.8"; NTS Map 115F). This site is located within the borders of a potential borrow pit. The site has a southwest exposure and the vegetation is characterized by sage, other grasses, kinnikinick, white spruce and aspen. The closest drainage is Silver Creek.

One small (<10 mm) black chert flake was collected 10 cm below surface in a red brunisol. Despite three additional shovel tests and extensive surface survey of the knoll, no other cultural material was collected. This is considered to be an isolated find and no further work is required.

JgVo-10 (Map 2, HR-14b)

JgVo-10 was first documented by Van Dyke (1978) and lies within the border of the potential Silver Creek borrow pit. Van Dyke recovered a moderate amount of lithic debitage and classified the site as a flake scatter. The site is located on a terrace overlooking an the access road to Silver City. The site is disturbed by the dirt road leading into Christmas Bay and Cultus.

The site was revisited and after extensive surface survey no cultural remains were documented. It appears that the upkeep of the road has destroyed much of the site and it is no longer a heritage concern.

JgVp-2 (Map 2 & 3, HR-23)

JgVp-2 is located within the realignment zone north of the present day Alaska Highway and on the north bank of an unnamed ephemeral creek flowing into Horseshoe Bay, Kluane Lake. The site provides a good view of the lake and was likely also used as a staging area for sheep hunting. Van Dyke (1977) collected a point fragment, a scraper and a number of flakes to first document the site. He also documented extensive disturbance of the site by a dirt road cut and old borrow pit activity.

During the site revisit the dirt road was surface surveyed. Three small (<10 mm) black obsidian flakes, one grey chert biface thinning flake and one large retouched obsidian flake were collected from the surface of the road. A reworked black obsidian lanceolate point-base was also collected. On the edge where the point was broken a notch was created, which was possibly used as a spoke shave for woodworking. A total of eight shovel tests on either side of the dirt road and spaced 5-10 m apart were excavated. None of the tests produced cultural material. The negative test results indicate that much of the site has been obliterated as a result of recent activity and no further work is warranted.

A small green chert flake was collected in disturbed deposits on Jackson Point that forms Horseshoe Bay. Much of Jackson Point has been disturbed by recent activity, not appearing to be highway maintenance related, and it is likely a continuation of JgVp-2. Most of the original deposits have been disturbed, probably from recreational activities resulting in the destruction of this locality of the site as well.

JgVp-3 & 4 (Map 4, HR-27, 28)

JgVp-3 and 4 are located on the terrace edge of Goose Bay, Kluane Lake. Both sites were first identified by Van Dyke in 1977 and classified as isolated prehistoric lithic scatter. The terrace that the sites are found on continues in a northeast fashion up into the mountains. This likely was a traditional access route to the mountains for sheep and caribou hunting in the mountain passes.

Road cut and exposure survey was conducted for JgVp-4 but no cultural material was observed. It appears that previous highway activities have erased the remains of the site that Van Dyke observed. This former site is in the southern margins of the right-of-way; however no further work is required.

JgVp-3 (HR-27) over looks Goose Bay and was considered to have high archaeological potential. A total of 11 test pits were excavated east of the centre-line stake to a depth of 80-100 cm. Three of the eleven test pits produced lithic debitage at a depth of 80-100 cm below the surface. In addition, a possible hearth was identified in Test Pit 5. It appears that the main concentration of activity encompasses an area of 20x10 m, 30 m east of the staked centre-line. Furthermore, a number of flakes were collected from exposures on the north side of the Alaska Highway where it crests the terrace. As well, a scraper and a fragment of chert shatter was collected at the north end of Goose Bay likely representing the same site.

The general stratigraphy of the site is as follows: 0-6 cm BS humus; 6-14 cm A horizon; 14-16 cm BS White River Ash; 17-73 cm beige aeolian silts; 73-75 cm buried organic; 75-92 cm red B horizon; 92+ cm yellow silt. It appears that the occupation of the site is associated with the red B horizon, which is below the White River Ash dated at 1,260 BP. The amount of lithic debitage (Table 2-3) coupled with the identification of a possible hearth suggests that the occupation may be significant and relatively rich. Therefore, if the site cannot be avoided mitigation will be required.

JhVp-3 (Map 4, HR-29)

JhVp-3 is located on the same terrace as JgVp-3 and JgVp-4. Johnson and Raup first identified the site during their investigations in the 1940s.

Table 2-3 Summary of Artifacts Recovered from JgVp-3

Test Pit No.	Artifact Type	Raw Material	Depth BS	Count
4	Flakes	Chert	70-80cm	2
5	Flakes	Basalt, chert, jasper	80-90cm	23
8	Flakes	Chert, jasper	85-95cm	11
North end of Goose Bay	Scraper and core fragment	Chert	Surface exposure	2
North of Alaska Highway	Flakes	Jasper	Surface Exposure	18
Total				**56**

This site has been revisited and tested by several researchers up until 1977 with the interpretation that this site functioned primarily as a hunting locale.

During the 1999 site revisit no evidence of previous archaeological work was documented. However, it appears that this area has significantly been altered by recent activities. The conclusion drawn is that these activities have erased the remaining traces of the site. Further up the ridge (100m to the northwest) bulldozer trenches through the ridge offered numerous exposures to observe any eroding cultural material. None was observed. Two shovel tests were excavated, approximately 120m northwest of JhVp-3 with one flake recovered 20 cm BS and 13 cm below ash in a red B horizon. This is likely a continuation of JhVp-3 and is not in the highway realignment right-of-way.

JhVp-1 (Map 4, HR-30)

JhVp-1 is located on the west bluff bordering Dutch Harbour. Van Dyke identified the site in 1977 and collected a projectile point fragment, biface, one scraper, a cleaver and a variety of flakes. Van Dyke during an Arctic Institute Northern Field School further tested the site. A brief stop was made and a survey of the dirt road that borders the bluff was conducted. Cultural material in the form of flakes and fire cracked rock were observed but not collected. This site is well out of the proposed highway realignment.

Mines Creek Site (Map 4, HR-31)

This is a small sub-surface lithic scatter first identified during the 1999 field investigations. The site is located on the north side of the highway on the west, north-south running terrace of Mines Creek (lat. 61° 12’ 51”; long. 138° 42’ 20.4”, NTS Map 115G/2). The vegetation is characterized by an open white spruce forest with aspen and an understory of grasses, kinnikinick and wild rose. The site is outside of the proposed realignment; however, Mines Creek is presently a borrow pit and is a potential borrow pit location for the project.

Initially the bank was determined to be of low to moderate potential. A total of five shovel tests were conducted along the bank. The first test was carried out at the northern terminus of the terrace. The remaining four centred around Test pit 2, which produced two small (<10 mm) red jasper flakes 10-20 cm below the surface. Although the site is intact, no significant cultural material was collected and it is considered to be an isolated find. No further investigation of this site is warranted.

JhVr-1 & 1a (Map 4, HR-34)

A brief stop was made at JhVr-1 & 1a, which are the same site, and located on a high bluff north of the telephone right-of-way near the shores of Kluane Lake at the mouth of Bock's Brook. The site was first identified by Johnson and was revisited by Van Dyke. Van Dyke collected two beveled flakes and two bifaces. This site is disturbed by a former borrow pit and is in the process of severe erosion by wind. Flakes were observed in several exposures but were not collected. This site is located well outside of the highway realignment and potential borrow pit activity.

JhVr-4 (Map 5, HR-35)

This site is located on a northwest terrace at the point were Lewis Creek empties into Kluane Lake. D. Davidge (ASC Archives MS. 2160) first documented the site in 1982 with a revisit in 1983. Davidge collected a number of flakes and the site was recommended for further investigation by J. Hunston (Heritage Branch Archaeological Sites Database).

During the stop at this site it was observed that the site is beginning to be heavily eroded by wind action and could possibly come to the same demise as JhVr-1. A biface preform and 11 large grey chert flakes were collected from the numerous exposures created by the wind. The site is out of the highway realignment and will not be impacted during construction. The site, however, does need to be tested immediately before the intact deposits are destroyed. Heritage Branch officials were notified of the site's condition.

JhVr-3 (Map 5, HR-37)

JhVr-3 was not relocated but is described as located on the south end of a high bluff between the edge and the highway road cut overlooking Copper Joe Creek. Its described location places it within the realignment right-of-way. In 1980 Van Dyke excavated a 1x1 m unit and several shovel tests. As a result, he recovered 10-12 flakes and a biface fragment.

There are at four channels of Copper Joe Creek that cross the highway and each was inspected thoroughly for traces of archaeological remains. At each of the channels there has been recent bulldozer activity 30-40m west of the highway. This recent activity has destroyed the last remains of JhVr-3 thereby making it no longer a heritage concern.

JiVr-2, JiVs-3, JiVr-3, JiVs-5, JiVs-4, JiVs-7 (Map 5, HR-40a, 40b, 40c, 40d, 40e, 40f)

These six archaeological sites fall within the Burwash Landing area and are out of the highway realignment zone. An attempt was made to relocate the six sites with varying degrees of success. No surface collecting was carried out at the sites. Their concentration and distribution suggests that in the distant past the Burwash Landing area was an important First Nation locality likely seeing reoccupation over the millennia.

JiVs-8 (Map 5, HR-41)

JiVs-8 is located approximately 1.5 km west of Burwash Landing on an old road leading to the Burwash airstrip and is in the realignment right-of-way. The site was first documented by Johnson and Raup in the 1940s. A number of hours were spent attempting to relocate this site to no avail. From the present Alaska Highway north to the old airstrip road, historic bulldozer trenches and surface scraping are evident and have disturbed much of the original deposits. No remains of the site were observed.

Site 48 (Map 6, HR-48)

Site 48, which had the field designation of Stop 13, is a newly documented archaeological site. The site is located on top of an east-west running terrace over looking an old dried creek bed, on the north side of the Alaska Highway (lat. 61° 28’ 28”, long. 139° 14’ 12”; NTS Map 115G/6). A small dirt road exits from the highway and ends 100m south of the site. The site’s vegetation is characterized by open stands of aspen grading northward into white spruce, with various grasses and kinnikinick. Recent camps are evident on the terrace.

The site is intact with no disturbance. Two test pits were excavated along the terrace edge at its west end. This spot provides a commanding southwest view of the area. Test pit 1 produced a small (<10 mm) grey, chert flake 25-35 cm BS and 0-10 cm below ash. A total of 116 grey chert flakes were collected from Test pit 2. Sixty-two flakes were collected between 30-35 cm BS and 15-20 cm BA and 54 were collected from 45-50 cm BS and 15-20 cm BA. All flakes recovered were within a red B horizon directly below the ash.

The general stratigraphy of the site is as follows: 0-10 cm BS humus; 10-20 cm BS Ae horizon; 20-25 cm BS ash; 25-60 cm BS red B horizon; and, +60 cm BS sterile grey silts. All of the material is small (<30 mm) lithic debitage as a result of stone tool maintenance and appears to come from a single occupation between 5-20 cm BA.

The material remains are in a high enough quantity to warrant further investigation such as excavation and intensive shovel testing. The site is likely confined to the western end of the terrace in an area 10x20 m. Site 48 falls just outside of the boundaries of a potential borrow pit location. If there is planned development of this potential borrow source, mitigation measures would need to be undertaken to protect the site. Of note is that the KFN objects to any development within this area since it is identified as an important traditional and present hunting area for the First Nation.

Site 49 (Map 6, HR-49)

Site 49 is located approximately 100m northwest of Site 48. It is situated on a flat, narrow knoll on the north side of the present day Alaska Highway and overlooks a small pond (lat. 61° 28' 19.8", long. 139° 14' 28.2", NTS Map 115 G/6). Vegetation of the site consists of open white spruce with aspen with an understory of kinnikinick, wild rose and grasses. The site provides a good view of the Kluane ranges, the pond and the valley bottom. It was likely most suitable as a hunting lookout.

Two tests were carried out and two flakes were recovered. The flakes were documented in test pit one 15-20 cm BS and 0-10 cm BA in a red B horizon. The general stratigraphy is as follows: 0-5 cm BS humus; 5-8 cm BS ash; 8-18 cm BS red B horizon, and +20 cm yellow sandy silt C horizon. The protruding knoll top is approximately 10x10 m. The remains, which appear to be outside of potential borrow pit activity, likely represent an isolated lithic scatter and no further investigations are warranted.

Site 49 is located west of the same potential borrow pit as Site 48.. At the base of the knoll is evidence of recent camps using log poles. The KFN objects to development in this area, identifying it as a recent and traditional hunting area.

Site 51 (Map 6, HR-51)

Derek Johnson, who was the KFN field assistant, identified this site as a camp site that his mother used to frequent. The site borders the north margins of a potential field camp and old borrow pit on the north side of the Alaska overlooking an unnamed creek that flows into Sakiw Creek (lat. 61° 29' 34.8", long. 139° 16' 41.4", NTS Map 115G/6). A dirt road leads into the site from the northeast corner of the old borrow pit. White spruce, grasses and moss characterize site vegetation.

A total of seven test pits were excavated at this site. As a result two black obsidian flakes, one green obsidian retouched flake fragment and one long bone fragment were recovered. These remains were collected from Test pit 4 and 3 which are located on the southern margins of the recent camp.

The deposits consist of a mottled silt matrix with evidence of frost heaving. The general stratigraphy is as follows: 0-5 cm BS humus; 5-10 cm BS Ae horizon; 10-20 cm BS ash (ash appears to represent the north and south lobes of the White River Ash fall). 20-20 cm BS organic layer; 20-28 cm BS mottled silts; and, +63 cm BS sterile silt with pebbles. It appears that the mottled silt layer is the culture bearing level at this site, except for those recent remains documented within the humus.

Much of the prehistoric component of the site has been destroyed by the previous borrow pit activity; however, there is a small area (10x10m) of intact pre-ash deposits. This area will likely not be affected by field camp activities, but sub surface disturbance should be avoided.

Site 56 (Map 6, HR-56)

Site 56 is located on a prominent southwest facing knoll on the west side of the Alaska Highway 70-80m south of the staked highway realignment centre line. It provides a commanding southwest view and over looks an unnamed creek that drains into Sakiw Creek. Site 51 is visible from this site (lat. 61° 29' 31.8", long. 139° 17' 06.6"; NTS Map 115 G/6). The site is situated in an open white spruce forest with stands of aspen with open areas covered by kinnikinick, sage and other grasses.

A total of five shovel tests were excavated on this knoll within a 15x15m area. A hearth was documented just under the surface and contained burned bone and fire cracked rock and is assigned to the late prehistoric period. The hearth was exposed by removal of the surface humic layer. No lithic or other cultural material was documented in association with the hearth. Test pits 1, 2, and 3 yielded sub-surface pre-ash lithic material indicating at least one other occupation of the site. The test pits were spaced 5m apart and bordered the south and west edges of the knoll. One red jasper flake and one grey chert shatter fragment was collected from Test pit 1 0-10 cm BS in a red B horizon. One small flake (<10 mm) was recovered in the screen from Test pit 2. It likely came from 0-28 cm BS. The fourth flake collected was recovered from 14 cm BA or 30 cm BS within the tan silts of Test pit 3.

The stratigraphy of the site is as follows: 0-2 cm BS littermat; 2-9 cm BS Ae horizon; 9-20 cm BS ash (the ash likely represents the north and south lobes of the White River Ash fall); 20-48 cm B horizon with tan silt lensing; 48-56 cm tan silts; 56-60 cm BS tan silts with pebbles; and, +56 cm sterile grey silt with cobbles. The vertical distribution of artifacts indicates that there are at least two different First Nation occupations of the knoll, which were likely related to using the spot as a hunting lookout.

The site falls within the southern margins of the highway realignment right-of-way. Highway realignment construction would likely disturb this site thereby necessitating mitigation measures.

2.3.2 Traditional Land Use

Traditional land use has been relatively well documented within the general study area. The CAFN and the KFN used and continue to use the area for traditional activities such as subsistence, trade and recreation. The two First Nations identified locales of importance most of which fall out of the new highway realignment right-of-way. Over the course of the interviews, elders shared their knowledge of the area indicating important subsistence locales and information relating to the early history of the area. This section provides a discussion of the general use of the area based on the study area divisions through the description of identified traditional land use sites and sites documented in the field. First Nations' place names are used wherever possible. The source of the data on place names used here comes from the "Greater Kluane Land Use Plan".).

Champagne and Aishihik First Nations Place Names

English Name	CAFN Name
Jarvis River	Tsigra Chua
Kluane Hills	Tthe Shaw A’an
Kluane Lake	Lu’an Man
Christmas Bay	Aghatth’an
Christmas Creek	Aghatth’an Chua
Sulphur Lake	Kwat’aw Man
Kloo Lake	K’ua Man
Hungry Lake	Aghatth’an Man
Silver Creek	Man Cheti’aya Chu

Note: Data obtained from: Kluane Land Use Plan

Traditional Trails

Maps of traditional trails were provided by the CAFN and the KFN and were identified as important heritage resources for the First Nations. The KFN specifically identified trails as important tangible monuments of their heritage. As with the old highway, the new realignment does intersect with traditional travel and trade routes, routes that are, at times, still used by the First Nations. None of the realignment activities will impact the entirety of a trail; rather, small segments of trails will be impacted during construction activities.

The highway realignment as it pertains to this study begins at the Jarvis River. At the Jarvis River (Tsigra Chuà–Little ochre mountain) several trails intersect, likely because of the important traditional village of Kloo Lake (K’ua Män–a place where you set a fish trap). From K’ua Män trails diverge. Trails continue from this point to Kluane Lake (Lu’àn Män–the fish place lake) to its eastern and western shores. As well, a trail continues up the Tsigra Chuà. This trail was used not only to access hunting and gathering locales but also to access a source of obsidian for stone tool manufacture and trade (Ron Chambers, Pers. Comm., 1999).

The trail leading to the western shores of Lu’àn Män diverges near the mouth of Silver Creek (Män Chèti’ aya Chu–where the lake branches off). The trail essentially splits in two, one trail continues on the Slims River and the other moves north to Christmas Bay (Äghàtth'an–shoulder blade bone) and points northeast. At the Slims River the trail follows the old Alaska Highway where at Sheep Creek Mrs. Grace Chambers and Mrs. Bessie Allen identify a raft crossing point. Once across the Slims the trail diverges into several trails leading up the Slims and into the mountains passes, likely accessing sheep and caribou hunting locales. The major trail continues northeast along the shores of Lu'àn Män. Just before Horseshoe Bay a tributary trail runs up an old creek bed to a sheep hunting locale (Gerald Dickson, Pers. Comm., 1999). The major trail continues on along the shoreline until the area of Burwash Landing where it diverges into two trails. One pathway continues along the shoreline to the Kluane River and Brooks Arm. The second trail continues northeast from Burwash Landing to Duke Meadows, which was and is an important traditional spot for the KFN. At Duke Meadows a traditional trail runs along the Duke River from the Kluane Ranges to where Lu'àn Män is drained by the Kluane River. Other intersecting trails like the Duke River trail occur at Burwash Creek and Quill Creek. The trail from Burwash Landing to the Duke River continues northwest to the Donjek River, which is out of the study area.

Although not identified by the maps, it is more than likely the several ephemeral streams entering into Lu'àn Män were used as trails to access the sheep and caribou hunting grounds in the highlands of the Kluane Range.

Tsigra Chuà to the Slims River Crossing: Subsistence Areas

This section of the highway falls within the traditional territory of the CAFN. KFN elders, however, indicated that they used this area as well, although not extensively. Along this stretch of highway there are numerous small to medium sized lakes, dry and sedge meadow areas. A number of specific hunting and gathering locales, which are identified on Maps 1 and 2 (Figures 2-1 and 2-2, Volume II), were identified by the elders interviewed.

Between Tsigra Chuà and the Slims River crossing there are a number of general subsistence locales. Tsigra Chuà is identified as a good grayling fishing spot as was Christmas Creek (Äghàtth'an Chuà – Shoulderblade bone creek).

Sulphur Lake (Kwät'äw Män–Lilly Pad Lake) was frequented in the spring and fall where muskrats, swans, ducks as well as pike were harvested. Mr. Thomas Joe stated that there were traditional camps located where the lake drains and where it is fed. From the Kwät’äw Män and K’ua Män camps, caribou were harvested in the Kluane Hills (Shäw A’an–Big rocks place) and blue berries picked in the wetter areas between Kwät’äw Män and Hungry Lake (Äghàtth’an Män–the shoulder blade bone lake).

Äghàtth’an Män and Äghàtth’an Chuà was identified by Mr. Thomas Joe, Mrs. Grace Chambers and Mrs. Bessie Allen as a good moose hunting area. The terrain is undulating characterized by willow and black spruce and sedge meadows.

Reeves (1978) identified the esker complex to the east of the mouth of Män Chèti’ aya Chu as a traditional gopher hunting area. It is more than likely that other game was taken from this area as well.

Traditional grayling and white fish fishing has been identified where the Slims River empties into Lu’àn Män. Mrs. Chambers stated that fish were exploited here during the spring and fall at times of spawning.

Tsigra Chuà to the Slims River Crossing: Traditional Sites

K’ua Män (Kloo Lake) (Map 1)

The remains of a traditional village and graveyard on the western shore of K’ua Män has been identified as a important location of the CAFN. This spot was the home for the Kloo Lake Band as identified by McClellan (1975) and six extant cabins remain. Unfortunately, no specific information was provided by the elders about this important traditional spot. The village falls out of the highway realignment, however, the CAFN has concerns that the realignment might make access to this important spot easier for outsiders (see discussion in Section 3.0, Current Land Use, for proposed treatment of this access road).

Tsigra Chuà (Jarvis River) Traditional Camping Area (Map 1, HR-4)

Mrs. Bessie Allen identified the rise on the south side of the Alaska Highway overlooking Tsigra Chuà as a brush camp locality. This is in the same location as JfVl-2. None of the researchers that had previously visited the site, including a revisit during the 1999 investigations, documented remains of brush shelters. It is likely that previous highway construction and borrow pit activity have erased the remains of this traditional spot.

Tsigra Chuà (Jarvis River) Cabins (Map 1, HR-6)

These cabins will not be disturbed by realignment activities, and are currently occupied.

Mr. Isaac Moose's Cabin (Map 1, HR-7)

Two extant cabins and a collapsed corral are located north of the present day Alaska Highway at the beginning of the dirt road access to Kloo Lake. These were once the secondary residences of Mr. Isaac Moose and Mrs. Kitty Joe. The north margins of the highway realignment are within 50m of these former residences.

Kwät'äw Män (Sulphur Lake) Hunting and Fish Camp (Map 1, HR-9,8,11)

The south end of Kwät'äw Män has been identified as a traditional hunting and fishing spot. Reeves (1978) documented historic evidence of Mr. Isaac Moose's camp (HR-9). Mr. Moose used this camp during the summer prior to and after construction of the highway for trapping and to hunt moose and caribou in the Shäw A'an (Kluane Hills). Remains, although scattered and heavily disturbed, are present in the form of historic debris and wooden tent pole fragments. This site is located in a brushy area at the west end of the Kwät'äw Män road turn around. This area is out of the highway realignment right-of-way.

No remains were identified in the location where Reeves (1978) identified the Kwät'äw Män fishing camp and trap (HR-8,11). This was an important spot for the Kloo Lake people for pike fishing in the spring (Reeves, 1978: 72).

Jack Allen's Hunting Camp (Map 1, HR-13)

Mr. Jack Allen primarily used this camp in the summer and fall to hunt moose and caribou in the Shäw A'an. During the late 1970s this camp consisted of a small trailer, drying racks, tables and benches. It was used by other CAFN member as well. Recent vandalism has occurred at the site and very little remains of it. This camp is not in the realignment right-of-way.

Män Chèti' aya (Silver Creek) Chu Fishing Area (Map 2HR-15)

The mouth of Män Chèti' aya Chu has been identified as a traditional fishing spot. Grayling were the primary species identified as being caught in this locality (Kluane First Nation, n.d.). Other species such as whitefish, suckers and some trout were netted there as well. No physical evidence of the past fishing activities were documented at the mouth of Män Chèti' aya Chu. This site falls outside of the borders of the potential borrow pit and realignment activities.

Slims River Crossing (Map 3 HR-17, 18)

The raft crossing and associate brush camp were not revisited during the 1999 investigations because no development is proposed for this area. Mrs. Bessie Allen identified the general location of brush camp remains (HR-17), which should be further investigated to identify the precise location.

All elders interviewed identified the raft crossing (HR-18) which is just south of where Sheep Creek empties into the Slims River. Like the brush camp locale this area warrants further investigation to identify traditional and possibly prehistoric cultural remains in the area. Unfortunately, such investigations are beyond the scope of this study.

Lu'àn Män (Kluane Lake shore): Subsistence Areas

For the purposes of this study, the Lu'àn Män shorelines begins at the Slims River and ends at Burwash Landing. Elders identified the Kluane Range hillside facing Lu'àn Män and the highland valleys on the other side (to the west) as sheep and caribou hunting grounds. These grounds were identified beginning in the Sheep Mountain area continuing along the slopes of the Kluane Range past Quill Creek.

Along the lakeshore, several good fishing localities were identified. They are as follows: Horseshoe Bay, Goose Bay, Dutch Harbour, the mouth of Bocks Brook, Destruction Bay, the mouth of Lewis Creek, the mouth of Copper Joe Creek and Burwash Landing. Elders identified that the principal technology used to cull fish was with fish nets and that these locales were used in the spring and summer. Important subsistence species identified include white fish, trout and grayling. Of note, is that KFN elders identified these locales as secondary to those camps on the Brooks and Little Arm of Lu'àn Män and camps along the Kluane River.

Lu'àn Män (Kluane Lake shore): Traditional Sites

Brush Camp Locality (Map 3, HR-22)

Gerald Dickson identified brush camp locations on a traditional trail running into the Kluane Ranges south of Horseshoe Bay. During the survey the highway realignment right-of-way in this area the brush shelters were not relocated. It is likely that they occur higher up from the realignment out of danger from impact during construction activities.

Congdon Creek Cache (Map 3, HR-24)

Remains of what appear to be a collapsed cache are located on the west side of the Alaska Highway on the north side of Congdon Creek. It is unknown whether or not the cache represents traditional or non-First Nation use. The cache could be associated with the prospector's shed 60m to the north on the west side of the highway. The area directly around the collapsed cache, which was constructed by notched poles, is heavily disturbed. Photographs were taken of the remains and no further investigations are required.

Goose Bay and Dutch Harbour (Map 4, HR-27 & 30)

Both locations were identified by elders as netting areas to capture a variety of fish. No recent remains relating to traditional activity were documented at Goose Bay. The shoreline of Goose Bay and the terrace were intensively surface surveyed for evidence of traditional activity.

Dutch Harbour did have evidence of recent human occupation over lying Late prehsitoric period cultural remains. Dutch Harbour is characterized as an excellent fishing location because it is well protected from the wind. Lake trout, suckers, pike, grayling and whitefish were and are netted from this harbour. Dutch Harbour will not be affected by the realignment activities.

Bocks Brook Traditional Fishing Spot (Map 4, HR-32)

The mouth of Bocks Brook was identified as a traditional fishing location. The site was identified by Mr. Ron Chambers on his traditional site maps. No other form of documentation of this site exists except that it is in the same location as JhVq-3. The site was not revisited and is well away from impacts from highway construction and borrow pit activity.

Lewis Creek Fish Camp (Map 5, HR-36)

Mrs. Grace Chambers and Mrs. Bessie Allen identified the mouth of Lewis Creek as a traditional fishing location. Nets are set in this area today (Kluane First Nation n.d.). A brief stop was made at this location, however, no cultural material was documented on the flats. No impact to this area will occur as a result of highway realignment and borrow pit activities.

Mouth of Copper Joe Creek Kluane Brotherhood Fish Camp (Map 5, HR-38)

This site was not revisited because in was well away from the highway realignment right-of-way and the potential borrow pit activities. A CYFN survey (ca. 1980s) documented a fish camp within the bay area where Copper Joe Creek enters the Kluane Lake. In addition to being a fish camp KFN people hunted gophers from this location between the Copper Joe and Mines Creek.

Burwash Landing to the Duke River: Subsistence Areas

The principal identified traditional subsistence area between Burwash Landing and the Duke River is the Duke Meadows area. Duke Meadows has been identified by the KFN as an important traditional location not only for subsistence activities but also as a gathering spot. Subsistence activities in Duke Meadows include trapping small mammals and gopher snaring. The west side of the Duke River (Map 6) is an identified moose hunting location near where it empties into the Kluane River.

Johnson and Raup (1964) and MacNeish (1964) documented a number of brush shelters at Duke Meadows and the general area has been given a Borden Number–JiVs-0. The brush shelters were not relocated during the survey. Other researchers have also attempted to relocate these shelters but with no success (Greg Hare, Pers. Comm., 1999). It is possibly that during a flooding episode of the Duke River the shelters were washed away.

A potential borrow pit was designated for the southwestern portion of the meadows. This area was surface surveyed and few historic remains were observed. Therefore, there are no identified specific traditional sites in the area, however, the KFN objects to borrow pit activity in the Duke Meadows area due to current land use and its historical significance to them.

Burwash Landing to the Duke River: Traditional Sites

Sam Johnson's Hunting and Trapping Cabin (Map 5, HR-42)

One specific traditional site was identified between Burwash Landing and the Duke River. This camp, which was a permanent residence until recently, is still used by the Johnson family. It is located 400m east of the present day Alaska Highway on the south side of the Duke River. This area will not be impact by highway realignment activities.

Duke River to Quill Creek: Subsistence Areas

A number of locations were identified by the elders as traditional hunting and gathering areas, which are still used today. Elders clearly identified the Kluane River as an important resource area where hunting occurred as well as some chum salmon fishing. The area identified as chum salmon fishing spot was the mouth of Quill Creek. A second important fishing creek identified was Sakiw Creek and it was principally used for grayling.

The primary hunting area identified in this section is the area north of the highway in the Burwash Flats area. Wet meadows, small ponds and pothole lakes characterize this area. This is documented as a moose hunting area. Recent camp remains were documented in the vicinity of Site 48 and Site 49 but no remains that could be confidently be assigned to the period prior to the highway were observed. The KFN have identified this area as a hunting location and object to any borrow pit development in the vicinity. This hunting area as identified by the KFN and elders is well north of the highway realignment right-of-way and will not be impacted during construction activities.

Further west of the present day Alaska Highway is the Burwash uplands. This area was identified as a prime sheep, caribou and moose hunting locality. As well, Mrs. Grace Chambers and Mrs. Agnes Johnson tell of travelling up (west) Quill Creek to hunt gophers and pick berries (blue berries).

Duke River to Quill Creek: Traditional Sites

Sam Johnson's Cabin (Map 6, HR-44)

This site is located east of the Alaska Highway on Burwash Creek. Access is a dirt road exiting the highway at an old borrow pit location. This area was cleared by the U.S. army for a construction camp and once dismantled and abandoned Mr. Sam Johnson established his residence, with two more recent framed structures added latter. Mrs. Agnes Johnson states that Sam Johnson moved his small log cabin from a location on Quill Creek to this spot after the highway was constructed. This site is currently used by the Johnson family and is out of realignment and potential borrow pit activities. There is silt build up from recent flooding of Burwash Creek and there is a need to ensure that flooding is not exacerbated by development activities in the area.

Quill Creek Fish Camp (Map 6, HR-57)

Mrs. Grace Chambers identified a fish camp located at the mouth of Quill Creek. Mrs. Chambers stated that she fished there in the past for chum (dog) salmon, however, because of the large beaver dam recently constructed down river, fishing was no longer as good along this stretch of the Kluane River. She also indicated that moose were culled from this area. The site was not visited during the investigations and is well away from development activities.

2.3.3 Historic Heritage Resources

The historic or Non-First Nation resources in the area principally relate to the construction of the Alaska Highway, the Kluane Gold Rush and the period in between. Previous studies especially the EIS located, on maps, the construction camps related to the Alaska Highway and CANOL project (Figures 2-1 to 2-6, Volume II). The following discussion pertains to only those sites within the highway realignment right-of-way for which physical material remains exist. It is likely that the majority of these camps have been obliterated as a result of highway construction and maintenance activities since the initial highway was built.

Jarvis River Alaska Highway Bridge (Map 1, HR-1)

A few standing log pillars extend out of the Jarvis River and are all that remain of the original Alaska Highway Bridge that crossed the river. The pilings are located approximately 250m south of the present day Alaska Highway and border the highway realignment right-of-way. The remaining pillars have been photographed and no further investigation needs to be carried out.

Kluane Wagon Road (Map 1, HR-3)

A portion of the Kluane Wagon Road, which was constructed in 1904, is evident on the south side of the Alaska Highway on a rise west of the Jarvis River. This area has been heavily disturbed by past borrow pit activity and highway construction. In other areas large segments of the Kluane Wagon road still exist and its route has been documented on a number of maps. Therefore, although it is in the realignment right-of-way no mitigation is required.

Silver City (Map 2, HR-16)

A number of extant log and balloon frame structures remain at Silver City, which was occupied more or less continually from 1903 to the end of the 1950s. These buildings are related to the Kluane Gold Rush and a U.S. Army highway construction camp. The site is out of the realignment and borrow pit activities; however, construction activities should take care not to exacerbate Silver Creeks meandering and flooding problems. Presently, Silver Creek is flooding and blanketing the site with silt in some areas and washing it away in others.

Further west of Silver City at the start of the access road are the scattered remains of U.S. Army debris as a result of training exercises. These remains are fragmented and widely disbursed and are not a heritage concern.

The Fisher Cabin (Map 2 & 3, HR-19)

Alexander Fisher, who was a resident of Silver City during the 1930s and 1940s, initially constructed this cabin. It is located at the base of Sheep Mountain and consists of a log cabin and out building. Much of the area in the immediate vicinity has been disturbed by highway activities. On a rise to the back of the cabin is Mr. Fisher’s grave marked by a white cross. Today the cabin is privately owned; however, it is not clear whether or not it is still occupied. This area should be avoided and mitigation measures will need to be taken if the site is to be impacted.

Small Shed Dwelling (Map 2 & 3, HR-21)

This small shed falls within the realignment right-of-way and will be impacted during construction activities. It is located south of Horseshoe Bay 60m west of the Alaska Highway skirting a former creek bed.

The shed or shack is constructed of logs and built into the side of the old stream bank. It is one room with a log pole bunk and the doorway faces Kluane Lake. It is approximately 2x2 m with three vertical posts on the east and west walls with two headers on the north and south walls supporting a shed log roof with sod. It is likely post 1940s, since part of a telephone post with chainsaw marks is situated in front of the cabin. Tar paper is tacked on the exterior of the walls likely to block the wind. Several tin cans surround the cabin and all are sanitary cans. There is no evidence of there ever being a stove so it is likely this cabin would have been occupied in the summer months.

The material remains observed suggest that the cabin post-dates the 1940s. The site has been photograph and except for its quaint construction and surroundings it is of little heritage value and not a heritage concern.

Prospectors Shed (Map 3 HR-25)

A shed roofed log structure was documented approximately 2.5 km northwest of Congdon Creek, 20m west of the Alaska Highway and lies 5m west of the staked centre-line. Extensive ground disturbance in the form of bulldozer push piles is evident in this area and it appears that the structure is not in its original location.

Mrs. Grace Chambers identified the shed as belonging to a German prospector prior to the construction of the Alaska Highway. The prospector was called “Soup-mix” by area locals because his real name, which is unknown, was too difficult to pronounce. Mrs. Chambers related the story of the prospector’s demise that was told to her by Silver City resident Mr. Morley Bones. One winter the prospector was quite ill and all alone so he tied a note calling for aid to his husky and set him loose. The husky arrived at Silver City sometime later, and half starved. Upon his arrival the residents of Silver City read the note and summoned a constable to go and check on the sick man. The constable arrived at Soup-mix’s cabin to find that he had succumbed to his disease and perished. Mrs. Chambers also states that the prospector was buried in the vicinity.

Extensive survey of the area in search of a grave was conducted but with no success. To the west of the structure there is evidence of extensive logging and scattered historic debris. Metal containers surrounding the shed are of the hole-in-top lead soldered variety. The tins observed were fruit and vegetable tins and such tins were most popular prior to 1906 (Rock 1983) suggesting the occupation of this structure is between 1906 and 1920.

The extant structure itself is small with an outside perimeter of 3x2 m. It has two poles inside the structure running its width spaced 30 cm apart. These poles are built into the walls of the structure and one pole is higher than the other. The structure does appear to have had a wood floor. A plank door leans against the structure and was secured to it with leather hinges. This structure likely represents an out building used by the prospector. No evidence of a main cabin was observed.

The site is extensively disturbed by past highway construction activity. Photographs have been taken of the structure showing the front and side elevations as well as the inside of the building. This data has been provided to Historic Sites Heritage Branch. The field documentation of this structure has successfully mitigated potential impacts and it is no longer a heritage concern.

Across the highway and to the east of the structure on the Kluane Lake beach are the remains of a dilapidated corral and scattered historic debris. Mrs. Chambers identifies the remains of the corral as belonging to Joe Jaquot. Also in this area are the remains of an old stove and chimney. The historic material in this area has already been significantly impacted and there are no heritage concerns in this area.

Survey Platform (Map 3, HR-26)

What has been identified as a highway survey platform is located on the Kluane shoreline between Williscroft and Congdon Creek. Its history and age is unknown, however, it may be associated with the Dominion Land Survey carried out in the early forties or with the surveying of the route for the Alaska Highway.

The site has little scientific value, however, it may be associated with the early surveying of the area and may have value for interpretive purposes. If at all possible it should not be destroyed.

Grave Marker (Map 5, HR-39)

Approximately 10m north of the present day Alaska Highway sits a recently placed grave marker situated approximately 11 km northwest of Destruction Bay. The marker itself is not historic, however, local residents state that it was erected in honour of a World War II pilot that crashed in Kluane Lake. The story has it that the downed pilot crawled out from the wreckage to this point and then died. There is no burial at this location. No mitigation measures are needed, however, some sort of recognition of this spot may be important to the persons whom erected the marker.

Alaska Highway Bridge Remains (Map 6, HR-43)

Log pilings and log bridge timbres of an old Alaska Highway bridge are located on the southern margins of an old Borrow pit 5 km south of Burwash Creek. The site is located outside of the southern margins of a potential construction field camp and borrow pit location. The bridge is in an extreme state of decay and is slowly being reclaimed by the natural surroundings. Since it is on the margins of this potential activity it will not be directly impacted as a result of the borrow pit activities. It is, however, in danger of scavenging by field camp occupants.

Collapsed Building Remains (Map 6, HR-43)

Two collapsed wooden structures are located 500m south of the Johnson’s Burwash Creek cabins on the west side of their access road. The collapsed structures consist of log, split log and timbered beams and both appear to be of balloon frame construction. The larger structure is rectangular with the approximate dimensions of 10x4m. A smaller square structure, 2x2m, lies 5m to the northwest. No other significant historic material is associated with these structures except for a variety of wire-drawn nails. It appears that the site has been previously salvaged by passersby.

It is likely that these remains are associated with the Pipeline or Alaska Highway construction projects. The structures border the north margins of the highway realignment right-of-way. They are beyond any sort of reconstruction and warrant no further investigation.

Jaquot Camp (Map 6, HR-46)

The intact remains of Joe Jaquot’s camp are located on the eastern side of the Alaska Highway approximately 4 km from where the highway crosses Burwash Creek. The camp is located near the highway realignment right-of-way and may be impacted as a result of the highway realignment.

Mrs. Grace Chambers, Mr. Peter Johnson, Mr. Edward Johnson and Mrs. Agnes Johnson all identified the remains as those of Joe Jaquot’s horse camp, which was built after the establishment of the Alaska Highway.

The camp encompasses an area of 200m north to south by 50m east to west. Approximately 25m east of the highway sits the main cabin, which is log with dog and saddle notched corners and fixed floor joists. The logs are numbered indicating that the cabin was dismantled at another location, likely Burwash Landing, and reconstructed at the site. Approximately 30m northeast of the cabin and across a small stream running through the camp is a horse stall with six stalls. A stack of building material is located 100m north of the cabin. Throughout the site is a variety of historic material some showing signs of reuse such as wooden crates readapted into horse packing crates. The exact timing of the construction of the camp is unknown at present except that it was constructed sometime after the highway.

The site is probably not going to be impacted; however, if it is to be impacted, then further investigation is warranted.

Cement Pad (Map 6, HR-47)

A rectangular cement pad and pilings are located approximately 500m south of the Jaquot Camp on the west side of the Alaska Highway. The remains may be associated with the CANOL Project or other recent. No other cultural material is associated with this site and it requires no further investigation.

Refuse Dump (Map 6, HR-50)

A relatively large refuse dump is located on the south side of the Alaska Highway where the highway crosses Sakiw Creek. Extensive push piles characterize this side (west side) of Sakiw Creek where the dump sits. It is likely that significant amounts of refuse are located in this vicinity buried in the overburden. Bottle and metal containers suggest that the site is post 1940s and may be associated with activities related to the Alaska Highway construction. However, this cannot be confidently determined at this time. The site is intensively disturbed and is not a heritage concern; however, there is a possibility of the existence of hazardous materials within the dump.

2.4 SUMMARY AND MITIGATION STRATEGIES

Over the course of the research and fieldwork carried out a wide variety of heritage resources were documented. Table 2-4 summarizes the sites documented during the research and fieldwork in the general study area. Table 2-5 provides the geo-reference database for the Heritage Resources sites.

The work carried out during this study identified 16 archaeological, traditional and historic locations where mitigation is required as a result of realignment, potential borrow pit and field camp localities. Mitigation measures are recommended for each of these sites if they cannot be feasibly avoided. Also included are additional sites that are close to the realignment right-of-way and must be recognized to ensure they are not accidentally impacted and those sites where mitigation is not required but would be of benefit.

2.4.1 Archaeological Sites

Site 12, HR-12

Site 12 is a newly documented site within the highway realignment where significant pre-ash archaeological remains were recorded. As result of its surface being graded down to the cultural layer it is in danger of erosion. The site is approximately 20x20m with cultural deposits between 5-20 cm below surface. The following mitigation strategy is recommended.

- *Light hand clearing of the site can proceed only if the site is not going to be avoided. The present vegetation does protect the site from heavy erosion.*

- *During clearing care should be taken to leave tree roots intact until the site has been properly mitigated.*

- *If the site is to be impacted archaeological site salvage is recommended. A minimum of 15m^2 should be excavated to accepted scientific standards. To excavate this amount it would take three individuals approximately five days.*

Table 2-4 Heritage Resource Sites and Mitigation Strategy

SHAKWAK HIGHWAY PROJECT - JARVIS RIVER TO QUILL CREEK -- TRADITIONAL LAND USE AND ARCHAEOLOGICAL SITES		SITE TYPE					SITE CONDITION			MITIGATION STRATEGY			
Map HR-No.	DESCRIPTION	HISTORIC	TRADITIONAL	PREHISTORIC	POST-ASH	PRE-ASH	INTACT	PARTIAL INTACT	DESTROYED	OUT OF IMPACT ZONE	AVOID	MITIGATION REQUIRED	NO MITIGATION REQUIRED
1	Jarvis River old Alaska Hwy Bridge	✓						✓					✓
2	JfVl-2			✓					✓				✓
3	Kluane Wagon Road Section	✓						✓					✓
4	Traditional camping area		✓						✓				✓
5	JfVl-1			✓						✓			
6	Jarvis River Cabins	✓	✓				✓			✓			
7	Mr. Isaac Moose Cabin	✓	✓				✓	✓		✓			
8	Sulphur Lake Fish Camp		✓						✓				✓
9	Sulphur Hunting/Trapping Camp (Mr. Moose)	✓	✓						✓	✓			
10	JfVl-3			✓					✓				✓
11	Fishing traps		✓						✓				✓
12	New Archaeological Site			✓		✓		✓			✓	✓	
13	Jack Allen’s Hunting Camp	✓	✓					✓		✓			

SHAKWAK HIGHWAY PROJECT - JARVIS RIVER TO QUILL CREEK -- TRADITIONAL LAND USE AND ARCHAEOLOGICAL SITES		SITE TYPE					SITE CONDITION			MITIGATION STRATEGY			
Map HR-No.	DESCRIPTION	HISTORIC	TRADITIONAL	PREHISTORIC	POST-ASH	PRE-ASH	INTACT	PARTIAL INTACT	DESTROYED	OUT OF IMPACT ZONE	AVOID	MITIGATION REQUIRED	NO MITIGATION REQUIRED
14a	New Archaeological Site (Silver Creek)			✓		✓	✓						✓
14b	JgVo-10			✓		✓			✓				✓
15	Traditional fishing area (Silver City)		✓						✓	✓			
16	Silver City	✓						✓		✓			
17	Brush camp location (Slims River)		✓							✓			
18	Traditional Crossing of the Slims		✓							✓			
19	Fisher (Fromme) Cabin and Grave	✓						✓			✓	✓	
21	Small Shed Cabin (Post 1940) (Stop 44)	✓					✓						✓
22	Brush camp locality (Near Horseshoe Bay)		✓							✓			
23	JgVp-2			✓					✓				✓
24	Congdon Creek Cache	✓	✓ ?						✓				✓
25	Prospector's shed	✓						✓					✓
26	Highway Survey Platform	✓					✓						✓
27	Goose Bay Site JgVp-3			✓		✓	✓					✓	
28	JgVp-4			✓		✓		✓		✓			
29	JhVp-3			✓		✓		✓					✓
30	JhVp-1 Dutch Harbour		✓	✓	✓	✓	✓			✓			
31	Mines Creek Site			✓		✓	✓						✓
32	Traditional Fishing spot (Bocks Brook)		✓							✓			
33	JhVq-3			✓						✓			

SHAKWAK HIGHWAY PROJECT - JARVIS RIVER TO QUILL CREEK -- TRADITIONAL LAND USE AND ARCHAEOLOGICAL SITES		SITE TYPE					SITE CONDITION			MITIGATION STRATEGY			
Map HR-No.	DESCRIPTION	HISTORIC	TRADITIONAL	PREHISTORIC	POST-ASH	PRE-ASH	INTACT	PARTIAL INTACT	DESTROYED	OUT OF IMPACT ZONE	AVOID	MITIGATION REQUIRED	NO MITIGATION REQUIRED
34	JhVr-1 & 1a			✓		✓		✓		✓			
35	JhVr-4			✓		✓		✓		✓			
36	Traditional Fishing Camp (Lewis Creek)	✓	✓				✓			✓			
37	JhVr-3 Copper Joe Creek			✓		✓			✓				✓
38	“KTB Fish Camp”	✓	✓					✓		✓			
39	Grave Marker	✓					✓						✓
40	(a)JiVr-2, (b)JiVs-4, (c)JiVs-7, (d)JiVr-3, (e)JiVr-1, (f)JiVs-6, (g)JiVs-3			✓				✓	✓	✓			
41	JiVs-8 (Stop 18)			✓		✓			✓				✓
42	Sam Johnson’s Hunting/Residence Cabin	✓	✓				✓	✓		✓			
43	Alaska Highway Bridge (old)	✓						✓			✓	✓	
44	Johnson’s Cabin Burwash Creek	✓	✓				✓			✓			
45	Collapsed building remains	✓							✓				✓
46	Jaquot Camp (Stop 10)	✓	✓				✓				✓	✓	
47	Cement Building Pad (Stop 7)	✓						✓					✓
48	New Archaeological Site	✓	✓	✓		✓	✓					✓	
49	New Archaeological Site			✓		✓	✓						✓
50	Refuse Dump Sakiw Creek	✓							✓				✓
51	New Archaeological Site	✓	✓	✓		✓	✓				✓	✓	
56	New Archaeological Site			✓	✓	✓	✓					✓	
57	Fish camp mouth of Quill Creek	✓	✓							✓			

Table 2-5 Heritage Resources Geo-Reference Database

Basemap Reference Number	DESCRIPTION	UTM EASTING	UTM NORTHING	HIGHWAY CHAINAGE
HR 1	Jarvis River old Alaska Hwy Bridge	X=654935.6239	Y=6765097.6376	1664+500
HR 2	JfVl-2	X=662918.7874	Y=6759959.4671	1665+500
HR 3	Kluane Wagon Road Section	X=662761.3083	Y=6760005.5275	1665+000
HR 4	Traditional camping area	X=663135.4581	Y=6759754.6972	1665+300
HR 5	JfVl-1	X=667188.3635	Y=6758739.8443	1664+900
HR 6	Jarvis River Cabins	X=668086.6841	Y=6758559.5908	1665+100
HR 7	Mr. Isaac Moose Cabin	X=668266.8399	Y=6758550.2618	1666+600
HR 8	Sulphur Lake Fish Camp	X=667972.8187	Y=6758210.3303	1670+600
HR 9	Sulphur Hunting/Trapping Camp (Mr. Moose)	X=667792.0955	Y=6758234.6646	1670+300
HR 10	JfVl-3	X=668066.7181	Y=6758122.8517	1670+800
HR 11	Fishing traps	X=668507.8911	Y=6757741.3133	1670+600
HR 13	Jack Allen's Hunting Camp	X=667972.8187	Y=6758210.3303	1680+200
HR 12	New Archaeological Site	X=651358.0000	Y=6766560.0000	1684+200
HR 14a	New Archaeological Site (Silver Creek)	X=643853.0271	Y=6768934.7183	1692+000
HR 14b	JgVo-10	X=642247.0000	Y=6769422.0000	1693+600
HR 15	Traditional Fishing Area (Silver City)	X=640941.6089	Y=6769898.9462	1694+500
HR 16	Silver City	X=640830.8826	Y=6770016.1089	1694+600
HR 17	Brush Camp Locations	X=634291.6247	Y=6763298.9701	1701+500
HR 19	Fisher (Fromme) Cabin and Grave	X=634076.0000	Y=6767183.0000	1704+100
HR 21	Small Shed Cabin (Post 1940) (Stop 44)	X=634549.6580	Y=6770410.4290	1707+900
HR 22	Brush Camp locality (Near Horseshoe Bay)	X=634174.6580	Y=6770327.4290	1707+900
HR 23	JgVp-2	X=634461.9940	Y=6771795.1850	1709+200
HR 24	Congdon Creek Cache	X=631286.3436	Y=6782168.2813	1720+900
HR 25	Prospector's shed	X=631157.4058	Y=6782519.3319	1721+300
HR 26	Highway Survey Platform	X=631627.4870	Y=6777499.2812	1716+100
HR 27	Goose Bay Site JgVp-3	X=629836.1263	Y=6784137.3665	1723+400
HR 28	JgVp-4	X=629681.9455	Y=6783736.2310	1723+500
HR 29	JhVp-3	X=628321.9930	Y=6783705.4206	1725+000
HR 30	JhVp-1 Dutch Harbour	X=628112.1500	Y=6784952.1915	1726+300
HR 31	Mines Creek Site	X=623270.5195	Y=6788721.1498	1732+100
HR 32	Traditional Fishing spot (Bock's Brook)	X=621038.6062	Y=6791447.6545	1739+800
HR 33	JhVq-3	X=621038.6062	Y=6791447.6545	1739+800
HR 34	JhVr-1 & 1a	X=615812.3002	Y=6796584.2940	1747+700
HR 35	JhVr-4	X=614663.8171	Y=6798766.7276	1749+700
HR 36	Traditional Fishing Camp (Lewis Creek)	X=614765.2963	Y=6798626.1252	1749+600
HR 37	JhVr-3 Copper Joe Creek	X=611570.1016	Y=6800192.8089	1752+800
HR 38	KTB Fish Camp	X=611701.0561	Y=6801000.2432	1753+200
HR 39	Grave Marker	X=610057.0000	Y=6801315.0000	1754+800
HR 40a	JiVr-2	X=608127.9421	Y=6804134.9693	1759+800
HR 40b,c	JiVs-4, JiVS-7	X=606987.8203	Y=6804299.6557	1759+800
HR 40d	Jivr-3	X=606628.7400	Y=6803698.1897	1759+800
HR 40e	JiVr-1	X=606901.9533	Y=6804573.0493	1759+800
HR 40f	JiVs-6	X=605924.6303	Y=6805502.5876	1759+800
HR 41	JiVs-8 (Stop 18)	X=606088.0000	Y=6804666.0000	1760+700
HR 42	Sam Johnson's Hunting/Residence Cabin	X=600085.6724	Y=6806572.7284	1767+800
HR 43	Alaska Highway Bridge (old)	X=597666.0000	Y=6809064.0000	1771+600
HR 44	Johnson's Cabin Burwash Creek	X=594925.0000	Y=6812944.0000	1776+300
HR 45	Collapsed building remains	X=594902.9362	Y=6812385.1450	1775+900
HR 46	Jaquot Camp (Stop 10)	X=594239.0000	Y=6814449.0000	1778+200
HR 47	Cement Building Pad (Stop 7)	X=594230.7232	Y=6813786.8522	1777+600
HR 48	New Archaeological Site	X=593650.1562	Y=6816316.8638	1780+100
HR 49	New Archaeological Site	X=593470.5001	Y=6816496.6384	1780+400
HR 50	Refuse Dump Sakiw Creek	X=591680.5446	Y=6818546.0000	1783+300
HR 51	New Archaeological Site	X=591672.0000	Y=6818912.0000	1783+500
HR 56	New Archaeological Site	X=591302.0000	Y=6818809.0000	1783+800
HR 57	Fish Camp mouth of Quill Creek	X=589552.5016	Y=6822343.8300	1787+800

Refer to Figures 2-1 through 2-6, Volume II, for Locations

JgVp-3–HR-27

This site is located on the terrace edge that borders the Goose Bay to the west and is in the highway realignment right-of-way. A large amount of debitage was recovered and a possible hearth identified in deep buried deposits 60-90cm below the surface. Site size is estimated at 20x10m. The following mitigation strategy is recommended if the site is to be impacted.

- *Site clearing is not a problem due to the depth of the cultural material and the absence of forest cover over the site.*

- *Archaeological site salvage should consist of a minimum of 15-20m^2 excavated to professional standards in the vicinity of productive shovel tests*. *Due to the depth of the deposits it would likely take a crew of four six days to complete 15 1x1m excavation units.*

Site 48–HR-48

Site 48 is located on the western end of an east-west running terrace on the north side of the Alaska Highway 5 km west of Burwash Creek. The site is approximately 10x20m with cultural deposits between 30-50 cm below surface. The site is within the borders of a potential borrow pit. The following mitigation strategy is recommended.

- *Ensure that the integrity of the terrace top is maintained during borrow activity.*

- *If impact is unavoidable then archaeological site salvage is required. Salvage would require that a minimum of 15m^2 excavated to professional standards in the vicinity of productive shovel tests. This would likely take a crew of three four days to complete.*

Site 51–HR-51

This archaeological site is located overlooking an unnamed creek that flows into Sakiw Creek. The site is close to the border of a potential borrow pit and construction field camp. It is unlikely that these activities will disturb the archaeological remains of the site; however, its close proximity to this activity may lead to accidental disturbance.

- *It is recommended that measures are taken during borrow pit activity and field camp occupation to ensure that there is no impact to Site 51.*

Site 56–HR-56

This newly found archaeological site is located on a prominent southwest facing knoll on the west side of the Alaska Highway overlooking an unnamed creek that flows into Sakiw Creek. The site is in the southern margins of the new realignment right-of-way.

The site is approximately 15x15m with at least two prehistoric occupations situated between 0-20cm below surface. The following mitigation strategy is recommended.

- *The area of the site should be hand cleared with special care taken not to disturb the ground surface. Tree stumps should be left in place until proper mitigation of the site has occurred.*

- *If the site cannot be avoided during construction activities then archaeological site salvage is recommended. A minimum of 12m^2 should be excavated to accepted scientific standards. This amount of work would likely take a crew of three, three days to complete*.

2.4.2 Traditional Sites

Traditional Trails

A number of traditional trails have been identified within the study area and a number of them cross the highway at varying points. Although there is no way to mitigate impacts to a trail except for mapping their existence the following is recommended.

- *Consultation should be held with the CAFN and the KFN to discuss potential ideas to acknowledge the importance of the traditional trails in the study area. This could include interpretive signage at certain points along the highway.*

Isaac Moose Cabins–HR-7

Two extant cabins and a collapsed corral are located 20-30m outside of the north margin of the new highway realignment. Construction activities will not impact this site, however the following is recommended.

- *Due to the structures proximity to the realignment right-of-way measures should be taken avoid impact to this site.*

Duke Meadows Potential Borrow Pit Location

The Duke Meadows area is identified by the KFN as an active traditional site and of significance to them. Although no traditional remains (pre-1940s) were observed that would be directly impacted as a result of borrow pit activity the KFN objects to borrow pit development in this area.

- *It is recommended that the KFN be consulted prior to any development of the potential Duke Meadows Borrow pit.*

Sam Johnson's Cabin–HR-44

The Sam Johnson cabin is located on the west side of Burwash Creek north of the highway realignment right-of-way. A potential borrow pit in and around Burwash Creek west of the present day Alaska Highway could have adverse down stream effects to this site.

- *It is recommended that measures be taken to ensure up stream borrow pit activity does not adversely affect Site 44.*

Potential Borrow Pit Activity near Sites HR-48 and HR-49

Although measures have been proposed to mitigate impacts to Site 48 and no other physical heritage resources were identified, the KFN objects to any borrow pit development in this area. This objection is based on the area being a traditional and present day hunting area for First Nation members.

- *It is recommended that prior to borrow pit activity consultations be held with the KFN to come to an acceptable solution to potential impacts.*

2.4.3 Historic Resources

Silver City–HR-16

Silver City is located at the mouth of Silver Creek. It is associated primarily with the Kluane Gold Rush but was also occupied by the United States Army during the construction of the Alaska Highway. The site is well west of the realignment right-of-way, however, measures should be taken to ensure the protection of the site from possible impacts as a result of a potential borrow pit in the vicinity of Silver Creek up stream from Silver City. The site is presently being flooded and washed away by Silver Creek.

- *It is recommended that an effort be made to stabilize the stream and at a minimum that the borrow pit activities not exacerbate the down stream flooding.*

Fisher Cabin and Fisher Grave–HR-19

The Fisher Cabin is located at the base of Sheep Mountain on the west shore of Kluane Lake. It lies within the right-of-way of the realignment. Site avoidance is preferred, however, if this is impossible then the following is recommended.

- *Consultation with Kluane National Parks, the present owners of the cabins. (Allen Fromme, contact #YJ3-5877).*
- *Consultation with Historic Sites, Heritage Branch, Yukon Government, to determine a program of mitigation for the standing structures.*
- *Consultation with the Department of Archaeology, Heritage Branch, Yukon Government, regarding measures needed pertaining to Alexander Fisher's grave site.*

Survey Platform–HR-26

The survey platform located on the shore of Kluane Lake does not require documentary mitigation measures. The value of this feature is its likely association with the early surveys carried out in the region for the Alaska Highway and Dominion Land Survey.

- *It is recommended that the platform not be destroyed during construction activities and that it be moved to a place along the Kluane Lake shore in the general vicinity where it will not be in the way of construction activities.*
- *Historic Sites, Heritage Branch, Yukon Government, should be consulted in order to move this feature.*

Grave Marker, WWII–HR-39

Although erected recently,(person or group not confirmed) the grave marker was presumably situated at the spot where a WWII pilot died after his plane crashed in Kluane Lake. It is not a burial site and is not a heritage concern, however, if the story stands true it does have interpretive value. No mitigation measures are recommended.

Alaska Highway Bridge–HR-43

The remains of an original Alaska Highway bridge are located on the southern margins of an old Borrow pit 5 km south of Burwash Creek. It is located 20m outside of a potential field camp and borrow pit location. Although the structure is in an extreme state of decay it does have aesthetic and interpretive value. Depending on the alignment chosen this site may be visible from the newly constructed highway. The bridge is in danger of potential scavenging from field camp occupants.

- *It is recommended that measures be taken to ensure the feature will not be adversely affected by accidental or intentional disturbance during field camp occupation and borrow pit activities.*
- *If the site is viewable from the highway Historic Sites, Yukon Government, should be consulted for interpretive potential of and possible signage for the collapsed bridge.*

Jaquot Camp–HR-46

The relatively intact remains of Joe Jaquot’s camp are located on the eastern side of the Alaska Highway approximately 4 km from where the highway crosses Burwash Creek. The camp is in the highway realignment right-of-way and will be impacted by construction activities. The site offers a look into the way of life for rural Yukoners during the 1940s from an anthropological perspective and study of the site remains coupled with archival research. Moreover, it does have interpretive value as well. If the site cannot be avoided then the following mitigation measures are recommended.

- *Historic Sites, Yukon Government, should be contacted to document the site prior to impact. If impact is avoided then consultations should focus on the interpretive value of this camp.*
- *At a minimum, the site should be photographed in detail, features mapped and shovel tested for identification purposes and surface artifacts recorded to accepted scientific standards. This would take a crew of two, two to three days to carry out.*

3.0 CURRENT LAND USE

3.1 INTRODUCTION

The general intent of the current land use section is to identify, locate, and describe current land use, land ownership status within a 2 km corridor, and identify specific land use impacts as a result of highway realignment and to highlight mitigation strategies. Figures 3-1 to 3-8, Volume II are provided to supplement current land use examinations by geographically identifying the location of existing land tenure and land use activities within the study area.

Please refer to Current Land Use maps (Figures 3-1 to 3-8, Volume II) for an accurate documentation and description of all current land use activities in the study area. Current permitted and non-permitted land use activities within the corridor have been identified and have been presented in the following tables and/or figures. While much of the land use in the study area corresponds directly to the associated land tenure, other land use activities have indeterminate land tenure status or are informal or more recreational in nature.

Current land use and tenured properties within the study area have been identified and described in Tables 3-1, 3-2 and 3-3. In addition, these tables provide the approximate location and Alaska Highway access points to these areas. A geo-referenced database, complete with the reconstruction highway chainage has also been compiled from field reconnaissance and is presented in Table 3-3. This will aid field-users of the environmental assessment update to travel to and investigate any areas of potential conflict with highway realignment or other parts of the planning process.

Section 3.2 provides an accurate and complete information database of land tenure within the study area. Section 3.3 identifies potential impacts to current land use and tenure and offers mitigative strategies. Section 4.0 offers further land status information by identifying waste and/or contaminated sites.

Section 2.0, Archaeological and Traditional Land Use Impact Assessment, and Section 8.0, Socio-Economic Impact Assessment, provide more detailed discussions of historic use patterns and baseline characteristics of the primary economic generators for the Kluane Region. The discussion below will focus on identifying general land use activities and their location and on the potential impacts to, and proposed mitigation for, those land use activities currently undertaken in the study area.

3.2 CURRENT LAND USE IDENTIFICATION

Current and historic land uses within a 2 km corridor of the existing highway have been identified and displayed in Table 3-1 in ascending order moving south east to north west up the highway. Table 3-1 provides a brief description and locations of the land uses. Many of the land uses in the study area are located off highway. Access to these areas is deemed important and has been identified on the Current Land Use maps. (see Figures 3-1 to 3-6, Volume II).

Table 3-1 provides general locations of the current land uses in the study area. As some of these locations are “off-highway”, the approximate reconstruction highway chainage that the land use is adjacent to is given. In addition, the nearest access point from the Alaska Highway to the point of interest is identified and can be referenced to the current land use maps (Figures 3-1 to 3-7, Volume II). A geo-referenced database is also cross referenced and provided here for a more precise location of the area of interest in relation to the reconstructed highway (see Table 3-3).

The communities of Destruction Bay and Burwash Landing are located within the study area and many local residents use the area for a variety of land uses.

Figure 3-1 through 3-7, Volume II graphically present the current land use within the study area. These maps have focused on identifying land use access points rather than graphically depicting each land use. Highway access points, identified by a “CL#”, indicate the type of land use that the access road is supporting. Unique land use activities within the study area are included. These include First Nation settlement lands, Arctic Institute trapping grid areas, quartz and placer mineral claims and recreational trails.

Figure 3-8, Volume II outlines the trapping concessions, outfitting concessions, First Nation Settlement Lands, and Kluane National Park boundary within the study area. Figure 3-8, Volume II also provides a listing of registered trapline owners and outfitter concession holders.

Much of the current land use in the study area consists of seasonal tourist activity and some commercial businesses, supporting highway traffic demands, such as fuel, food, and lodging. Recreational and cultural/social uses of the study area by local residents are varied and may include various types of resource extraction such a berry picking, fishing, and hunting. Other recreational land uses include hiking, snowmobiling, boating. Outfitting and trapping concessions in the area provide employment and outfitting, in particular, also draws numerous tourists/hunters.

3.3 LAND TENURE IDENTIFICATION

One of the more significant impacts of the road reconstruction will be its affect on those who have developed usage patterns and, indeed, lifestyles around the old road alignment. The Land Disposition Register at Yukon Government, Lands Branch, and DIAND Land Resources as well as the Land Titles office in Whitehorse were consulted to complete a record of permitted land use, licensed, leased or titled land within the study area. Land reconnaissance was also conducted to confirm and/or augment this information. These surveys occurred in June and August, 1999. Brief descriptions and locations of tenured land are presented in Table 3-2. Similar to Table 3-1, Table 3-2 describes a general location of the tenured land, and provides the highway access to these areas. Table 3-3, the geo-referenced database, offers a more precise location for these areas. Figures 3-1 to 3-6, Volume II identify highway access locations for various land tenures within the study area.

As the Silver Creek floodplain has been identified as a potential vulnerable area during reconstruction, a detailed Silver City area property map has been prepared and is provided in Figure 3-7, Volume II.

3.4 IMPACT ASSESSMENT AND MITIGATION PROPOSALS

3.4.1 General Impact Assessment

In addition to potential environmental impacts to such features as soil and water quality and the disturbance of habitat on lands currently used, the main impact that arises from the proposed realignment of the existing highway, as it pertains to current land use, is that of highway access. The issue of highway access can be described in the following two groups:

1. **Existing Businesses Access:** Highway lodges, private and government campgrounds are those types of accesses that require continued access; without special treatment. Some portions of the proposed road alignment may isolate these businesses from the traveling public for certain alignment options.

2. **Local Land Use Access:** Business activities, for example mineral claims and forestry operations, and hunting, fishing, recreation, etc. require continued access. These local areas and some specific sites have been used by locals for many years, and may be interfered with due to the raising of the highway centerline and wide or coarse rock shoulders.

In the first scenario, the businesses located along the Alaska Highway depend on traffic literally driving by their doorstep to attract customers. These are not necessarily 'destination' sites for tourism; therefore, the majority of traffic comes from tourists who consider the site useful and convenient upon discovery. A change in horizontal alignment of as little as one hundred meters away for the entrance to the business could possibly have a profound negative impact on that business.

The concept of "Scenic Routes" has been developed as one option to address the local business concerns, and has been described in this section as well as in Section 7.0, Aesthetics.

Basically, the concept entails the retention of certain portions of the old highway alignment, with a reduced speed limit, and seasonal summer usage for access to these businesses. The new highway alignment would be constructed as planned, with appropriate signage and intersections for the businesses and the scenic route. The portions of the highway that are proposed for 'Scenic Route' treatment are presented on the 1:60,000 scale corridor maps (see Figures 7-3 and 7-4, Volume II). .

In the second scenario, the local residents are accustomed to being able to use multiple choices of roads off the highway to access special places for fishing, hunting, berry picking, and many other forms of recreation.

The construction method to be employed for the Shakwak Highway Project consists of a wide-pad that both broadens and raises the road surface. Additional berm-type shoulder treatment methods are used only in permafrost areas. Depending on local topographic relief, the new road surface will be from 1.5 to 2 meters higher than the existing surface, along with an approximate doubled width of the roadbed footprint. This will have the effect of isolating the new highway from the current local road access at most locations, requiring a prioritizing of the access points that will be given special intersection treatments to retain access. These highway access points are identified on Figures 3-1 through 3-7, Volume II. Depending on the necessary type of access, the Transportation Association of Canada (TAC) personal residence standard, or TAC commercial standard, are proposed to address this issue.

Information gathered from interviews with local residents has been used to attempt to facilitate that prioritization, based on usage patterns and levels.

During interviews with local residents, it became clear that these "local access" intersections should not be constructed so as to encourage tourist traffic. The local residents consider these roads as semi-private, and do not wish to open up their 'special' places to local tourist traffic. In these instances, it is recommended that a lower design standard (TAC personal residence standard - narrower, sharper cornered, steeper) be utilized for road construction. This 'lower standard' intersection could be accomplished within accepted side road TAC Design Standards, with appropriate intersection development.

The specific locations proposed for intersection access are depicted on Current Land Use Maps, Figures 3-1 through 3-6, Volume II.

3.4.2 Physical Works and Operation: Mitigating Potential Impacts to Current Land Uses

To reiterate, many of the potential impacts to current land use as a result of reconstruction of the highway are those of potential access. Impacts may be felt by business operators or others with tenured property or conducting activities on lands isolated from the realignment area. Impacts to each of the land use categories are described in Table 3-4. Table 3-4 summarizes potential impacts to various current land use activities during construction and operation/maintenance periods. Mitigation options are presented to address potential impacts.

3.5 CONTAMINANTS/ WASTE SITE IDENTIFICATION

Existing waste disposal facilities are identified and depicted on the Current Land Use maps (Figure 3-1 to 3-6, Volume II). Information regarding waste and contaminated sites within the study area was gathered from the Department of Indian and Northern Affairs Northern Development (DIAND) Contaminants/Waste Program – Arctic Environmental Strategy (AES), specific references, interviews with local residents, and other study results. The AES maintains a detailed database of information on waste and contaminated sites in the Yukon. In addition to their own field operations and investigations, identification and examination of waste and/or contaminated sites has been conducted by various consultants. The results of these investigations have been documented and consulted in the course of preparing this report. The report entitled “Use, Disposal and Transportation of Selected Contaminants in the Yukon” (INAC, 1993), identified various waste sites from oral interviews with knowledgeable Yukoners.

All of the waste and/or contaminated sites identified within the study area are classified, by AES, as being free from environmental hazards (AES ranking of environmental hazards = 0, No risk of hazards). The majority of the sites are inactive or abandoned staging areas and/or dumpsites created during the construction of the highway by the Canadian and American Military. Thirty-four waste and/or contaminated sites were identified during examinations of the AES Waste Site Inventory. However, only ten of these sites are considered to be of direct importance to this portion of the Alaska Highway realignment, as determined from their proximity to the proposed highway realignment centerline (see Table 3-5).

As previously stated, these sites are mostly abandoned or inactive and pose no significant environmental hazard or risk. Despite this, there still remain some environmental concerns as it pertains to construction of the proposed highway realignment. The waste and/or contaminants sites within the study area are predominantly characterized by the presence of refuse, debris, and scrap metal. Other sites may include the presence of soils contaminated by hydrocarbons, pesticides, PCB's, polycyclic aromatic hydrocarbons (PAH's), and/or heavy metals. The sites listed in Table 3-5 contain contaminants in negligible concentrations and may only be of concern if significant changes or disturbances are contemplated for the substrates in which they reside. Should these sites be significantly disturbed, additional analytical testwork may be required. Refuse, debris and scrap metals are of concern only to the degree in which they may hinder construction, affect unwary pedestrians or other land uses, and to the degree to which they are aesthetically displeasing.

Only one new abandoned waste site was identified during the course of the archaeological/tradition use field investigations. This site, identified as HR50 (Table 3-5), is located near Sakiw Creek and contained buried refuse and debris. The site is disturbed, considered historic (post 1940's) and may contain hazardous materials within the dump. If the site cannot be avoided, additional field investigations and analytical testing for hazardous material may be warranted.

Appendix III presents the AES Waste and Contaminated Sites that fall within the study area. This appendix provides a more detailed description of the sites and their evaluation by regulatory authorities. It is important to recognize that the database will change as a result of land tenure changes, site remediation, and the discovery of new information about the sites. Therefore consultation with the appropriate authorities should be engaged once a determination on the location, timing, and scale of the reconstruction works has been made.

Table 3-1 Study Area Current Land Use Identification

Specified User (if any)	Land Use Permit # (if any)	Land Use Description	Land Status (reserve, historic, current, long-term)	Area (ha)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
YTG	-	Bridgehead	Long-term	12.5	1665.0	-	1	115 A/13	-
CAFN	-	Jarvis River Cabins	current		1665.7 (RHS)	CL2	1	115 A/13	North of Highway (R.H.S.)
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1669 (RHS)	Between CL3 & 4	1	115 A/13	One parcel of several, comprised of over 200 ha in total land area
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1670.6 (RHS)	After CL5	1	115 A/13	One parcel of several, comprised of over 200 ha in total land area
Northern Pipeline Agency	expired/closed	Campsite	Long-term/Historic	98.0	1669-1670 (RHS)	Between CL3 & 4	1	115 A/13	Inactive
Boutin, Stan	-	Research Field Camp	Long-term/Reserve	2.0	-	-	1	115 B/16	Current status unknown, near 1672 (RHS)
Northern Pipeline Agency	expired/closed	Stockpile Site	Long-term/Historic	48.0	1676.2 (RHS)	-	1	115 B/16	Inactive
YTG	-	Wildlife Research Preserve	Long-term/Reserve	83.0	1678.9 (LHS)	CL 17a	1	115 B/16	-
YTG	-	Wildlife Research Reserve	Long-term/Reserve	142.1	1678.9 (LHS)	CL 17a	1	115 G/01	-
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	6.1	-	-	1	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 2km North of km 1683 (RHS). No visible access.
YTG	expired/closed	Gravel Pit	Long-term	9.0	1683.7 (RHS)	Before CL 18	1	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1683.6 (LHS)	CL 17a	1	115 G/01	One parcel of several, comprised of over 200 ha in total land area
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	7.4	-	-	1	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 1.5 km North of km 1684 (RHS). No visible access.
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	22.1	-	-	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 1 km North of km 1685 (RHS). No visible access.
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1685.5 (RHS)	-	2	115 G/01	One parcel of several, comprised of over 200 ha in total land area
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	-	-	2	115 G/01	One parcel of several, comprised of over 200 ha in total land area. Near km 1685 (RHS). No visible access.
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	-	-	2	115 G/01	One parcel of several, comprised of over 200 ha in total land area. Near km 1685 (RHS). No visible access.
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1689.6 (RHS)	CL 22	2	115 G/01	One parcel of several, comprised of over 200 ha in total land area. No visible access.
YTG	-	Wildlife Research Preserve	Long-term	Portion of 210 ha	1689.6 (RHS)	CL 22	2	115 G/01	One parcel of several, comprised of over 200 ha in total land area
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	10.6	1691.5	CL 24	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 6.5 km north of km 1689.5 (northeast of Christmas Bay). No visible access.
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	16.9	1692.5	CL 25	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 6.5 km north of km 1689.5 (northeast of Christmas Bay). No visible access.
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	12.0	1693.5	CL 26	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 6.5 km north of km 1689.5 (northeast of Christmas Bay). No visible access.

Table 3-1 Study Area Current Land Use Identification

Specified User (if any)	Land Use Permit # (if any)	Land Use Description	Land Status (reserve, historic, current, long-term)	Area (ha)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	22.4	1694.5	CL 27	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; Along pipeline easement. 6.5 km north of km 1689.5 (northeast of Christmas Bay). No visible access.
YTG	expired/closed	Gravel pit	Long-term	36.0	-	-	2	115 G/1	Abandoned/inactive or occasional commercial, government, and or local use. South of km 1690 (LHS). No visible access.
Public Works Canada	expired/closed	Gravel Pit	Long-term	171.5	1691.5 (RHS)	CL 24	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use; YTG Wildlife Research Preserve contained within pit area.
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	11.9	1691.5	CL 24	2	115 G/01	Abandoned/inactive or occasional commercial, government, and or local use. North of km 1695, On Christmas Bay.
YTG	-	Campground	Long-term	64.6	1691.5	CL 24	2	115 G/01	North of km 1695, East end of Christmas Bay
YTG	expired/closed	Bridgehead	Long-term	7.0	1691.5	CL 24	2	115 G/01	Christmas Bay and Cultus Bay Road
Brian Williams (deceased)	-	Grave Marker	Current	-	1697.8 (LHS)	-	2	115 G/01	-
Government of Canada	-	I.B.P. Site 16a	Long-term/Reserve		-	-	2	115G/I	**International Biological Preserve. 140 square miles in total area. Including Slims River Delta (Downstream of Slims River Bridge). See figures 3-2 and 3-3.**
YTG	expired/closed	Gravel Pit	Long-term	5.0	1703.8 (LHS)	-	2	115 G/02	Abandoned/inactive or occasional commercial, government, and or local use
Parks Canada	YA5X948	Sheep Mountain Interpretive Centre	Long-term	3.0	1703.4 (LHS)	CL 31	2	115 G/02	Active tourist site
YTG	expired/closed	Gravel Pit	Long-term	2.0	1706.9 (LHS)	-	2	115 G/02	Abandoned/inactive or occasional commercial, government, and or local use
YTG	-	Television Transmitting Station	Current	0.4	-	-	2	115 G/02	Kluane Hill
Cottonwood Park Limited	-	Campground/ picnic site	Current	1.4	1713.1	CL 42	3	115 G/02	Active
Northern Pipeline Agency	expired/closed	Stockpile Site	Long-term	58.3	1719.5 (RHS)	CL 45	3	115 G/02	Inactive
YTG	-	Campground	Current	258.6	1720.6 (RHS)	CL 48	3	115 G/02	-
DIAND - Forest Resources	-	Sample plot	Long-term/Reserve	1.0	-	-	4	115 G/02	Approximately 1000m off highway at km 1723 (LHS). No visible access.
DIAND - Forest Resources	-	Sample plot	Long-term/Reserve	1.0	-	-	4	115 G/02	Approximately 500m off highway at km 1723 (LHS). No visible access.
Northern Pipeline Agency	expired/closed	Compressor Station	Long-term	46.5	1726 (LHS)	-	4	115 G/02	Inactive
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	128.2	1730.1 (LHS)	CL 53	4	115 G/02	Abandoned/inactive or occasional commercial, government, and or local use
Northern Pipeline Agency	expired/closed	Construction camp	Long-term	304.0	-	Near CL 53	4	115 G/02	Inactive; Near km 1730 (LHS)
YTG	expired/closed	Gravel Pit	Long-term	9.0	1732 (RHS)	Between CL 53 & 54	4	115 G/02	Abandoned/inactive or occasional commercial, government, and or local use
DPW	-	Bridgehead	Long-term	10.0	1738.2, Destruction Bay	-	4	115 G/02	-
Northern Pipeline Agency	expired/closed	Borrow Pit	Long-term	120.1	1738.2 (LHS)	Between CL 54 & 55	4	115 G/02	Abandoned/inactive or occasional commercial, government, and or local use
Northern Pipeline Agency	expired/closed	Stockpile Site and Fuel Storage Site	Long-term	32.0	1739 (LHS)	Near CL 55	4	115 G/02	Inactive

Table 3-1 Study Area Current Land Use Identification

Specified User (if any)	Land Use Permit # (if any)	Land Use Description	Land Status (reserve, historic, current, long-term)	Area (ha)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
YTG	-	TV transmitter tower	Current	0.4	1748.5 (RHS)	CL 58	4	115 G/7	-
YTG	expired/closed	Gravel Pit and dump	Long-term	9.0	1748.5 (RHS)	CL 58	4	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Northern Pipeline Agency	expired/closed	Borrow site	Long-term	63.8	At Lewis Creek, near km 1749 (LHS)	Between CL 58 & 59	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use; 1 km upstream.
Dept. of Public Works	-	Bridgehead	Long-term	10.0	1749.0	Between CL 58&59	5	115 G/7	-
DIAND	expired/closed	Gravel Pit	Long-term	4.6	1749.8 (RHS/LHS)	Between CL 58&59	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Allinger, T.E.	Lease	Grazing	Long-term	64.8	-	-	5	115 G/7	Inactive; Near km 1751 (RHS), 200 -400 m off highway. Access point uncertain. Between CL#58&59
Dept. of Public Works	-	Bridgehead	Long-term	10.0	1752.0	Between CL 58&59	5	115 G/7	-
Northern Pipeline Agency	expired/closed	Borrow site	Long-term	46.3	1753.8 (LHS)	CL 61	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Northern Pipeline Agency	expired/closed	Borrow site	Long-term	13.5	1753.8 (LHS)	CL 61	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Indian & Inuit Affairs	expired/closed	Agriculture and Grazing	Long-term	22.0	1754.3 (RHS)	CL 62	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Canadian Broadcasting Corporation	-	Broadcasting site	Current	1.0	1754.8 (RHS)	CL 63	5	115 G/7	-
YTG	expired/closed	Gravel Pit	Long-term	5.0	1758.8 (RHS)	After CL 66	5	115 G/7	Abandoned/inactive or occasional commercial, government, and or local use
Indian & Inuit Affairs	-	Cemetery	Historic	1.1	Burwash Landing	-	5	115 G/7	-
Nav Canada	-	Airstrip	Long-term/Historic	11.0	Burwash Landing	-	5	115 G/7	-
YTG	-	Gravel Pit	Long-term/Historic	21.0	1763.2 (LHS)	Gravel Pit 27(b)	5	115 G/06	-
YTG	-	Gravel Pit	Long-term/Historic	108.0	1766.5 (LHS)	Gravel Pit 28(b)	5	115 G/06	-
YTG	-	Gravel Pit	Long-term/Historic	21.0	1771.8 (RHS)	Between CL 73 & 74	5	115 G/06	-
Water Survey of Canada	-	Hydrometric Station	Long-term/Historic	0.7	1768.7 (RHS)	CL 73	6	115 G/06	-
DIAND	-	Stream Gauging Station	Long-term/Historic	0.0	1775.8 (LHS)	CL 75	6	115 G/06	-
Northern Pipeline Agency	-	Borrow Site	Long-term/Historic	56.0	1775.8 (LHS)	CL 75	6	115 G/06	-
Northern Pipeline Agency	-	Borrow Site	Long-term/Historic	19.0	1776.9 (RHS)	near CL 78	6	115 G/06	-
Northern Pipeline Agency	-	Stockpile Site	Long-term/Historic	33.5	1782.8	Gravel Pit 33(c)	6	115 G/06	-

*** Note: See Figures 3-1 to 3-7, Volume II for locations**

Table 3-2 Study Area Land Tenure

Holder	Land Tenure Status (lease; reserve; fee simple; historic; long term)	Land Tenure Description	Land Use Description	Area (ha.)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
Frank Joe Ruby Range Trail Rides	Fee simple	-	Commercial/Residential (Ruby Range Trail Rides)	-	1664.5	CL1	1	115 A/13	-
Prestone, Joel & Roxanne	Fee simple	-	Commercial/residential (vehicle recycling yard and garage)	8.0	1691.5	CL24	2 & 7	115 G/01	-
Williams, Anne	Fee simple	-	Residential	6.5	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Northern Pipeline Agency	Fee simple	Lot 1007	Commercial	-	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Gilbert, Scott Bertram	Fee simple	Lot 1003	Residential	2.5	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Upton, Peter Todd	Fee simple	Lot 1011	Residential	6.0	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Upton, Carl Donjek	Fee simple	Lot 289	Residential	6.8	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Bouvier, Maurice & Louise	Lease	-	Commercial	1.4	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Bouvier, Maurice & Louise	-	-	Recreational vehicle	1.9	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	115 G/01	See Figure 3-7, Volume II
Obeissart, E&A	Fee simple	Lot 1012	Residential	-	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2 & 7	116 G/01	See Figure 3-7, Volume II
Denise Leone Williams	Agreement of Sale	Adj. Easterly boundary Lot 289	Residential	2.8	1691.5, 1694.7, or 1696.8	CL 24, 25, or 27	2	115 G/01	See Figure 3-7, Volume II
Allen Roy Fromme	Fee simple	Lot 1002	Fischer's Cabin (Historic Residence)	1.1	1704.1	CL32	2 & 3	115 G/02	-
Dana Naye Ventures	Lease (closed)	Adjoining Lot 296, Group 852, Horseshoe Bay	water lot leases (3 sites) (dock facilities)	0.1	1708..9	CL41	2	115 G/02	-
Brough, Robert G.	Commercial Lease	Lot 296, PL 52936	Commercial/Bayshore Motel	94.0	1708.3	CL40	3	115 G/02	-
Cottonwood Park Limited	Fee Simple	Lot 1001, Pl 71677, Group 852	Commercial campsite	1.4	1713.1	CL42	3	115 G/02	-
Cottonwood Park Limited	Lease	-	Mini-golf course	0.9	1713.1	CL42	3	115 G/02	-
Cottonwood Park Limited	-	-	Commercial picnic/campsite	1.4	1713.1	CL42	3	115 G/02	-
Grantham, Thomas and Denise	Fee simple	Adjoining lot 312, CLSR 58781, LTO 39992,	Residential	2.5	1722 (RHS)	Between CL49&50	3	115 G/02	-
Tillinghast, John & Deborah	-	-	Agreement of Sale	3.3	1722 (RHS)	Between CL49&50	3	115 G/02	-

Table 3-2 Study Area Land Tenure

Holder	Land Tenure Status (lease; reserve; fee simple; historic; long term)	Land Tenure Description	Land Use Description	Area (ha.)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
Grantham, Thomas and Denise	-	-	Agreement of Sale	4.5	1722 (RHS)	Between CL49&50	3	115 G/02	-
Dana Naye Ventures	Fee simple	Lot 296, Group 852,	Assigned to commercial	0.8	1708.3	CL40	3	115 G/02	-
Forestry	Fee simple	Lot 243, Group 852	Patrol Cabin	0.4	Destruction Bay	-	4	115 G/07	-
Parks Canada	Fee simple	Lots 19 and 20	Residential	0.1	Destruction Bay	-	4	115 G/07	-
DIAND	Fee simple	Lot 309, Group 852, CLSR 56929 LTO 34922	Park Headquarters	0.7	Destruction Bay,	-	4	115 G/07	-
Parks Canada PC1987-1979	Fee simple	Lots 50 & 51, Group 852,	Office building	0.1	Destruction Bay	-	4	115 G/07	-
National Health & Welfare	Fee simple	Lots 17 and 18, Group 852,	Health centre	0.1	Destruction Bay	-	4	115 G/07	-
Indian & Inuit Affairs	Fee simple	Lots 22, 23, 24 & 25, Group 852,	Housing	0.04 each	Destruction Bay	-	4	115 G/07	-
Health & Welfare Canada	Fee simple	Lots 16 & 21,	Residential	0.1	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Repeater stations	4.4	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
NHW	-	-	Health centre	0.1	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
MOT	-	-	Housing	0.0	Destruction Bay	-	4	115 G/07	-
Indian & Inuit Affairs	-	Lot 1011, CLSR-7 2803 LTO-90-46	residential	8.0	Copper Joe Creek, near km 1753 (RHS)	Between CL59&60	5	115 G/07	-
Indian & Inuit Affairs	-	-	Commercial	8.0	1754 (LHS)	Between CL61&62	5	115 G/07	-

Table 3-2 Study Area Land Tenure

Holder	Land Tenure Status (lease; reserve; fee simple; historic; long term)	Land Tenure Description	Land Use Description	Area (ha.)	Access Gained from Alaska Hwy. (approx. Km) *If Applicable*	Access (at or near) Current Land Use Number (from CLU Maps)*	CLU Map #*	Map Sheet #	Comments
Indian & Inuit Affairs	-	-	Agriculture and Grazing	22.0	1754.5 (RHS)	Between CL62&63	5	115 G/07	-
Indian & Inuit Affairs	-	-	Commercial	10.4	1758.0	Between CL65&66	5	115 G/07	-
Indian & Inuit Affairs	Lease	Lot 4 Group 852	Reservation Res	1.3	Burwash Landing	-	5	115 G/07	-
Indian & Inuit Affairs	Lease	Lot 1003	Indian Handicraft store	40.2	Burwash Landing	-	5	115 G/07	-
Indian & Inuit Affairs	Lease	Lot 2-1, Group 852C	Residential	2.5	Burwash Landing	-	5	115 G/07	-
YTG	Historic	Parcel E, Lot 4,	Cemetery	1.2	Burwash Landing	-	5	115 G/07	-
Indian & Inuit Affairs	Lease	-	Village housing campsite	40.4	Burwash Landing	-	5	115 G/07	-
Indian & Inuit Affairs	Lease	-	Campsite (Duke Meadows, Site A)	25.0	1765.6	near CL72	5	115 G/06	2 km down access road
Indian & Inuit Affairs	Lease	-	Residential	4.0	1765.6	near CL73	5	115 G/06	600m down access road
Indian & Inuit Affairs	Lease	-	Residential	4.0	1775.9	CL79	6	115 G/06	-
Indian & Inuit Affairs	Lease	-	Residential	4.0	1775.9	CL79	6	115 G/06	-
Indian & Inuit Affairs	Lease	-	Agriculture and Grazing	65.0	1775.9	CL79	6	115 G/06	-
All North Resources Ltd.	Lease	-	Industrial	62.9	1786.2	CL86	6	115 G/11	-

*** Note: See Figures 3-1 to 3-7, Volume II for locations**

Table 3-3 Current Land Use Geo-Reference Database

Basemap Reference Number	DESCRIPTION	UTM EASTING	UTM NORTHING	HIGHWAY CHAINAGE
CL 1	Jarvis River pullout	X=668655.5387	Y=6758187.0188	1664+500
CL 2	Jarvis River Cabins - access retain TAC #1	X=667534.0064	Y=6758524.8518	1665+700
CL 3	Chamber's Cabin - residential access retain TAC # 1	X=667043.6336	Y=6758717.4567	1666+200
CL 4	Kimberly Creek Access - access retain TAC #2	X=666424.2886	Y=6758511.7390	1666+800
CL 5	Sulphur Lake - access retain northside TAC #1, Southside TAC #2	X=662888.4291	Y=6759791.8882	1670+600
CL 6	Lloyd Trapping Grid - access southside retain TAC #1	X=662430.2535	Y=6759896.4984	1671+000
CL 7	Pipeline ROW	X=662196.0000	Y=6760097.0000	1671+300
CL 8	Pipeline ROW access retain TAC #1	X=662104.8251	Y=6760243.1595	1671+500
CL 9	Possible Field Camp	X=661436.0000	Y=6761025.0000	1672+500
CL 10	Pipeline ROW trail access retain TAC #1	X=661046.4499	Y=6760904.1713	1672+700
CL 11	Squirrel Camp access	X=660829.8416	Y=6761371.5347	1673+100
CL 12	1C Field Camp	X=660305.4702	Y=6761709.9651	1673+800
CL 13	2C Field Camp	X=659584.0803	Y=6762226.8648	1674+700
CL 14	Old Borrow/Camp access retain TAC #2	X=657127.7387	Y=6763250.0584	1677+500
CL 15	CAFN Lodge/Camp access retain TAC #1	X=657010.1550	Y=6763562.6727	1679+400
CL 16	Fry Lake Ski-Doo access	X=655445.1026	Y=6764300.8342	1678+900
CL 17a	Hungry lake access retain TAC #1	X=655642.5298	Y=6763864.0349	1683+600
CL17	Hungry Lake access retain TAC #1	X=651867.2876	Y=6766494.0659	1684+000
CL18	Borrow (possible Field Camp)	X=651434.4090	Y=6766705.5339	1684+700
CL19	CAFN Jack Allen's Cabin access retain TAC #1	X=650817.2831	Y=6766713.8025	1685+300
CL20	Christmas Creek Hill viewpoint & pullout	X=650196.0000	Y=6766606.6012	1688+200
CL21	Christmas Creek	X=649398.5302	Y=6766802.6672	1686+900
CL22	NorthwesTel access retain TAC #2	X=646066.0000	Y=6767071.0000	1689+600
CL23	Kluane Lake scenic pullout access retain TAC #2	X=644887.0000	Y=6767699.0000	1690+900
CL24	Silver City access retain TAC #2	X=644358.4637	Y=6768123.8172	1691+500
CL25	Airstrip access retain TAC #2	X=641130.0000	Y=6768124.5074	1694+700
CL26	Old Gulf station, Silver City	X=640498.0000	Y=6769405.0000	1694+800
CL27	Glacier Flights Helicopters access retain TAC #2	X=639405.9250	Y=6766971.6605	1696+800
CL28	Potential expansion tourist pullout TAC #2	X=638572.0000	Y=6766280.0000	1697+900
CL29	Local access retain TAC #1	X=636908.7034	Y=6764589.7411	1700+100
CL30	Slims River East trail head access retain TAC #1	X=635687.0000	Y=6764308.6134	1701+200
CL31	Sheep Mtn. Interperative Cntr. access retain TAC #2	X=633631.2155	Y=6766452.9171	1703+400
CL32	Fisher's Cabin	X=633981.0000	Y=6767273.0000	1704+100
CL33	Fisher's Cabin lakeside pullout	X=634169.0000	Y=6767359.0000	1704+300
CL34	Soldier's Summit pullout access retain TAC #2	X=634749.0000	Y=6768189.0000	1705+300
CL35	Kluane Lake pullout access retain TAC #2	X=635015.2438	Y=6768232.9355	1705+500
CL36	Lake entry access retain TAC #1	X=635198.0000	Y=6769040.0000	1706+300
CL37	Lakeshore Spit	X=635205.0000	Y=6769271.0000	1706+500
CL38	Lakeside pullout access retain TAC #2	X=635169.0000	Y=6769451.0000	1706+700
CL39	Lakeshore Berm	X=634655.0000	Y=6770341.0000	1707+800
CL40	Bayshore Inn access retain TAC #2	X=634795.5580	Y=6770908.5879	1708+300
CL41	Scenic Area, recreational access retain TAC #2	X=634705.5773	Y=6771604.6016	1708+900
CL42	Scenic Area, Cottonwood park access retain TAC #2	X=633012.6504	Y=6775233.7163	1713+100
CL43	No Name Creek access retain TAC#1	X=631351.1043	Y=6778237.6657	1716+800
CL44	Local lake access retain TAC #1	X=631759.3580	Y=6779726.4301	1718+400

Table 3-3 Current Land Use Geo-Reference Database

Basemap Reference Number	DESCRIPTION	UTM EASTING	UTM NORTHING	HIGHWAY CHAINAGE
CL45	Borrow access (possible field camp)	X=631579.2293	Y=6780842.0000	1719+500
CL46	Trail Head access retain TAC #1	X=631288.9152	Y=6781150.6465	1719+800
CL47	Congdon Trail Head access	X=631397.1826	Y=6781899.1899	1720+600
CL48	Congdon Creek Campground access retain TAC #2	X=631182.2041	Y=6781919.2214	1720+600
CL49	KFN winter lake access retain TAC #1	X=631270.0000	Y=6782673.0000	1721+400
CL50	Goose Bay viewpoint access retain TAC #1	X=630212.7632	Y=6783984.9342	1723+100
CL51	ETSUA Road, hunter access retain TAC #1	X=628516.7781	Y=6783704.8808	1724+700
CL52	Dutch Harbour boat launch access retain TAC #1	X=627772.7171	Y=6783900.1723	1725+500
CL53	Nines Creek northside private access (KFN), southside local access retain all TAC #1	X=624594.5877	Y=6787205.3191	1730+100
CL54	Local access (mining) retain TAC #2	X=621014.5566	Y=6789707.5035	1734+500
CL55	Local access retain TAC #1	X=620539.0000	Y=6790312.0000	1739+400
CL56	Destruction Bay pullout access retain TAC #2	X=617266.0000	Y=6793241.0000	1743+800
CL57	Rifle Range and lake access retain TAC #1	X=615070.7386	Y=6796081.1560	1747+500
CL58	Existing scrap metal dump (possible field camp)	X=614624.5007	Y=6797034.7450	1748+500
CL59	CBC broadcasting site/trail head access retain TAC#1	X=611628.9658	Y=6800167.1778	1752+800
CL60	Existing Burwash Landing domestic landfill access retain Tac #2	X=611364.3124	Y=6800592.2327	1753+300
CL61	Private access retain TAC #1	X=610891.0000	Y=6800728.0000	1753+800
CL62	Private access retain TAC #1	X=610494.7379	Y=6801092.8524	1754+300
CL63	NorthwesTel access/proposed Burwash Landing sewage treatment facility	X=609973.3557	Y=6801160.0982	1754+800
CL64	Private access retain TAC #1	X=608888.6443	Y=6801658.5433	1756+000
CL65	Private access S. retain TAC #1, comm. tower N. access retain TAC #2	X=607866.4619	Y=6802097.6377	1757+100
CL66	Private access retain TAC #1	X=607059.0000	Y=6802709.0000	1758+300
CL67	Local access retain TAC #1	X=605869.0000	Y=6804727.0000	1760+900
CL68	Airstrip access retain TAC #2	X=605496.9904	Y=6804870.3043	1761+400
CL69	Local access retain TAC #1	X=601536.0000	Y=6805756.4567	1765+600
CL70	Duke River access via Pipeline ROW retain TAC #1	X=600535.0205	Y=6805744.1585	1766+600
CL71	Squirrel Crk./Duke River access (mining) retain TAC #2	X=600195.0072	Y=6805556.5582	1766+900
CL72	Possible wildlife viewing pullout access retain TAC #2	X=599435.0000	Y=6805871.0000	1767+800
CL73	Mining access retain TAC #2	X=598652.0549	Y=6806453.8730	1768+700
CL74	Borrow/Field Camp access retain TAC #2	X=597293.8994	Y=6809485.2497	1772+100
CL75	Borrow/mining access retain TAC #2	X=594771.1699	Y=6812315.3987	1775+900
CL76	Private Access retain TAC #1	X=594492.7062	Y=6812900.3956	1776+500
CL77	McElhaney 0069 (poss. benchmark)	X=594154.0000	Y=6812916.0000	1776+700
CL78	Private access to Foothills pipeline test site retain TAC #1	X=593905.0000	Y=6812983.0000	1776+900
CL79	Private access retain TAC #1	X=594306.7896	Y=6814016.0000	1777+800
CL80	Local access retain TAC #1	X=594168.6136	Y=6815107.7861	1778+900
CL81	Possible trail to Borrow	X=593969.5552	Y=6815999.3970	1779+700
CL82	Local access retain TAC #1	X=592515.7062	Y=6817735.9105	1782+100
CL83	No. 1 post HCT + RAD poss. land claim marker	X=591627.0000	Y=6818884.0000	1783+500
CL84	Sakiw valley field camp access road	X=591351.0000	Y=6818868.0000	1783+500
CL85	Kluane River roadside lookout access retain TAC #2	X=590835.3531	Y=6819505.3972	1784+600
CL86	Wellgreen mine site access retain TAC #2	X=588793.0000	Y=6820297.0000	1786+200
CL87	Quill Creek access @ potential Borrow site retain TAC #2	X=589631.2104	Y=6820535.0597	1786+400

Note: See Figure 3-1 through 3-6, Volume II for current land use number locations.

Table 3-4 Potential Impacts and Mitigation to Current Land Use Activities and Land Tenure

Current Land Use Activity	Construction		Operation & Maintenance		Comments
	Potential Impacts	Mitigation	Potential Impacts	Mitigation	
Tourism	Reduced access to current tourism sites and/or facilities	Maintain appropriate access to areas of significant tourist use	Permanent loss and/or Isolation from customer base (I.e. highway tourist traffic), as a result of ineffective access to the area	Continued appropriate access to tourist areas	Re. Proposed Scenic Route Strategy
	Delays in Road Travel	Limit reconstruction efforts and/or facilitate appropriate access during tourist 'high season'	Reduction in visitation by highway traffic as a result of ineffective identification of the area	Appropriate signage to identify the associated access points	-
				Removal of visual barriers	-
Mining	Reduction or loss of access to areas of active mineral exploration and/or mining	Maintain appropriate access to areas currently identified as mineral exploration or mining areas	Reduction or loss of access to areas of active mineral exploration and/or mining	Maintain appropriate access to areas currently identified as mineral exploration or mining areas	Retention of access for current land use activities of this nature identified on Figures 3-1 through 3-8, (identified as 'mining access')
Forestry	Reduction or loss of access to areas of active domestic firewood and/or commercial timber harvest	Maintain appropriate access to areas currently identified as active domestic firewood and/or commercial timber harvest. Ensure salvage of timber in right-of-way.	Reduction or loss of access to areas of active domestic firewood and/or commercial timber harvest	Maintain appropriate access to areas currently identified as active domestic firewood and/or commercial timber harvest	Little or no commercial timber harvesting in study area. Primarily restricted to domestic firewood harvest and some selective logging (including recent Burwash Landing area burn)
Agricultural	Little or no impact aside from access concerns	Agricultural proponents to endeavour to employ existing highway access to areas of potential agricultural interest	Continued access to potential sites of agricultural development will be limited as a result of highway maintenance/operation	Agricultural proponents to endeavour to employ existing highway access to areas of potential agricultural interest	Agriculture in the study area predominantly restricted to grazing lands and domestic vegetable growing
Trapping & Outfitting	One trapline immediately adjacent to road right of way may be impacted; little or no impact aside from access concerns for remainder.	Maintain appropriate access to areas currently identified as mineral exploration or mining land use areas; YTG trapper compensation	Little or no impact	No mitigation necessary	All Access to both trapping and outfitting concessions occurs on the R.H.S. of centreline
Residential/Commercial (Tenured or Otherwise)	Reduction or loss of access to residential land use areas	Maintain appropriate access to residential land use areas	Little or no impact	No mitigation necessary	Retention of access for current land use activities of this nature identified on Figures 3-1 through 3-8, Volume II, (identified as local, residential, trail access)
	Reduction or loss of access to commercial land use areas	Maintain appropriate access to commercial land use areas	Reduction in visitation by highway traffic as a result of ineffective identification of the area	Appropriate signage to identify the associated access points	
				Removal of visual barriers	
Recreation and Other Uses	Reduction or loss of access to residential land use areas	Maintain appropriate access to areas currently identified as fishing and/or hunting land use areas	Difficulty if locating areas and hence reduced usage by visitors (local or otherwise) as a result of ineffective identification of the area	Appropriate signage to identify the associated access points	Retention of access for current land use activities of this nature identified on Figures 3-1 through 3-8, Volume II, (identified as local and/or trail/trailhead access)
				Removal of visual barriers	
Traditional/Cultural Uses	Reduction or loss of access to traditional land use areas	Maintain appropriate access to traditional land use areas	Little or no impact	No mitigation necessary	Retention of access for current land use activities of this nature identified on Figures 3-1 through 3-8, Volume II, (identified as local, trail/trailhead, private, residential and/or first nations access); (additionally identified on Heritage Resource maps, Figures 2-1 through 2-6, Volume II)
Fishing & Hunting (Licenced and Subsistence)	Reduction or loss of access to hunting and fishing land use areas	Maintain appropriate access to areas currently identified as fishing and/or hunting land use areas	Little or no impact	No mitigation necessary	Retention of access for current land use activities of this nature identified on Figures 3-1 through 3-8, Volume II, (identified as local, trail/trailhead, and/or hunting access)

Table 3-5 Identification of Waste Disposal & Contaminated Sites of Concern to Highway Realignment

Current Land Use Map # (Volume II)	AES Site # (Highway Chainage)	Site Description	Potential/Existing Contaminants/Wastes	Concerns for Construction
2	HJ026 (1686+900)	Gravel Pit - KM 1687.4 Alaska Hwy. L.H.S.	Holiday Trailer & Scrap Metal	Removal to approved dumpsite if necessary to remove
2	HJ045 (1696+700)	Old landfill from highway construction (military and commercial use). Located at Kluane lake near service station.	Buried refuse and debris	Avoid disturbing buried waste
4	HJ032 ((1732+400)	Haines/Fairbanks Pipeline. Pipeline cut and spill. 500m southwest of Alaska Highway Access Mile 1082.5 on overgrownroad, botharms of road cross spill area. (Within Vicinity of Mines Creek and Borrow site (nearby area identified as possible field camp))	Hydrocarbons/fuel, PAH's, PCB's, BTEX	Limit soil Disturbance to prevent hydrocarbon migration
4	HJ031 (1739+300)	Destruction Baypump station 4.5 km east of Destruction Bay on west side of Alaska Highway, 200m on gravel road. Associated dump located on other side of Highway. Above ground storage tanks on site. (Within Vicinity of Brock's Brook and Borrow site (nearby area identified as possible field camp))	Hydrocarbons, Metals (Cadmium, Manganese, Nickel), Pesticides, PCB's, PAH's (Subsurface conditions not yet defined, groundwater contamination concerns (i.e.. metals))	Limit or avoid soil disturbance (observe groundwater testing wells in vicinity)
4	HJ038 (1744+000)	This inactive dump is located in a dry channel immediately south of Cluett Creek 400m upstream, just north of Destruction Bay. Located 500m west of the Alaska Highway on the south side of Cluett Creek.	Hydrocarbons, debris, refuse	Limit or avoid soil disturbance
5	HJ040 (1760+200)	Active Dump. Old Military dump/staging area. On both sides of old access road to Burwash Landing just north of Alaska Highway. WWII location of a pan american building with a borrow pit acros the road. Access road now a residential street in Burwash Landing.	Hydrocarbons (below CCME detection limits), debris, refuse	Avoid disturbing buried waste
5	HJ039 (1761+900)	Dump for domestic and construction waste (abandoned). Near mile post 1086 north f Destruction Bay on Alaska Highway, acces is an army pioneer road from the shore of Kluane Lake near tower marked AM186W, adjacent site nerar junction of army pioneer road andtelephone right of way.	Refuse, debris, Some groundwater metal concentrations exceed CCME criteria for freshwater aquatic life (presumed natural presence except chromium)	Avoid disturbing buried waste
6	BC036 (1771+200)	Mile1100 Alaska Hwy (north of Duke River). Abandoned Gravel pit and staging area.	Hydrocarbons/fuel, drums, debris, refuse	Cover waste and/or removal to approved dumpsite if necessary to remove
6	HJ041 (1772+700)	Mile 1102 Alaska Hwy (North of Duke River) 750-1000 metres northeast of highway.	Hydrocarbons, asbestos, debris, refuse	Limit disturbance and/or removal to approved dumpsite
6	BC008 (1775+700)	Burwash Creek (RHS). Military Staging area, abandoned dump. In vicinity of Borrow site (identified as a possible field camp)	Debris, refuse, scrap metal (culverts)	Cover waste and/or removal to approved dumpsite if necessary to remove
6*	HR 50 (1783 + 300)	Sakiw Creek (L.H.S.) Old refuse dump	Buried refuse and debris	Avoid disturbing buried waste

* Refuse dump Identified on Heritage Resource maps (as HR-50) & Described in Section 2.0 Archeological & Traditional Land Use Impact Assessment.

4.0 WILDLIFE & WATERFOWL

4.1 GENERAL

This environmental assessment update addresses the potential impacts of the Alaska Highway realignment from Jarvis River to Quill Creek, on four principal species/guilds, including Dall sheep, woodland caribou, birds of prey and Sharp tail grouse. These species/guilds were considered the Valued Ecosystem Components (VEC) in the original Environmental Impact Assessment for the Shakwak Project (DPW, 1978), and specified in the terms of reference for this project. This choice reflects their local and national importance, and their inherent vulnerability.

Other species including moose, grizzly bears, ground squirrels, and porcupines, although not specified in the terms of reference for this project, are discussed, but did not receive the degree of attention given to the four principal species/guilds. Canids (dog family), although specified in an earlier environmental assessment from Quill Creek north to Beaver Creek (Sentar, 1979), were given minimal attention in this review. Wolves have been subjected to an intensive cull program north of the corridor. Coyotes as a recent immigrant to the area are abundant, adaptable, and require no special attention, while foxes are ubiquitous to the north and exhibit broad habitat tolerance. The highway realignment was deemed of trivial consequence to these resilient canid species.

4.1.1 Approach

To assess and mitigate impacts on wildlife and their habitat from the proposed realignment project, the following general approach was used:

- assess what ecosystem components are at risk (Baseline Data);
- predict how these components are at risk (Risk Assessment);
- develop guidelines and options to avoid or minimize the predicted impact (Mitigation);
- consider options which will rehabilitate impacted areas; and

- propose a monitoring plan intended to measure the long term residual impacts of the project.

Risk assessment attempts to predict the degree of risk to different species and habitats imposed by different land use activities. The effects of the impact will depend on a number of factors: when the activity will occur; how sensitive habitats and species are to habitat change and disturbances; and the severity and scale of the activity. Risk assessment can be categorized as:

(a) impacts to habitat (i.e. direct loss of habitat, habitat fragmentation, or habitat changes which influences forage species);
(b) impacts which influence an animals distribution pattern (displacement from habitats due to avoidance or movement barrier);
(c) impacts which influence an animals activity pattern and/or produce physiological stress (i.e. these changes can result in suboptimal body condition and subsequently predisposition to disease or loss of productivity, or result in the breaking up of groups predisposing animals to greater risks of predation and more vigilant behaviour); and
(d) impacts which directly kill or injure an animal (i.e. roadside revegetation or road salting can attract animals to the road and therefore predispose them to higher risk of traffic accidents).

Obviously these attributes are interconnected; for example displacement can affect habitat availability, or predispose animals to higher levels of predation.

Therefore, <u>for each species or guild</u> identified through the study objectives or identified through previous studies and resource information, the following was generally undertaken:

- assess the relative value of the species;
- assess its vulnerability to disturbance or habitat loss;
- consider the timing of the impact and sensitive periods in the animals annual cycle; and
- assess the severity or degree of the impact, with attention to impacts which disturb habitats, alter the animals behaviour, and induce mortality.

Results of various wildlife and waterbird studies that could be graphically shown are presented in Figures 4-1 through 4-13, Volume II.

4.2 CARIBOU

4.2.1 Introduction

The Kluane caribou herd is one of four distinct Alpine wintering caribou populations occupying ranges within the precipitation shadow of the St. Elias Mountains. Seasonal activities of the herd are concentrated in two areas: the Burwash uplands to the south of the Shakwak Trench (Project corridor) and the Alpine plateau west of Brooks Arm north of the trench. There has been recent range extension into the Tincup Lake and the Serpenthead Lake Uplands between Brooks and Talbot Arms.

Population estimates of 350 – 450 animals (Gauthier, 1984) and fewer than 200 (1998) (B. Hayes, per comm.), demonstrate a population decline over the last two decades. Reasons for this decline are unknown but climate may be a factor (R. Farnell, pers comm.). In this context, any direct mortality or reduced productivity through range alienation related to the project is significant to a population already stressed by hunting, high predation rates, and other human activities in their range south of the Shakwak Trench.

4.2.1.1 Area Concerns

Project construction and operational phase corridor activity will not directly impact remotely adjacent uplands supporting seasonal activities such as the rut, calving, post calving and foraging. Although significant numbers of caribou were observed in the project area south of the road between Burwash and Glacier Creeks in late winter, 1982 (Gauthier, 1984 and 1993, R. Farnell, pers. comm.), there is no evidence that the project area is consistently occupied as seasonal range, (Gauthier, 1983).

Both construction and operational phases however, may directly impact caribou movements in the approximately 22-km migration corridor between the Duke River and Quill Creek.

4.2.1.2 Timing Concerns

Peak caribou movements across the Shakwak Trench between the Duke River and Swede Johnson Creek normally occurs in the spring during the entire months of April, May and during the fall months of September and October and November. Minor movements in both directions however are documented during the winter months of January, February and March (Gauthier 1984, Wing, 1982, and Brown, 1981). Significant movements of caribou during September are documented by Gauthier, et. al (1983) and further supported by analysis of recent telemetry data and recent anecdotal sightings (D. Makkonen, R. Chambers, pers. comm., 1999).

Construction phase impediment of these movements is a concern.

4.2.2 Methods

There is an extensive database for the Kluane caribou herd dating back to the late 1970’s. Two graduates theses have been produced based on studies of this herd. Anecdotal records have been mapped by Parks Canada, and more recently YTG has accumulated a comprehensive data set. Key habitat maps have been produced by YTG Renewable Resources. This product does not take into account more recent and continuing empirical studies within the YTG Fish and Wildlife Branch.

With the co-operation of the caribou section of the Yukon Fish and Wildlife Branch, a raw data set has been analyzed which provides geographic locations of radio collared caribou and caribou observed during systematic searches during key periods of their annual life cycle. A G.I.S. map has been produced which identifies seasonal ranges (Figure 4-7, Volume II).

A search for relevant material in the technical literature and interviews with personnel from federal and territorial agencies and interviews with knowledgeable residents of the Kluane area outline the current picture of Kluane caribou movements and range use patterns.

There are few studies of the impacts of linear developments on woodland caribou (see reviews by Barichello and Johnson, 1996 and Shideler, et al., 1986).

4.2.3 Discussion

Background:

The original Shakwak Highway improvement impact statement (DPW, 1977) provided broad guidelines to mitigate impacts on a variety of terrestrial mammals. Caribou in general and the Kluane herd in particular were not identified as a priority species of concern. This was due to a lack of knowledge of caribou demographics in the region.

However, the Environmental Assessment Panel Report - Shakwak Highway Project recognized the need for developing demographic studies on the Kluane caribou herd, and coordinated with similar work being undertaken by Foothills Pipelines (Yukon) Ltd. Conclusions and recommendations (#14) in this Panel Report provide that no new facilities such as camps, gravel crushers and asphalt plants be located between Burwash airport (km 1765) and Quill Creek (km 1794).

Between 1978 and 1982, scientific information on the Kluane caribou herd was expanded with the work of Gauthier (1984) and Brown (1981). Kluane caribou herd demographics, migration routes and timing and seasonal range use patterns were investigated and described in detail. Continuing studies by YTG Renewable Resources (1990-1999) confirm these earlier findings. These studies elevated concerns for the Kluane caribou herd.

4.2.4 Potential Impacts - Highway Realignments

4.2.4.1 Construction Phase

Habitat alteration: - Physical barriers to caribou movements.

Highway cross sectional profiles as usually constructed, with low gradient side and backslopes and a gently contoured right-of-way, should not impede caribou movement. However, deep cut and fills or a high-grade line relative to the adjacent terrain could impede caribou movement (Miller, 1983). These construction features at specific crossing locations would be undesirable.

Specific crossing areas on the right-of-way (km 1780 – km 1790) and adjacent Kluane River floodplain should not be compromised by extensive local habitat alteration – i.e. camp facilities, borrow pits, and new ancillary structures such as rest areas, roadside turnouts, etc. Potential camp construction and borrow sites 32 (B), 34 (B), 33 (C) and 37 (C) are poorly situated in this regard (see Figure 4-6, Volume II).

Revegetation of the right-of-way: - Duke River to Quill Creek

Concern has been raised by YTG – Renewable Resources personnel of the potential risk to caribou of vehicle collision due to their persistence in the corridor because of favorable foraging conditions (L. Larocque, R. Farnell, pers. comm.). Yukon Government, Community & Transportation Services, Transportation Engineering Branch, responded by modifying the seed mix for reclamation within the highway corridor from White River to Beaver Creek. Although caribou are known to have been involved in vehicle collisions (A. Nixon, pers. comm., D. Drummond, pers. comm.), the revegetation (modified accordingly) is not necessarily the cause of these accidents. Nevertheless, the concern should be acknowledged with the continued application of a seed mix devoid of legumes (as applied along the right-of-way north of White River), to minimize the attraction of caribou to the roadside.

Right-of-way clearing: - km 1780 to km 1790

Clearing a minimum right-of-way width would likely be less of a barrier to caribou movement (R. Farnell, pers comm.). Supporting data is not available; however, a minimal right-of-way in conjunction with the necessity of revegetation with the a seed mixture devoid of legumes should minimize caribou road encounters..

Because the question of revegetation is an important one to caribou managers, and seed mixes have not been thoroughly tested as to their attractiveness to caribou, there should be an open dialogue between Yukon Government, Departments of Renewable Resources and Community & Transportation Services. It is expected that these discussions will lead to an acceptable seed mix which can be applied in such a way as to meet reclamation objectives while minimizing use by caribou.

4.2.4.2 Operational Phase

Collision Mortality:

A primary concern is traffic collision mortality. Peak traffic volume during the summer tourist season occurs when caribou numbers on the road are expected to be an occasional occurrence. However, regular movements across the road, particularly during the spring and fall migration periods (April, May, and September through November, respectively), and the occasional presence of caribou in the corridor during winter months increases the probability of collisions. Late winter collision mortality is documented between Sakiw Creek and Glacier Creek (D. Drummond, pers. comm.), however detailed numbers are not available.

Use of Road Salts:

Predisposing caribou to traffic mortality during the winter months through the use of road salts is a concern. Forest wintering woodland caribou in southern Yukon and Northern B.C. are commonly observed on the Alaska Highway licking salt from the road surface (Tetsa, Stone Mountain and Muncho Provincial Parks, and Little Rancheria herd west of Watson Lake Yukon.) Three caribou were killed west of Watson Lake in mid November 1999. Road salt was likely a contributing factor (R. Florkiewcz, pers. comm.) Road salt, when available, is eagerly sought by caribou, their persistence often impedes traffic. Kluane caribou normally winter away from the corridor. However, their cross-corridor winter movements and occasional extended presence near the corridor (1982 and 1993) requires that the use of road salts be minimized. It is noted that currently little salt is used between Jarvis River and Quill Creek (M. McArthur, pers. comm.). Salt is typically mixed with sand at a ratio of 25 to 1, applied primarily to hills and corners. Only when temperatures exceed –5^{o}C, is 100% salt applied. Continued practice of minimal application of salt is recommended, in particular in the section of road between Duke River and Quill Creek.

Perceptual Barriers to Caribou Movement:

Pertinent to the Shakwak project are the concerns expressed by Gauthier, et. al. (1983).

Specifically, regarding the implications of the Alaska Highway gas pipeline to the cross-trench movements of the Kluane Caribou herd, they concluded that “disruption of these movements could ultimately lead to reduction in herd numbers (functional loss of range), therefore, factors that may affect movement between the two subregions such as the proposed pipeline must be of major concern”. They also state that the degree of disturbance that Kluane caribou will tolerate before population level effects of increased mortality or decreased productivity are evident is not known.

The eighth North American Caribou Workshop Panel Discussion (1998) brought out the following points in the context of linear development:

- The types of activity that most disturb caribou are ground based moving stimuli such as vehicles, in comparison to stationary developments like pipelines; and,
- Weaknesses in the environmental review and assessment process fail to quantify the effects of cumulative impacts.

Caribou tolerance thresholds to various human disturbances are unknown. Increased human disturbance factors such as traffic noise, volume and speed, increased tourism and recreational activities are all possible consequences of the Shakwak Highway Project.

A rationale for mitigation will accommodate this perspective.

Hunting:

Caribou are a highly valued country food and recreational resource for Yukon resident and aboriginal hunters. These activities commonly occur where roads intersect migration routes or seasonal ranges. Kluane caribou are hunted on seasonal ranges in the Burwash Uplands and the Brooks Arm area and until recently along the existing Alaska Highway (R. Chambers and L. Larocque, pers. comm.)

Currently resident or aboriginal hunters do not hunt the Kluane caribou herd by regulation, and a compliance agreement exists with Yukon First Nations in a 2 km wide corridor along the highway between Slims River and the Alaska border.

This appears to be a non-issue at the moment, however it is entirely dependent on compliance. The degree of compliance is not known. The no hunting corridor is not popular with many area residents and First Nations, and is presently under review. Aside from direct hunting mortalities, hunting from and near roads add another human caused perceptual barrier to normal migration movement and should be considered a cumulative impact.

4.2.5 Mitigation Recommendations

The following recommendations generally pertain to the approximately 22-km portion of the project between Duke River and Quill Creek. Site specific recommendations focus on the 10 km portion of the project between km 1780 and 1790 (Quill Creek).

4.2.5.1 General Recommendations (Duke River to Quill Creek & Glacier Creek)

1. Erect attractive and reflective permanent signs forewarning the public that caribou may be on the road. Public safety and reduction of collision mortality require common sense and precautionary warning.

- At identified crossings: km 1780 –1782, km 1783-1786 (Sakiw Creek) and km 1790 – 1793 (Glacier Creek), erect similar signs identifying the area as a crossing. This may require fine-tuning based on collision records, additional survey results and post construction monitoring experience.

- During peak migration periods and during the winter months when caribou are known to be in or near the corridor, additional warning procedures should be implemented to the extent of regulating and enforcing traffic speed. Warning signs are not an effective measure in reducing ungulate collision mortalities because drivers typically do no respond by sufficiently reducing speed (Brown and Ross 1994).

2. Revegetation of the right-of-way:

   It is recommended that reclamation seed mixes devoid of legumes continue to be applied to reclaim the right-of-way. Continued dialogue between Yukon Government, Departments of Renewable Resources and Community & Transportation Services might yield a more appropriate source of seed – this dialogue is encouraged. For example, Arctic poppy has been successfully used in Alaska for bison control on ROW and commercial quantities are apparently available.

   If native grass mixes are available only in limited quantity, they should be applied on the identified caribou crossing areas (km 1780-km 1790). Native grass seed mixes are available locally (S.A. Ryan, pers. comm.).

3. Right-of-way Clearing

   Clear the minimum right-of-way width. This is especially recommended from km 1780 to km 1790. The right-of-way clearing and revegetation recommendations are intended to help caribou cross the corridor while discouraging any incentive to remain in the area.

4. Construction timing: Burwash Creek – Quill Creek

   The timing of construction activity can significantly reduce disturbance impact. Caribou will least likely be in or near the corridor during the summer months of June, July and August of possible construction activities should be scheduled to accommodate this natural window.

5. Construction Phase Habitat Alteration (km 1780 to km 1790) including the adjacent Kluane River floodplain:

   Potential camp construction sites 34 (B), 33 (C) and 37 (C) (Figure 4-6, Volume II) lie dead centre on the most intensively used caribou crossing at Sakiw Creek. Alternates to these borrow (camp) sites is strongly recommended. Site 32 (B) is similarly situated on an important caribou crossing. An alternative to this site is also recommended.

An option to those sites for which an alternative cannot be found is related to construction timing: utilization, preliminary reclamation (site contouring) and abandonment of the area during the summer construction period.

6. The current practice of minimal use of road salts should be encouraged, particularly for sodium chloride. Calcium chloride already in common use is less attractive to ungulates (K. Brown, pers comm.).

   Entering experimental trials in Alberta, lithium chloride is being investigated as an alternative for limited applications in areas of chronic ungulate collision mortality. This compound acts as a repellent as well as discouraging habitual use (K. Brown, pers comm.)

7. The prevailing Yukon Government, Department of Renewable Resources policy of a hunting closure as it applies generally to the Kluane caribou herd should remain in place in addition to the enforcement of the Yukon Wildlife Act.

8. A five year monitoring program should be put in place to address the objectives outlined in the discussion section. Generally, the program would involve ground truthing and documentation of seasonal herd movements. Remedial mitigation may be required.

9. Existing local land use access between Burwash Creek and Quill Creek for recreation and subsistence purposes should be accommodated at the present level of use. However, the development of new off highway access is discouraged. Currently practiced scarifying and cross trenching at the points of egress from the new roadway should be continued.

10. Vulnerable area identification: aside from the retention of the Kluane River lookout, it is recommended that no new roadside structures such as rest areas, pull outs, kiosks, etc., be built between Burwash Creek and Quill Creek.

4.2.5.2 Kluane Caribou Herd - Identified Migration Crossings

Gauthier (1984) found that all caribou crossings of the Shakwak Trench occurred within a 37 km zone-from Burwash landing to Swede Johnson Creek. Within this zone, 97% of all observed crossings occurred in a 14 km portion between Burwash and Glacier Creeks. Within this main portion, three major crossings lie within and immediately north of the current project: km 1780 to km 1782, km 1783 to km 1786 (Sakiw Creek – Quill Creek) km 1791 to km 1792.3 (Glacier Creek).

That these main crossings are still used is supported by recent sightings reported to the Haines Junction Yukon Government Regional office and by interviews with Kluane area residents. Crossings between Duke River and Burwash Creek, while apparently less frequent, are recently documented.

Caribou activity in the Copper Joe Creek area is in the uplands between Copper Joe Creek and the Duke River in late summer (L. Larocque pers. comm., R. Chambers, pers. comm.) and in the spring (based on Yukon Government telemetry data). No evidence of highway crossings was found.

It appears then that mitigation provisions should focus on the areas between Duke River and Quill Creek, and particularly the ten kilometres between km 1780 and km 1790 (see Figure 4-7, Volume II).

4.2.5.3 Species Vulnerability

Habitat sensitivity:

Seasonal movements among various habitat types are crucial to the productivity and survival of woodland caribou. These movements are learned and traditional. Because of their wide ranging nature, caribou are particularly susceptible to human development which may impede these movements and access to preferred habitats. Isolated calving, winter foraging (with project related exception) and rutting habitats are particularly sensitive, but of no immediate project concern. Migration corridors are sensitive to disturbance and directly concern the Shakwak Project.

Behavioral sensitivity:

A broad and confusing literature is summarized in the Yukon land use guidelines and analysis of this material would not lead to any meaningful recommendation for mitigation.

None of the 23 distinct populations of woodland caribou in the Yukon have been examined by the Committee on the Status of Wildlife in Canada (COSEWIC). Woodland caribou populations in British Columbia, Alberta, Saskatchewan, and Manitoba were last examined in 1984. Risk status is considered vulnerable (a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.)

Alberta has recently designated several woodland caribou populations as endangered due to increased exposure to linear developments.

Potential impacts of linear developments:

The existing highway has the potential to form a barrier to the normal movements of the Kluane caribou herd by physical disruption of key corridor crossing areas (km 1780 – Swede Johnson Creek) and perceptual disturbances such as traffic noise and movement.

Construction phase impacts (physical barriers and disturbance) are relatively less difficult to mitigate than the longer term impacts of human activities in the operational phase. Disturbance can be defined as any activity by, or associated with humans, which increases the physiological costs of survival or decreases the probability of successful reproduction (Barichello and Taylor, 1997). As noted earlier, caribou tolerance thresholds to these types of disturbances are not known.

In order to address disturbance impacts and evaluate the success (or failure) of adopted mitigation recommendations, a proactive rather than a reactive response to these problems should be adopted.

To this end it is strongly recommended that the Department of Community & Transportation Services assist in coordinating and funding a post construction-monitoring program with the Fish and Wildlife Branch, Department of Renewable Resources, and the Kluane First Nation. Alberta has successfully implemented an interdepartmental program to monitor and mitigate similar problems with two woodland caribou populations near Grand Cache on route 40 (K. Brown, pers. comm.).

Details of program design, co-ordination, and implementation would rest with the respective departments and KFN. Basic program design should accommodate the following:

- Ground monitoring of caribou movements and locations September through May;
- Periodic aerial monitoring especially along the corridor, and complementary to the on going seasonal telemetry based surveys currently being conducted by YTG Fish and Wildlife Branch; and
- The possibility of using GPS Technology. Even on a small scale this has contributed substantially to the Alberta program (K. Brown, pers comm.).

Program objectives would include:

- Ground truth adopted mitigation options;
- Fine tune mitigation options;
- Provide timely response to the extended presence of caribou in the corridor;
- Quickly identify contributing causes of collision mortality; and
- Assist in understanding herd demographics.

One of the benefits of a monitoring program beyond evaluating consequences and remedies is that it introduces a broader based community approach to problem solving. The endorsement of mitigation provisions by Kluane region residents, with the idea of “being involved ” both in the planning and implementation of a monitoring program, will go along way in assuring it’s success.

4.3 DALL SHEEP

4.3.1 Introduction

Dall sheep have been identified as a key species along the Alaska Highway (EIA, Shakwak Panel Report; Sentar, 1994, terms of reference for this project). The unglaciated portion of the mountains of Kluane National Park and the Kluane Wildlife Sanctuary adjacent to the Alaska highway represent the best thinhorn sheep habitat in the Yukon, and at Sheep Mountain Dall sheep reach their highest densities. To heighten concern, there is general agreement among ecologists that wild sheep are the most sensitive of all northern big game species to disturbance and impacts to their habitat (Hoefs and Mychasiw, 1996).

The potential risks within the current project area are concentrated in two areas, both in the Kluane National Park where sheep are relatively safe from recreational hunting. Sheep occur immediately adjacent to the Alaska Highway from fall through spring at Sheep Mountain and occasionally along Williscroft Creek below Mount Wallace. With the exception of a seasonal movement to a mineral lick below the highway at Sheep Mountain, and a rarely used movement corridor below Quill Creek (R. Chambers, pers. comm.), there are no known sheep highway crossings within the project area. Although there are serious concerns here due to the sensitivity of sheep to disturbances and their periodic contact with the road, it is noted that sheep will habituate to a considerable amount of human activity if they are not “perceived” to be in danger (Hoefs and Mychasiw, 1996; MacCallum, 1991). Nevertheless, mitigation should be precautionary, with attention to indirect dangers associated with the road and it’s traffic.

4.3.2 Methods

Existing Data

Sheep have been intensively studied and regularly watched since 1969 at Sheep Mountain (Hoefs and Cowan 1979; Marsha Flumerfelt, pers. comm.). In fact, probably more is known of this population than any other across their range. For the current project, observations and opinions about sheep were drawn from M. Hoefs Ph.D. thesis and discussions with local experts familiar with this sheep population (see Appendix I). No current field observations were made.

4.3.3 Discussion

4.3.3.1 Sheep Distribution, Abundance and Habitat Use Patterns.

The following synopsis of sheep abundance, range use, and activity patterns are drawn from Hoefs and Cowan (1979), and fine-tuned by observations from Marsha Flumerfelt, Parks Canada, Interpretative Centre.

Sheep using Sheep Mountain and Williscroft Creek represent a population generally bounded by Kluane Lake, Slims River, Congdon Creek and Bullion Creek. From 1969 to 1974 the population was found to number between 195 and 206 adult sheep; the range is believed to sustain 150 to 200 adults. Sheep Mountain is the principal winter range, with an additional wintering area along the north side of Williscroft Creek which supports up to 60 individuals. Most of the population (90% of nursery bands and 50% of ram bands) summers along the west flank of Mt. Wallace, the north slope of Sheep Mountain, and the headwaters of Williscroft Creek. Most of the remaining population extends across Bullion Plateau and north to the Duke River.

Migration between ranges is a gradual process taking place in the first half of June with a return in the second half of August (Figure 4-3, Volume II). Sheep are seldom if ever present on Sheep Mountain in July. A vertical migration also takes place, dictated largely by nutritional factors, snow, and insects. Rams are confined to lower elevations in the Boreal zone in the winter (December to April), climbing with the retreating snow line, and descending again during the second half of December. Ewes retreat to higher elevations during the lambing period (May) but otherwise follow the early plant phenology preceding the rams up the slope, reaching their alpine summer range by late June and attaining their highest vertical distribution in July. This general pattern of movement along an elevational gradient is modified in May and early June by the use of scattered mineral licks. Based on 23 years of observation at Sheep Mountain, M. Flumerfelt indicated that the latest evacuation of the winter range was on 22 June, 1999.

Movement patterns have changed somewhat since Hoefs detailed study in the early 1970's. In recent years sheep are found frequently on the bluff above the road at km 1707.5, and periodically crossing the road between km 1708.5. A shift in the location of lambing has also been evident, with lambing now relatively common near the bluff adjacent to the road between km 1707 and 1708 (M. Flumerfelt, pers. comm.). Two plausible explanations may explain this shift in distribution. The recent reconstruction of the highway at Parks Canada Soldier Summit may have exposed or deposited mineralized materials thereby creating an attractant near km 1708 (M. Hoefs, pers. comm.). As well, with increased traffic levels, the corridor may provide more security from Golden eagles during the lambing season (M. Flumerfelt, pers. comm.).

Three mineralized areas have been identified within the project area (Figure 4-3, Volume II). One area is approximately 20 m from the Alaska Highway just above Alex Fishers cabin and below the telephone lines at km 1707.5 (M. Flumerfelt, pers. comm.). A second has recently been identified beside Kluane Lake at km 1708. And a third licking area has been identified as a possible result of road reconstruction in the vicinity of km 1707–1708 (M. Hoefs, pers. comm.). Use of these licks begins soon after 15 April and can persist until late June; during this time sheep periodically move between the lick and spring pastures, crossing the road when utilizing the lick near the lake's edge. Disturbance studies on the north side of Kluane Lake observed a preponderance of lick use after 10 a.m. during the spring and early summer (Frid, 1995).

The synopsis above underlines five points which can be made in relation to Dall sheep and the current realignment project.

1. Sheep are typically prevalent within or immediately adjacent to the project corridor from October though May at the base of Sheep Mountain, and in some years the north side of Williscroft Creek. In some years sheep return to the winter range as early as 20 September.
2. April through mid-June are particularly sensitive periods; in April sheep are typically confined by snow conditions (snow reaches greatest accumulation in April), May is the lambing month (reaching a peak in the 3rd week of May) and from late April to late June sheep occasionally compromise their safety by venturing to mineral licks.
3. Key habitats within or immediately adjacent to the road corridor include winter range and mineral licks.
4. Sheep occasionally cross the road to utilize a lick beside Kluane Lake. An infrequently used migration route (R. Chambers, pers. comm.) (perhaps repeated once every 10 to 20 years) along Quill Creek and across the Alaska highway to the mountains north of the Kluane River is considered too rare an event to stimulate mitigation measures.
5. The recent prevalence of sheep near the road in late March through May could be the result of lick use in the vicinity of escape terrain at km 1707.5.

4.3.3.2 Species Vulnerability

As mentioned in the introduction, sheep are vulnerable to human activities. Sheep are small and gregarious, they cannot excavate through deep snow, they eat coarse low-quality forage throughout the winter and so require mineral supplementation in the spring, and they cannot sustain fast speeds when pursued. Therefore they have specialized needs for relatively snow-free open pastures adjacent to cliffs and mineral licks. Access to cliffs, which provide refuge from predators, is particularly important during the lambing period. Traditional use of these key habitats, knowledge of which is passed between generations, underlines their importance (Geist, 1971). Wild sheep are also prone to stress (MacArthur, et al,1982) which may predispose them to diseases. Disruption of movements, damage to habitats, or persistent elevated stress levels, may have a severely debilitating impact on populations. Dall sheep are also very obvious and often accessible to all terrain vehicles and other intrusions, predisposing their vulnerability.

Negative effects of disturbance have been described by Geist (1971), Hoefs and Mychasiw (1996) and Frid (1995), and include injury from flight responses, fragmented social structure (including separation of mother and offspring), displacement from key habitats, disruption of activity patterns, reduced foraging efficiency, and increased heart rates. These behavioural and physiological adjustments can result in deterioration of body condition, depressed reproduction, or increased lamb mortality. For details, refer to Geist (1971), Hoefs and Cowan (1979), Hoefs and Mychasiw (1996), and Frid (1995).

As a testimony to cautious management, thinhorn sheep, despite their fragile nature, number over 100,000 across their range, and are one of the most common species of sheep in the world (Hoefs and Mychasiw, 1996). In Canada, and, in particular, the Yukon populations are for the most part robust and stable, and they are classified “not at risk” by COSEWIC and management agencies.

4.3.4 Potential Impacts of Linear Development

On the basis of current literature review, it has been shown that linear developments can have a devastating impact on sheep if poorly planned and associated with hunting (Hoefs and Mychasiw, 1996). The rationale below is drawn from land use guidelines prepared by Hoefs and Mychasiw (1996).

4.3.4.1 Displacement due to Perceptual Disturbances

Few studies have been conducted to evaluate the response of sheep to unfamiliar noise, smells, and movement of machinery. The studies that have been done indicate that sheep are sensitive to noise (Fudyk, 1983; Fletcher and Busnel, 1978; McCourt, et al, 1972), and will make increasing use of steep terrain when disturbed (Murie, 1944). Sheep were found to abandon preferred habitats when disturbed by helicopters flying 100 feet above the ground, particularly in the spring (Bleich, et al, 1994). Also, sheep have been found to abandon range following new access roads, although it is unclear whether they were displaced from noise, smell, or hunting pressure (DeForge, 1972; Geist, 1975; Tracey, 1977). Frid (1997) in a comprehensive review of the literature, proposed that disturbance might alter antipredator behaviour in Caprinae (sheep and goats), and result in displacement, greater energetic costs, or reduced foraging efficiency. However, it has been suggested that sheep adapt to noise if it is not accompanied by danger (Cowan, 1975), or if the disturbance is of low intensity (Reynolds, 1974). Acknowledging these reports, a precautionary approach is suggested simply by avoiding construction activities when sheep are close by.

4.3.4.2 Physical Barrier to Movements and Collisions with Automobiles

There has been considerable attention to the problem of roads as a physical barrier to sheep. Losses through collisions have been found to be common in some areas (Flygave, 1979; Geist, 1971; Hansen, 1971; Harrison, et al, 1982; Holroyd, 1980; VanTighem, 1981). Also, concern has been raised about the possibility of blocking migration routes and disrupting traditional range use (Geist, 1971; Graham, 1980; Hansen, 1971; Horejsi, 1976; Packard, 1946), which could result in a functional loss of habitat or a loss of genetic diversity over time.

Within the project area, the principal concern is the potential for collisions if sheep continue to use the lick on the northeast side of the highway or on the edge of the road at km 1708. There is no simple inexpensive solution to mitigate movements across the road. Fences and underpasses have been erected in Banff National Park to deflect sheep away from high volumes of traffic or allow them safe passage across the road. However, these mitigation efforts have largely failed. A fence erected to keep sheep off the road in Banff National Park denied them access to a road cut that was used as escape terrain, and coyotes quickly learned to intercept and chase sheep into the fence and kill them (D. West, pers. comm.). Similarly, predators have adjusted their hunting effort in the vicinity of the underpass, predisposing sheep and other ungulates to elevated levels of predation pressure (R. Breneman, pers. comm.). Thus, although providing an option to minimize the risk of traffic accidents, these projects have facilitated greater levels of predation.

For the Shakwak Project, a number of options may mitigate the problem of lick use and movement across the highway, including:

(a) Rehabilitation of the mineralized site north of the alignment, by covering the mineralized materials with overburden may eliminate or reduce visitation by sheep;
(b) A fence may provide another means to keep sheep off the road and prevent them from crossing; or

(c) the scattering of salt blocks away from the road near this migration corridor may disrupt traditional movements across the road.

To reduce sheep contact with the road and the risk of accidents and predation over the entire conflict area, the following may be required: (a) minimal use of road salting and replacing sodium salts with calcium salts, (b) scattering salt blocks away from the road, and/or (c) fencing the entire length of highway at this location.

4.3.4.3 Habitat Loss

Habitat loss within the winter range is anticipated, and a mineral lick may be at risk to excavation within the alignment at km 1707.5. Loss of a small portion of the winter range is considered a minimal impact. The loss of the mineral lick may be of greater consequence. The new alignment should avoid disturbing this lick (see Figure 4-3, Volume II). If unavoidable, consideration should be given to drop mineral supplements away from the edge of the road, if agreeable to Kluane National Park staff. Reconditioning of sheep behaviour to use alternate licking sites may take time; in the short term, contact with the road and its traffic may be unavoidable.

4.3.4.4 Disturbance and Increased Mortality due to Roadside Attractions

Revegetation and the use of salt has been found to bring sheep in contact with traffic, leading to collisions, disruption of normal range use patterns (McCrory, 1975; Damas and Smith, 1982; Sanderson, 1983), and increased risk of wolf predation (Murie, 1944; R. Chambers, pers. comm.). Along the Shakwak right-of-way, five principal concerns emerge:

(1) the continued application of road sand with salts enticing sheep to the roadside puts them at risk for collisions and wolf predation;
(2) the destruction of an existing lick will alter sheep movement patterns and possibly result in insufficient mineral supplementation, or increase their use of salts along the roadside;
(3) the exposing of new mineralized areas that will draw sheep to the roadside;
(4) revegetation of the right-of-way with forage plants may attract sheep to the roadside; and

(5) the creation of road cuts may provide sheep with escape terrain, and therefore increase contact of sheep with the highway.

To mitigate, consideration should be given to fence, supplement minerals with salt blocks, avoid creating shear cliffs (escape terrain) on the lake side of the road corridor, which may induce sheep to cross the road to access such cliffs, reduce application of road salts, and plant undesirable plants to stabilize the right-of-way.

4.3.4.5 Disturbance and Hunting Mortality from Increased Recreational Opportunities.

There are numerous examples of elimination or redistribution of local sheep populations from increased hunting pressure (Cowan, 1971; Hoefs and Cowan, 1979; Pendergast and Bindernagel, 1977; Sanderson, 1983). Here in the Yukon overharvest and population declines have been observed off the Nahanni Range Road, Long Lake Road, Montana Mountain and Granite Lake Road. Clearly, hunting, off-road vehicles, and free-ranging dogs must be prohibited within the highway corridor if there is any hope of maintaining existing sheep distribution and a relatively stable population. To discourage off-road activities, highway pulloffs and kiosks should be minimized in this area.

4.3.5 Mitigation

Table 4-1 summarizes the principal impacts, concerns and general mitigation guidelines for Dall sheep.

Table 4-1 Principal Concerns of Road Realignment and Mitigation Options for Dall sheep, between km 1704 and 1719

Principal Concerns	***General guidelines***
Displacement due to Perceptual disturbances	
• *Potential displacement of sheep away from winter range, lambing cliffs and mineral licks as a result of disturbances from heavy equipment (compacting, trucks, sirens), and blasting* • *Potential displacement as a result of camps and pedestrian activity*	• *Construction activities should not take place within this section of road corridor between 1704 and 1719 from 30 September - 25 June.* • *Do not establish camps, gravel quarries, or other staging areas within this corridor. Where this is unavoidable, place facilities where terrain features obstruct line of sight with sheep concentration areas.*
Physical barrier to movements & collisions	
• *Traffic accidents as a result of sheep using the roadside or crossing the road.* • *Where sheep are in contact with the roadside there is an increased risk of predation by wolves.*	• *Do not deny sheep access to the bluffs which serve as escape terrain at km 1707.* • *Rehabilitate the lick on the northeast side of the current alignment by covering with overburden or removing the mineralized materials; or provide mineral supplements away from the road; or prevent sheep from using the lick by fencing.* • *Use signs to advise drivers of potential presence of sheep within the corridor.* • *Design roadway (road profile, ditching, and width of right-of-way) to maximize line of sight at sheep contact points to decrease risk of surprise encounters with sheep.* • *Consider erecting fences at sheep contact points (km 1707 to 1712).*
Habitat Loss	
• *Mineral licks* • *Escape terrain* • *Loss of winter range is considered a minimal risk in relation to the extent of the winter range.*	• *Do not remove mineral licks, unless purpose is to deflect sheep away from dangers. If unavoidable consider mineral supplementation.* • *If possible, do not destroy, or prevent access to, cliffs which serve as refuge from predators* • *If possible, avoid cutting down trees in the winter range.*
Risk of disturbance and accidents due to roadside attractants	
• *Road salt* • *Revegetation* • *Cut banks (cliffs) which provide escape terrain.*	• *Use hot sand to reduce road icing if possible.* • *If salting occurs, use calcium and not sodium salt, and use modestly.* • *Stabilize the right-of-way with coarse, poor quality forage plants.* • *Do not enhance roadway with fertilization or mulching.* • *Avoid creating escape terrain on downslope side of the highway.* • *Consider fencing to keep sheep off the road.*

Principal Concerns	*General guidelines*
	• *Consider depositing overburden over the mineralized cut bank northeast of the current alignment, or remove the mineralized material, or provide salt blocks away from the roadway, or fence the point of crossing, to reduce the accessibility of these minerals to sheep.* • *Erect signs to advise drivers of the risk of contact with sheep along the roadside.* • *Consider dropping mineralized salt blocks away from the road corridor in an effort to discourage sheep from using the highway corridor*.
Hunting and disturbance associated with increased recreational opportunities	
• *Mortality from Hunting* • *Disturbance from pedestrian traffic, off-road vehicles, & photographers*	• *Encourage Parks Canada & YTG Renewable Resources to enter into agreement with CAFN to eliminate hunting from km 1704 – 1719.* • *Restrict use of off road vehicles.* • *Avoid placing highway pull-outs within this corridor. The Soldier Summit pull-out site is acceptable.* • *Do not locate camps, gravel quarries, or other staging areas within this corridor.* • *Erect signs to advise traffic that hunting is prohibited.*

4.4 OTHER SPECIES

4.4.1 Other Species

Although not targeted as valued ecosystem components in the original environmental assessment, nor referenced in the terms of this project, attention was drawn from local consultations to four other species, including Grizzly bears, moose, ground squirrels, and porcupines.

Grizzly Bears

Grizzly bears are both of significant value in the Kluane region and vulnerable to developments. In the Kluane area grizzlies reach their highest Yukon densities, and Parks Canada has identified them as an indicator of biological integrity for the Park. However, grizzlies are not abundant by nature, reflecting a very low reproductive rate that is the outcome of delayed age at sexual maturity, 3+ year interval between breeding, and small litters (1-3). Adding to a low reproductive rate, a social hierarchy among males (Bunnell and Tait, 1978) for few breeding opportunities may put cubs at risk to marauding males who gain some genetic advantage by killing cubs in order to gain breeding access to the mother.

Grizzlies also have very specific habitat needs. The persecution on cubs by males has led to dependence among producing females for maternity areas where the chance of encounters with males is small. Also, due to a relatively inefficient herbivorous digestive system, grizzlies have evolved denning requirements where they are dormant for a minimum of 7 months in order to minimize energy expense when food is difficult to acquire. During this denning period, cubs are born. In order to survive and lactate through the winter in a state of dormancy, grizzlies must gain substantial weight in the fall; this places a premium on specific fall foraging areas. Similarly, in the spring after emerging from hibernation, grizzlies must find adequate food of high quality to make up for winter weight loss. Again there is apparent preference for specific foraging plants and their habitats.

A generalist omnivorous diet also brings bears in contact with people through habituation to accessible garbage. With contact, there is increased risk to people of aggressive/defensive encounters, and a risk to bears of their being shot by hunters or as “nuisance” bears. If garbage becomes accessible in areas where bears naturally frequent, this poses risks on people and bears. The currently applied policy of establishing camps in disturbed areas should be practiced in conjunction with Yukon Government, Department of Renewable Resources garbage handling standards. Where practical, choose candidate camp sites away from the areas described below.

Recognizing that grizzlies are demographically fragile, with key habitat demands at specific times of the year and that they are readily attracted to garbage, this project attempted to identify maternity areas and concentrated feeding areas within or near the road corridor. Four key feeding areas were identified: along Silver Creek (M. Flumerfelt, pers. comm.), between Congdon Creek and Dutch Harbour (K. McLaughlin, pers. comm., D. West, pers. comm., R. Chambers, pers. comm.), along the east fork of Nines Creek (K. McLaughlin, pers. comm.), and along the Kluane River at the edge of the project area (R. Hayes, pers. comm., L. LaRoche, pers. comm.). Camps and staging areas should not be located in these areas if at all possible.

Furthermore, if practical, gravel quarries should not be located here in order to minimize the damage to these habitats.

Moose

Moose are not an obvious victim to changes in land uses. Moose are a successional species often benefiting from changes in the landscape which produce early succession seral stages (i.e. wildfires, logging, transmission line right-of-ways, etc.). Moose are also capable of adjusting distribution patterns to climatic and other environmental changes. However, they often meet calving needs in special habitats that offer predator avoidance characteristics, such as islands, wetlands, and peninsulas. Furthermore, in some parts of their range, deep snow displaces moose to specific “yarding” areas during the winter where they are concentrated and confined by snow. Also, as the most hunted species in the Yukon, moose are vulnerable to excessive hunting pressure imposed by improved access.

Two sites were identified as important moose habitats. An island in the Slims River delta has been a calving area to a moose for the last number of years (M. Flumerfelt, pers. comm.), and the area between the Jarvis River and Sulphur Lake is known as a seasonal movement corridor (R. Hayes, pers. comm.). The principal concerns for moose in these areas are: (a) disturbance from the calving site off Sheep Mountain, and (b) pull-outs or kiosks in the Jarvis River Valley which will improve hunting access. Mitigation measures include: delay construction activities in the Slims River area until after calving (mid to late June), and minimize the number of roadside pull-outs in the Jarvis area, while maintaining the existing pull-out. Yarding areas are not apparent over most of the southwest Yukon because snow conditions generally do not restrict movements and distribution.

Ground squirrels

Ground squirrels are a cornerstone species in the Kluane area, supporting a relatively robust food chain, as well as providing country food to First Nation people. But within the project area they are not widespread, occurring in two concentrated populations along Silver Creek (J. Allen, pers. comm.) and in the Duke Meadows (G. Dickson, pers. comm.). Roads often produce conditions that benefit ground squirrels, first, by producing elevated well-drained berms and debris mounds that facilitate burrowing, and second, by producing forage openings. The downside is that ground squirrels incur heavy losses from vehicle collisions. Nevertheless, linear developments are generally not considered debilitating to ground squirrel populations. With this in mind, and if practical, the establishment of elevated berms in the reclamation of borrow pits may enhance ground squirrel populations. A concern raised by G. Dickson that the highway upgrade may increase First Nation hunting opportunities on the Duke Meadows is beyond the scope of this assessment.

Porcupines

Porcupines are currently uncommon within the corridor, but are known to fluctuate in numbers. Although benefiting from disturbances which generate willow stands, porcupines are prone to collision from traffic when they are attracted to the roadside by road salts. Furthermore, there is some concern that denning sites may be altered or damaged within the corridor (G. Dickson, pers. comm.). Although this concern is acknowledged, there is little apparent mitigation given the low numbers and insufficient knowledge about denning sites in the corridor. Minimizing the use of road salts may reduce the risk of collisions with traffic.

4.4.2 Concerns and Mitigation

Table 4-2 summarizes other species potential impacts and mitigation options.

Table 4-2 Summary of Other Species Potential Impacts and Mitigation Options

SPEC	LOCATION	CONCERN	MITIGATION
Grizzly bear	Jarvis Silver Creek Dutch/Goose Nines Kluane River	Movement corridor Summer feeding area Early fall feeding Early fall feeding Fall salmon feeding	• No camps in these areas • If possible, do not establish gravel pits. • Adopt Yukon Government garbage handling standards
Moose	Jarvis	Migration corridor	• Minimize the number of highway pulloffs
Moose	Sheep Mountain	Calving on the island	• No construction activities between 15 April and 15 June. • No camps, staging areas, gravel quarries.
Ground Squirrel	Silver Creek	none	• Create elevated berms in reclamation of borrow pits to facilitate new colonies
Ground Squirrel	Duke River Meadows	Hunting by First Nations	• n/a
Porcupine	General	Road kills	• Minimize use of road salts.

4.5 BIRDS OF PREY

4.5.1 Introduction

The original environmental impact assessment (EIA) for the Alaska Highway realignment (Shakwak Project) identified Birds of Prey (Falconiforme and Strigiforme species) as a guild worthy of mitigation from impacts arising from the project. This group of birds has received attention for two principal reasons; as predatory birds at the top of the food chain many species, are at relatively low densities in the environment, and they are an indicator species of environmental change. Obviously, this guild is ecologically diverse, some species being much more vulnerable to impact (see section below).

4.5.2 Methods

4.5.2.1 Existing data

There is a relatively extensive database of nesting birds of prey within this section of the Alaska Highway. The entire corridor is of management concern to four jurisdictions (Parks Canada (PC), Yukon Government (YTG), Champagne and Aishihik First Nation (CAFN), and the Kluane First Nation (KFN)). Furthermore, the southern portion straddles a number of research areas established by the Arctic Institute of North America (AINA) in the 1960’s. Also the Kluane Land Use Plan, and a number of development projects (Shakwak Project, the proposed Alcan pipeline, Mount Wellgreen mining project) have generated previous EIA’s. Parks Canada has nesting records from helicopter surveys conducted between 1978-1988. The Arctic Institute similarly has records of nesting birds of prey logged in 1994 from systematic ground surveys (Alice Kenney, pers. comm.), primarily in that area of the corridor from Jarvis River to Sheep Mountain. Incidental observations helped the Yukon Government’s Department of Renewable Resources to generate key habitat polygons, which were used for the Kluane Land Use Study. A comprehensive inventory was also completed during the original Shakwak EIA in 1978. For this study the historic nesting records were mapped and the clumping of nest sites were assumed to reveal important nesting areas.

4.5.2.2 1999 Corridor Survey

To provide a current evaluation of probable nesting sites within the highway corridor, systematic searches were made for birds of prey along the proposed right-of-way over 7 weekends from 22 May to 01 August, 1999. Particular attention was paid to potential borrow pits and camp sites, and to areas where raptors were known to have nested in previous years. The timing of these surveys coincides with the active nesting period; a time when breeding pairs are loyal to nesting sites and typically conspicuous when engaged in courtship flights and food deliveries to the nest. Approximately 25 km of the entire right-of-way was covered on foot, while the entire length was searched repeatedly while driving the existing Alaska Highway at speeds less than 30 km/hour. The occurrence of pairs of adults was assumed to indicate the location of an active nesting area. These probable nesting areas and the known nesting areas were recorded and mapped.

4.5.2.3 Results

Species Occurrences. Of the 12 species of Falconiformes (hawks, eagles, harriers, falcons, buteos) reported within the Shakwak Trench (Hoefs, 1973), 8 were observed during the study period between the Jarvis River and Quill Creek, including Goshawk (*Accipiter gentilis*), Sharp-shinned hawk (*Accipiter striatus*), Gyrfalcon (*Falco rusticolus*), Kestrel (*Falco sparverius*), Bald Eagle (*Haliatus leucocephalos*), Golden Eagle (*Aquila chrysaetus*), Harlans Hawk (*Buteo jamaicensis harlani*), and the Northern Harrier (*Circus cyaneus*). Also, an historic Peregrine Falcon (*Falco peregrinus anatum*) nest was identified by R. Chambers (pers. comm.), although this species was not observed during systematic searches. Of the 5 owl species (*Strigiformes*) previously reported within the Trench, 3 were observed within the study area, including the Great Horned owl (*Bubo virginianus*), the Great Gray owl (*Strix nebulosa*), and the Northern Hawk owl (*Surnia ulula*). Of the 6 Falconiformes and Strigiformes species (raptors) observed by Hoefs (1973), but not observed in the 1999 survey, the Boreal Owl (*Aegolius funereus*) was considered a probable nesting resident within the corridor, based on its known distribution and historic nesting records from the Arctic Institute.

Nesting/Pair distribution, by species. The distribution of current and previously active nest sites by species is shown in Figures 4-1 through 4-6, Volume II. The occurrence of multiple sightings at one geographic location indicates successive year's occupancy of a nest site, presumably by one pair of birds. The combination of active nest sites (1999) and the clustering of previously active nest sites reveal key nesting habitat within the project area.

***Habitat suitability within the corridor**.* Habitat classifications within the corridor and knowledge of ecological requirements provide a broad habitat suitability rating for raptors. Key habitats were defined as those that were essential to a particular species, either because the habitats were relatively rare in the environment, or because the habitat is of primary ecological importance to the species (see Table 4-3). This definition deviates from Yukon Government, Department of Renewable Resources (YDRR) classification which uses broad features (riparian and upland habitats) to define key habitats. YDRR classification is far too general to provide a useful determination of key habitats for birds of prey.

4.5.3 Discussion

RARE or VULNERABLE SPECIES

Vulnerability is implied when species are rare in the environment, sensitive to changes, or have experienced a significant population decline. Rarity is usually an expression of low productivity (i.e. eagles or gyrfalcons), a dependence on few prey species that are by nature uncommon or cyclic (Northern Hawk owls), or a dependence on special habitats that are uncommon or widely distributed in the environment (Boreal owls, Peregrine falcons).

Within the forest a distinction can be made between those species with broad habitat tolerance (harlans hawk, sharp-shinned hawk, goshawk, kestrel, great-horned owl) and those with specific habitat needs (peregrine falcon, bald eagle, great-gray owl, boreal owl). Peregrines require wetlands, river margins, or lake shores, while bald eagles require water with accessible fish resources. The great gray owl is confined to climax coniferous forests adjacent to or within wetlands. The boreal owl has been found to require older forest stands where cavities and available prey are most common (Hayward, 1997), and here in the Yukon may be confined to "islands" of climax coniferous forests in muskeg environments (D. Mossop, pers. comm.).

These specialized habitats occur in patches in the landscape and therefore the species that depend on these areas are often relatively uncommon, or at best have a scattered distribution. Rarity of these raptors and the limitation of available habitat make these species relatively vulnerable to changes in land use.

A further distinction is drawn between species that build their own nests, those that require existing nest platforms or cavities, and species that nest on cliffs opposed to trees. Cavities, in particular are often rare in the environment, and their occurrence dictates the distribution and abundance of species that require them. Such cavity-nesting species include Kestrels, Hawk owls, and Boreal owls. These cavity nesters may have a further dependence on woodpeckers which produce cavities (Hakkarainen et al, 1997). Similarly, the number and distribution of cliff nesters is dictated by the availability of relatively stable cliffs with adequate ledges and platforms, and as such these species are typically considered sensitive to environmental change. Within or adjacent to the project area, concern that cavity nest sites may be limited, although worthy of mention, is possibly diminished by the fact that a recent bark beetle infestation may have resulted in a preponderance of woodpeckers and cavity trees.

The original Shakwak Highway EIA made specific reference to 5 birds of prey species which they considered vulnerable either due to their rarity, endangered status, or their sensitivity to construction activities. Their list included Osprey (*Pandion pandion*), Bald Eagle, Golden Eagle, Gyrfalcon, and Peregrine falcon. This list omits 2 species that arguably are vulnerable or of special importance to the area: the Northern Hawk owl, and the Boreal owl.

In the early 1990’s, there was increasing concern for the conservation of Northern Hawk owls (Walker, 1974; Fyfe, 1976), leading to an evaluation of its status by the Committee on the Status of Wildlife in Canada (COSEWIC; Duncan, 1993). More recent studies in the Kluane area have revealed that breeding densities of Northern Hawk owls fluctuate with changes in cyclic prey populations (Rohner et al, 1995). However, its low breeding density, erratic and often remote distribution, dependence on few prey species, and requirement for cavity nesting sites, make this species vulnerable to changing land use practices (Duncan and Harris, 1997).

The Boreal owl, which is the least common of Canadian owls (Catlin, 1972), also displays fluctuations with cyclic prey. Recent observations of Boreal owls in the Yukon suggest that this species may be dependent on old growth forests in muskeg environments (D. Mossop, pers. comm.); habitats which are widely scattered in the Yukon.

Although considered a robust species with wide habitat tolerance and diverse food habits, it is noteworthy that the Harlans hawk, which is a dark colour phase of the Red-tailed hawk, inhabits an exclusive breeding range extending from the Kluane area into the central and west central parts of Alaska (Mindell, 1983), and is therefore relatively unique to the north.

Of the raptors identified within the Shakwak corridor, only the Peregrine falcon (*F. p. anatum*) is currently listed in a category of risk through COSEWIC, although it is recovering and was recently downlisted from “endangered” to “threatened” (COSEWIC, April 1999). The remaining resident raptors in the corridor are not considered at risk nationally, but the status of most have been reviewed by a COSEWIC panel because of conservation concerns (Gyrfalcon, Bald and Golden eagle, Northern Harrier, Red-tailed hawk, Northern Hawk owl, Boreal owl, and Great grey owl).

An arbitrary vulnerability rating of the raptors identified within the project area provides a guide to differentiate between highly sensitive or rare, and more robust or common raptor species (Table 4-3). Table 4-4 provides a probably nesting phenology of birds of prey in the study corridor.

Table 4-3 Habitat and Nest Site Characteristics of Birds of Prey in the Shakwak Corridor

Species	Habitat Characteristics	Nest type	Vulnerability *
Gyrfalcon	Montane upland	Cliff, scrape	7
Peregrine	Riverine, lakeshore, wetland	Cliff, scrape	6
Kestrel	Open, mixed forest	Cavity	5
Sharp-shinned	Coniferous thicket	Tree, stick	3
Goshawk	Boreal; coniferous	Tree, stick	3
Harlans Hawk	Open, mixed forest	Tree, stick	3
Northern harrier	Marsh	Ground stick	4
Golden eagle	Montane upland	Cliff, stick	6
Bald eagle	Riverine, lakeshore	Tree/Cliff, stick	5
Hawk owl	Open, boreal	Cavity	6
Boreal owl	Climax coniferous muskeg	Cavity	8
Horned owl	Boreal coniferous	Tree/Cliff stick	4
Great-gray owl	Wetland coniferous	Tree, stick	7

Note: Vulnerability code – the more vulnerable the species, the higher number the relative vulnerability code With vulnerability rating based on an arbitrary assessment of the species rarity and sensitivity, habitat availability, and nest site availability*

Table 4-4 Probable Nesting Phenology of Birds of Prey in the Alaska Highway Corridor from Jarvis River to Quill Creek

SPECIES	***MONTH***								
	Feb	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*OW*
Gyrfalcon	◄	─	─	─	►				*yes*
Peregrine			◄	─	─	►			*no*
Kestrel				◄	─	►			*no*
Sharp-shinned				◄	─	►			*no*
Goshawk		◄	─	─	─	►			*yes*
Harlans hawk			◄	─	─	►			*no*
Golden eagle			◄	─	─	─	►		*rare*
Bald eagle			◄	─	─	─	►		*no*
Northern Harrier			◄	─	─	►			*no*
Boreal owl		◄	─	─	►				*yes*
Hawk owl		◄	─	─	►				*yes*
Great-horned owl	◄	─	─	─	►				*yes*
Great-gray owl		◄	─	─	─	►			*yes*

Note: OW=overwintering

4.5.4 Potential Impacts of Linear Development

For the purpose of this analysis, a disturbance is defined as any activity associated with humans which increases the physiological cost of survival or decreases the probability of successful reproduction (Barichello and Taylor, 1997); this definition distinguishes trivial from non-trivial impacts. Road construction and traffic-related activities can impact birds of prey through habitat loss, displacement from key habitats (through perceptual disturbances (audio, visual, or smell detractant) or physical barriers to movements, or attraction to the roadside through salting, revegetation, or carrion from road kills, which increases their risk to traffic collisions. The facilitation of recreational opportunities impose additional impacts (DPW, 1978). Below is a summary of the risks and the empirical evidence for such risks on raptors. This will provide the rationale for the mitigation recommendations that follow.

4.5.4.1 Construction Noise and Disturbance

Generally disturbance studies seldom differentiate noise impacts from visual deterrents. For example, when a helicopter flies over a nest it is unclear whether the birds reaction is from the noise, the sight of the intrusion, or a combination of both. It can be assumed that birds of prey react to both noise and visual disturbances, including blasting, heavy equipment and traffic noise, helicopter overflights, etc. Most birds of prey use sound and sight to advertise and display dominance, detect prey, and detect predators and conspecifics (Strasser and Dixon, 1986). Noise disturbances alone can predispose raptors to elevated stress (Clough, 1982; Tromberg et al, 1994), mask important biological signals, or result in changes in behaviour (avoidance reactions). The behavioural responses, which are generally more easy to measure, may include the disruption of courtship activities, displacement from nest sites or favourable habitats, or reduced hunting efficiency; these adjustments can have energetic and reproductive consequences.

However, perceptual disturbances are difficult to measure and evaluate (Larkin, 1996). Species have different hearing thresholds and tolerances, dependent in part on their need to differentiate sounds to communicate, hunt or avoid predators. Also, some species may be more apt to habituate to noises than other species. There are also different types of noises that may elicit different tolerances. Continuous noises, which are seldom encountered by wildlife, may be more distracting than impulse noises. There may also be a reaction by some species to noise vibrations. Furthermore, there may be individual variation in noise tolerance or the reaction to noises. An evaluation of noise and sight disturbance is therefore complicated; the degree of response varies and may be offset by habituation (see review by Larkin, 1996).

The effects of disturbance can be impossible to measure. Usually conclusions regarding disturbance are drawn when the animal displays an overt response to the disturbance source by moving away or flushing, or when changes in productivity or habitat use patterns are correlated with the disturbance activity.

The empirical evidence of disturbance on birds of prey is few and often inconsistent or variable (Awbrey and Bowles, 1990). For example, studies have revealed that some medium sized diurnal raptors flee from helicopters (Anderson et al, 1989; Platt, 1975; Platt and Tull, 1977), others refused to be flushed from the nest (Poole, 1989), and larger ones sometimes attacked the intruding helicopter (Mooney, 1986; Watson, 1993). The timing of such disturbance has also revealed inconsistent conclusions. Platt (1977) found gyrfalcons more apt to flee during nesting than during the winter, although nest success was reduced where birds were harassed during the winter. Anderson, et al (1989) found no tendency of adult hawks to flee at later stages, as opposed to earlier periods in the nesting cycle. Watson et al. (1973), quoted in the original EIS for the Shakwak Project, was concerned about disturbance throughout the nesting period.

The timing of the disturbance relative to the bird’s life cycle is critical. Life stages for birds of prey are usually categorized as follows: nonbreeding, courtship, prelaying, laying, incubation, hatching, and fledging. Most raptors are particularly sensitive to disturbance during reproduction (Fyfe and Olendorff, 1976), in part because they are committed to a nest site and this resource may be limiting in the environment. Fyfe and Olendorff summarized the risks of disturbance, as follows: a) the complete desertion of the nest site or the eggs, b) egg breakage, c) trampling of young broods, d) excessive chilling or heating of eggs or the brood, e) premature first flights and risk of injury or predation on fledglings, f) agitated parents or young may inadvertently attract predators to the nest, g) attention to a nest site may result in repeated or continuous visits by photographers or eco-tourists. Desertion of the nest prior to laying or desertion of the eggs is probably the most common detriment. Grier and Fyfe (1987) concurred with Newton (1975) that desertions were more apt to occur earlier rather than later in the breeding season. Fyfe and Olendorff (1976), and Newton (1975), suggested that site tenacity was weakest early in the nesting period, and therefore adults were most apt to desert immediately prior to laying, although Sibley (1969) and Durstan (1973) observed desertion during early incubation. In a study of gyrfalcons in the central Yukon, desertions from natural causes were evident prior to laying and during the early incubation period, but not later in the incubation period or during the brood period (Barichello, 1983). Presumably, early desertion allows time for adults to locate an alternate nest and successfully fledge young in that year. Displacement later in the nesting period precludes successful production for that year; therefore, raptors are probably more tenacious to their nests and less apt to desert later in the nesting period.

The principal concern along the Shakwak corridor with respect to disturbance is the displacement of birds from nests, and in particular the vulnerable species. This is particularly relevant during the establishment of nesting sites when pairs are particularly sensitive, and during the incubation period when temperature is critical to the successful hatching of the eggs. The timing is probably equally as important as the degree of the impact.

To mitigate against the desertion of the nest, buffers should be established around the nest and construction activities should not take place within sensitive periods. The size of exclusion buffers and construction windows may vary between species. Suter and Jones (1981) recommended a protected buffer zone for Golden eagles, Ferruginous hawks (Buteo regalis), and Prairie falcons (Falco mexicanus), of 1 km, whereas Becker and Ball (1983) suggested only 400m for Prairie falcons, and White et al. (1979) proposed 1.6 km for Ferruginous hawks. Platt and Tull (1979) concluded that frequent helicopter overflights below 160m impacted all nesting gyrfalcons, and some pairs up to altitudes of 300m. At this level of disturbance, they found gyrfalcon sites were not occupied in the following year. Yet Ellis et al. (1991) found frequent low-level jet overflights and jet flights associated with sonic booms did not limit productivity in a variety of North American raptors. Grubb and King (1991) observed that Bald eagles reacted to aircraft flights within 172m but habituated to air traffic. In the original EIS for the Shakwak Highway Improvement, Watson et al. (1973) stated that nesting sites “may be influenced” by construction activity as far away as 5 km; the mitigation recommendation that followed was to prohibit blasting within 5 km and other construction within 3 km of nesting bald eagles, golden eagles, osprey, gyrfalcons, or peregrine falcons from 15 April to 31 July. Windsor (1979) was less conservative in his recommendations for the section of the Alaska Highway north of Quill Creek. He recommended that construction activity be "avoided between March 18 and September 15" for much of the right-of-way and failing this that overburden "pads" be applied to detonations, that camps and staging areas be located beyond 3 km of active nests, and helicopters respect a 450m no-fly zone around active nests. The ambiguous results of these disturbance studies and previous environmental assessments make it difficult to provide specific mitigation recommendations. Grubb and King (1991) suggested that exclusion zones (buffers) should be tailored to fit particular species and habitat types.

On the basis of these results, it is recommended that buffers around active nests within the Shakwak corridor applied differently to different species and times of the year, based on nesting phenology (Table 4-4) and the species vulnerability (Table 4-3). These buffer zones are smaller and applied more discriminantly than those originally prescribed in the 1978 EIS, which are highly precautionary and liberally generated from the empirical evidence. As a general guide, larger buffers should be applied,

(a) to species that are uncommon in the area or at risk nationally;
(b) to species that have very specific habitat requirements;
(c) to species that are by nature sensitive to ecological changes; and,
(d) during the early part of the nesting period.

4.5.4.2 Physical Barriers to Movements, Including Road Kills

It is unlikely that physical barriers on birds of prey will be imposed as a result of highway upgrading. The published literature addresses two potential concerns:

(1) there is evidence that raptors are periodically killed in collisions with automobiles (Williams and Colson 1987), and

(2) there is evidence that increased road width may inhibit movements of small mammals (Oxley and Fenton 1976) and therefore indirectly impact birds of prey.

In the Yukon, raptors killed in vehicle collisions are often turned in to wildlife officials. On the basis of these returns, it can be argued that three Yukon species are prone to collisions: great horned owls, hawk owls and kestrels (D. Mossop, pers. comm.). Presumably these species are attracted to road corridors due to elevated levels of prey along the roadside, including microtines and birds in migration, and the occurrence of insects and animals killed in traffic collisions. However, the Alaska Highway is an established corridor and surrounded by relatively pristine habitats, therefore the risks that an upgraded alignment will produce a physical barrier to small mammal movements or increase collisions with birds of prey is believed to be minimal. Stabilizing the right-of-way with coarse and sparse vegetation should lessen the risk of increased prey and associated raptor mortality from vehicle collisions.

4.5.4.3 Habitat Loss

Habitat loss from roadside clearing is believed minimal when compared with more extensive habitat changes such as clearcut logging, or wildfires. Nevertheless there is concern for:

(a) the loss of nesting trees, particularly cavity nests;
(b) the alteration of suitable nesting cliffs; and,
(c) the loss of specialized habitats.

The loss of nesting trees is the most obvious detriment. Nesting sites are often a limiting resource to birds of prey. Kestrels, Boreal owls and Northern hawk owls require large cavities which are uncommon in the north because of the relatively small size of mature trees and the relatively low density of woodpeckers (cavity agents). Owls and falcons cannot construct their own nest platforms so depend on topographic features, or other birds, to create nesting platforms. Because of this dependency, nest sites are often used repeatedly year after year. This is particularly true for gyrfalcons and peregrines. Early nesting phenology of gyrfalcons further constrains nest choice to those platforms protected from snow and cold winds (Barichello, 1983). Mitigation against habitat loss should be guided by a requirement to protect key nesting sites, or provide alternative nesting sites to cavity nesters.

Habitat change due to roadside clearing is a less obvious impact. There is minimal concern for forest species that demonstrate wide ecological tolerances and therefore may benefit from habitat disturbances that create edges or openings (Harlans hawks, Great horned owls, Goshawks, Sharp-shinned hawks, Kestrels, Hawk owls). Others, such as Boreal owls or Great Gray owls, have very narrow ecological tolerance and require habitats which are uncommon or widely distributed. Recent studies suggest that Boreal owls may be restricted to scattered old growth muskeg communities (D. Mossop, pers. comm.) that may be adversely impacted by habitat fragmentation imposed by clearing within the road alignment. Northern harriers are another species with a specific requirement for marsh wetlands; fortunately these low lying areas will be avoided by highway realignment. Overall, the scale of the disturbance within the Shakwak corridor in relation to extensive pristine habitats adjacent to the corridor trivialize a concern that habitat change will significantly reduce available habitat for most birds of prey. Nevertheless, disturbance to old growth muskeg and marsh communities should be minimized, if possible.

4.5.4.4 Roadside Attractants (Revegetation, Reclamation, and Road Salting)

As mentioned above, concern has been raised that salts or revegetation may attract animals to the edge of the road, which will increase the risk of vehicle collisions, or harvest. Studies have implied that the revegetation of the roadside can increase the abundance of small mammals, insects, or carrion, and therefore increase hunting activities by birds of prey. In the Yukon great horned owls are frequently involved in vehicle accidents during years of snowshoe hare abundance, where road corridors support high densities of snowshoe hares. Northern hawk owls and Kestrels are also prone to vehicle collisions because of the abundance of microtines, migratory birds, and carrion (small mammals, birds and large insects) along the edge of the road (D. Mossop, pers. comm.). The original EIA drew attention to the risk that ravens, attracted to garbage would put young falcons at greater risk from predation; however, there is no evidence to support this claim. There is also no evidence to indicate that road salting imposes greater risks to birds of prey, other than attracting species (i.e. porcupines) that become carrion for birds of prey. The problem of roadside attraction and associated fatalities with birds of prey is currently believed to be minimal along the Alaska Highway. As a precautionary guide, a minimal right-of-way, reclaimed with sparse, course forage, would reduce the risk of attracting birds of prey to the roadside.

4.5.4.5 Recreational Activities

Increased recreational activity is not expected to impact birds of prey, unless nest sites are known and regularly visited by photographers and sight-seers. As a guide, nest sites should remain as privileged information.

4.5.5 Mitigation Guidelines

The following mitigation guidelines are based on the previous evaluation and observations made in 1999, and include principal concerns and general mitigation guidelines, followed by specific guidelines that refer to a specific location (disturbance nodes).

Table 4-5 provides general mitigation guidelines for birds of prey, while Table 4-6 provides specific mitigation options for key raptor sites disturbance nodes.

Table 4-5 Principal Concerns and General Mitigation Guidelines for Birds of Prey

Concerns	*General Guidelines*
Displacement due to Perceptual disturbances	
• *Displacement of nesting pairs due to heavy equipment (compacting, trucks, sirens), blasting, etc.* • *Displacement of nesting pairs from pedestrian activities & generator noise at camp sites.*	• *Establish exclusion buffers around active nest sites and adhere to operating windows to avoid disturbance at sensitive periods.* • *Do not establish camps, staging areas, or gravel quarries within buffer zones of active nests.* • *Keep nest site locations confidential to avoid visitation by photographers.* • *Avoid constructing pull-offs or kiosks near to key nesting areas to minimize risk of disturbance from photographers, dogs, hikers.* • *As a pro-active measure, erect boreal owl nest boxes away from the road in areas where nest sites have been located near the road (typical nest box dimensions: height 22.5 cm - 45 cm, width 15 cm - 17.5 cm, entrance hole - elliptical with dimensions 6.25 cm - 12.5 cm. Entrance hole 5 cm - 7.5 cm below roof.*
Physical barrier to movements & collisions	
• *Traffic accidents* • *Inhibition of prey movements*	• *Use minimal width cleared right-of-way;* • *Revegetate with coarse, sparsely-growing vegetation, to avoid increasing the density of small mammals and of attracting migrant birds along the roadside.*
Habitat Loss	
• *Nest site*	• *Avoid cutting down nest tree;* • *If nest trees cannot be protected, relocate nests, or erect bird boxes away from the highway corridor.;* • *Avoid blasting suitable nesting cliffs*
• *Habitat loss*	• *Where possible, circumvent special climax habitats;* • *Do not locate camps, staging areas, gravel quarries within special climax habitats;* • *Identify sensitive habitats adjacent to the road corridor and redirect future developments away from these areas.*
Attractants & collisions	
• *Risk of collisions with vehicles due to attraction of birds of prey to the roadside because of higher prey densities, and carrion (road kills)*	• *Minimize width of the cleared right-of-way.* • *Stabilize right-of-way with coarse, sparse vegetation to maintain low densities of small mammals, and minimize use of the corridor by migrant birds.* • *Periodically cut brush within right-of-way to detract small mammals.* • *Minimize use of salts which may attract mammals that become carrion.*
Disturbance & hunting from recreation activities	
• *Disturbance from Pedestrian traffic, Off road vehicles, Photographers*	• *Keep nest site information confidential* • *Avoid constructing pull-offs within buffer zones*

Table 4-6 Specific Mitigation Options for Key Raptor Sites

Species	***Location***		***MITIGATION OPTIONS***
	Hwy. km.	*from hwy*	
ACTIVE NEST SITES (1999 SURVEY)			
Harlans	*1668*	*<200m*	• *Avoid construction activities from 1-31 May within 1 km from nest site, or* • *Undertake construction prior to migrant pairs establishing a nest site (20 April).*
	1717	*<200m*	
	1723	*1.5 km*	
	1736	*500m*	
	1773	*1 km*	
Red-tail	*1758*	*<200m*	
G.H.Owl	*1694*	*<200m*	• *Avoid construction activities from 20 Feb-30 April within 1 km from nest site, or* • *Undertake construction prior to migrant pairs establishing a nest site (20 Feb).* • *If feasible, avoid removing nest tree.*
S.S.Hawk	*1717.5*	*<200m*	• *No mitigation recommended.*
Kestrel	*1722*	*1.3 km*	
G.Eagle	*1708*	*1 km*	• *see Sheep Mountain area (below)*
BOREAL OWL NESTING AREAS (previously active nests)			
Boreal owl	*1667.5*	*1.2 km*	• *Erect boreal owl nest boxes in suitable habitat at least 2 km away from the right-of-way, and monitor from Feb through May.* • *If possible avoid establishing camps and gravel quarries within 2 km of these sites.*
	1677.5	*200m*	
SHEEP MOUNTAIN AREA (Nesting areas)			
Gyrfal.	*1699- 1710*	*1.5 km*	• *Avoid construction activities within a 2 km buffer from 15 Feb to 30 June.* • *If possible avoid establishing camps and gravel quarries within this corridor.*
Peregr.		*1 km*	
G.Eagle		*1 km*	
		1 km	

4.6 UPLAND GAME BIRDS

4.6.1 General

Although 7 species of upland game birds are known to occur within the Alaska Highway corridor, only the Sharp tailed grouse (*Pediocetes phasianellus caurus*) warrants special consideration. Sharp tails have a fragmented distribution where they occur at low densities and experience population fluctuations across their Yukon range. In the southwest Yukon Sharp tails occur in localized areas where populations are precarious and poorly understood (Rand, 1946; Godfrey, 1976; Mossop, et al., 1979).

Sharp tail grouse occupy a variety of habitats across their range, including open grasslands and sage communities, deciduous parklands, and openings within boreal forests (Aldrich, 1963; Moyles, 1981). In the Yukon Sharp tails similarly occupy a diversity of habitats as far north as the Arctic Circle, including open bogs, grassland-forest interface, aspen patches in openings in coniferous forests, parklands, old burns, and taiga muskegs. A feature of Sharp tail grouse habitat is a special lekking theatre where males congregate on elevated knolls (leks) where they drum and dance to attract females.

4.6.2 Methods

4.6.2.1 Existing data

The proposed Alaska Highway gas pipeline (Foothills Pipe Lines Ltd.) prompted an inventory of Sharp tail grouse and their winter habitat within a 2 km corridor along the Alaska Highway, and a more intensive study which included individual marking and telemetry to address lek use and movements in the Donjek River area in the late 1970’s (Mossop, et al, 1979). Inventory results were based on an analysis of hunter questionnaire data, and systematic searches of potential grouse habitat in late winter and spring.

4.6.2.2 Current Study

As a result of the 1979 study, two subpopulations and lekking areas were identified within the Alaska Highway corridor between Jarvis River and Quill Creek, one on the Duke River Meadows and Burwash Airport, the other along the lower reach of Copper Joe Creek. These areas were resurveyed in April 1999 (see Figure 4-5, Volume II). Systematic searches were made on the advice of D. Mossop in the areas in, and surrounding, the historic lekking areas from dawn until noon, and late afternoon until dark. Brief stops were made to listen for calling grouse, tracks were followed, and sighted birds were watched to determine flock size, according to methods adopted by Mossop, et al. (1979).

4.6.3 Results

4.6.3.1 Distribution and Abundance

In the southwest Yukon Sharp tail grouse populations are small and very uncommon, appear to be very localized, and have suffered a decline in numbers since the 1970's. Declining numbers and possible disappearance in some areas along the Alaska Highway follows a trend apparent over their entire range (Campbell, et al, 1990; Berger and Baydack, 1992; Miller and Graul, 1980). The cause of this decline is consistent across their southern range: loss of open areas due to succession (Berger and Baydack, 1992; Amman, 1963), loss of riparian habitat and thickets adjacent to open areas due to changing land use practices (Campbell, et al, 1990), and hunting (Campbell, et al, 1990).

Duke River Meadows and Burwash Airport. Although the historic population was estimated at between 30 to 50 adults, only two broods were observed during the 1979 survey and no birds were seen in April, 1999. Observations by local people confirm the continued existence of a remnant population, although population size is unknown and the location of the lekking area is unknown. This subpopulation occurs where aspen regrowth is occurring, where open areas are grazed by horses, camping and use of ATV's is common, and where live-release and sport shoot of pheasants has been, and is currently, practiced. Clearly, the odds are stacked against this precarious subpopulation.

Copper Joe Creek. In 1979 a local hunter identified this area as a possible lekking area, although no birds were observed in 1979. In the current survey, two Sharp tails were observed adjacent to the Alaska Highway beside Copper Joe Creek; however, the existence of a traditional "lek" was not confirmed. Population size remains unknown. The apparent reduction in the populations is supported by local opinion from persons familiar with the area.

4.6.3.2 Habitat Suitability

Sharp tail grouse habitat varies across its range, and particularly in the Yukon. Generalizing across its range, this species appears reliant on open uplands, with grass and low shrub (Gratson, et al, 1990), adjacent to riparian shrub or thickets and patches of aspen (Berger and Baydack 1992; Campbell, et al, 1991). The breeding grounds are centred around leks, which are elevated knolls in open grasslands with low or sparse vegetation (Berger and Baydack, 1992). Habitat selection appears to be driven by the need to maintain ties to the traditional lek, compromised by recurring forest succession (Brown, 1967; Berger and Baydack, 1990). In Manitoba, Berger and Baydack found that leks were abandoned when aspen forest increased above 56% and grassland fell below 15% of the total area within 1 km of the lek.

In the Shakwak corridor south of the Duke Meadows, a recent wildfire will probably influence the distribution and demography of Sharp tail grouse. These habitat changes will presumably facilitate a population recovery (D. Mossop, pers. comm.), but the rate at which this may occur is difficult to predict. It is unclear whether leks will be completely abandoned in the short term or whether these habitat changes will create new lekking opportunities. Also, there is no empirical basis to predict whether leks can be artificially produced through habitat manipulation (i.e. elevated berms in open habitats). The extent of seasonal movements of Sharp tail grouse in the Kluane area is also unknown. Against this backdrop of widespread and significant habitat changes and demographic uncertainty, it will be difficult to forecast the impact of highway realignment on the Sharp tail grouse population.

4.6.4 Discussion

SPECIES VULNERABILITY

Although occupying a diversity of habitats in the Yukon, Sharp tail grouse have very specialized habitat needs. They require grasslands, thickets and scattered deciduous stands to provide predator refuge and roosting, and an elevated lekking theatre. These special requirements result in a fragmented distribution where subpopulations are apparently loyal to a traditional lekking area, but fluctuate in numbers as an outcome of successional changes.

Although not classified as threatened through COSEWIC, Sharp tail grouse are believed to have declined across their range. In British Columbia, only two centres of habitation remain (Campbell, et al, 1991). Here in the Yukon, Sharp tail grouse populations appear erratic, presumably influenced by many factors.

4.6.5 Potential Impacts of Linear Development

Little is known about the effects of road building, drilling, blasting, heavy equipment operation, increased frequency of human presence, surface disturbance, and contamination, on behavior, habitat use patterns, and mortality rates of Sharp tail grouse. Nevertheless, research results are summarized to provide a rationale for the few mitigation recommendations that follow.

Perceptual disturbance

Little is known about the detrimental effects of noise and visual disturbances on Sharp tail grouse. Few field studies have been conducted and those controlled laboratory studies have found that noise on upland game birds has little effect (Barichello and Taylor, 1997b). Little reaction and habituation was observed when several species were subjected to sonic booms Cottereau (1977). Similarly no effect was found on productivity and mortality rates of Bobwhite quail exposed to sonic booms (Teer and Truett, 1973). Where experiments have produced hearing damage in quail, repair and restoration of hearing has been rapid (Adler, et al, 1995; Niemec, et al, 1994; Ryals, et al, 1995). On the basis of these studies, perceptual disturbances associated with the Alaska Highway realignment are presumed to have minimal effect on Sharp tail grouse; little adjustment in movement patterns and distribution, and rapid habituation, is expected.

Physical barrier to movements, including road kills

As with perceptual disturbance, examples of physical barriers imposed on upland game birds by development are few. There are two studies that attributed significant mortality of ptarmigan and black grouse from collisions with ski-lift cables, particularly in woody habitats soon after they were erected (Watson, 1982; Miquet, 1990). No studies have attributed increased mortality of upland game birds to traffic collisions, although based on anecdotal reports and the frequency with which birds are observed by the roadside picking crop gravel, it can be presumed that many birds are killed in highway collisions.

Habitat Loss

The loss of nest sites, roost sites, and feeding areas has not been explicitly identified as a significant impact of linear developments. Studies have revealed that predation on black grouse was higher and breeding success impaired when forests were fragmented, particularly along the field-forest edge (Kurki and Linden, 1995). However, other studies found relatively low rates of predation on ruffed grouse nests with increasing forest fragmentation (Yahner, et al, 1993). The habitat needs of Sharp tail grouse imply that forests fragmented by cleared road right-of-ways would be of benefit, or at worst have no detrimental effect, so long as lekking areas are not disturbed.

The distribution of Sharp tail grouse appears inextricably linked to lekking areas. Protection of these traditional landmarks may be essential to the viability of Sharp tail grouse. It remains unclear whether the creation of elevated leks or habitat manipulation around known leks is a management option. Consideration could be given to developing elevated mounds/berms in suitable habitats off the highway right-of-way as lekking sites.

Revegetation/reclamation, and other roadside attractions

There is no evidence to suggest that roadside salting, habitat change, or the revegetation of stabilizing species along the right-of-way will influence Sharp tail grouse distribution by attracting them to the roadside where they may be prone to collisions or increased predation.

Recreation

Any concentration of unregulated human activity will undoubtedly contribute to an increase in the incidental sport/subsistence killing of Sharp tail grouse. Camps or staging areas established near lekking theatres or other concentration areas will increase the risk of hunting mortality, if unregulated. The proliferation of pull-outs may increase recreational activities in the corridor. If hunting or off-road vehicle (ATV, 4-wheelers, snowmobile, etc.) traffic is associated with increased levels of recreation, this may have a debilitating effect on local, small Sharp tail grouse populations. This potential impact can be avoided by establishing camps and staging areas away from lek sites, and limiting the number of pull-outs in proximity to lekking areas.

4.6.6 Mitigation Options

Table 4-7 summarizes the potential impacts associated with the highway realignment and general mitigation guidelines for Sharp tail grouse.

Table 4-7 Principal Concerns and General Mitigation Guidelines for Sharp Tail Grouse

Potential Impact	*General Guidelines*
Displacement due to perceptual disturbances	
• *Displacement of males from breeding leks, due to disturbance from heavy equipment (compacting, trucks, sirens), blasting, etc.* • *Displacement of males from breeding leks, due to disturbance from pedestrian activities & generator noise at camp sites.*	• *Do not establish camps, staging areas, or gravel quarries within 2 km of lekking areas* • *Do not establish camps between km 1766 and km 1769, and between km 1752 and km 1755.* • *Avoid establishing highway pull-offs between km 1766 and km 1769, and between km 1752 and km 1755. .*
Physical barriers to movements & collisions	
• *Traffic accidents*	• *Minimize the width of the cleared right-of-way;* • *Stabilize the right-of-way with sparse vegetation.*
Habitat Loss	
• *Destruction of Lekking theatres*	• *n/a*
• *Habitat loss*	• *n/a*
Create possible lekking theatres	• *Establish elevated mounds/berms in suitable habitat off the right-of-way in the vicinity of Copper Joe Creek and Duke Meadows*
Increased mortality due to roadside attractants	
• *Risk of collisions with vehicles due to attraction of sharp tails to the roadside due to revegetation, or the application of road salts.*	• *Stabilize right-of-way with coarse, sparse vegetation* • *Periodically cut brush within right-of-way*
Disturbance & hunting mortality due to recreation activities	
• *Disturbance from pedestrian activities, off-road vehicles, and photographers.* • *Risk of deliberate and incidental hunting of sharp tails.*	• *Avoid constructing an excess number of pull-offs* • *Restrict hunting of work crews in the vicinity of the Duke Meadows and Copper Joe Creek areas.* • *Do not establish camps between km 1766 and km 1769, and between km 1752 and km 1755.*

Note: General guidelines applicable to Copper Joe Creek (km 1766 and 1769) and Duke River Meadows (km 1752 – 1755)

4.7 WILDLIFE MONITORING

Because environmental impact assessments (EIA) are rarely tested, predictions continue to be based on theory founded on natural history or indirect studies. This limits the opportunity to learn, and therefore impedes future predictions. Simple monitoring programs may allow predictions of this EIA to be tested to benefit future projects. The following wildlife monitoring programs are suggested.

- Monitor Kluane caribou movements and locations in late fall/winter.
- Monitor Sheep movements in the spring with attention to use of mineral licks.
- Monitor Sharp tail grouse population in the vicinity of Copper Joe Creek.
- Monitor Boreal owl occupancy of nest boxes, in relation to highway realignment.

As well, an ongoing dialogue with, or inspection by, wildlife experts or local First Nations during construction may be helpful to all concerned.

4.8 WATERBIRD SURVEYS

4.8.1 Study Objectives

The following were the waterbird study objectives:

- Provide a general resource description of the study area in relation to waterbirds and waterbird habitat and determine its relative ecological importance to the broader ecosystem and the Yukon.

- Determine the significance and extent of waterbird habitat in the study area and quantify the use of the habitat by waterbirds during spring and fall migration and staging and summer breeding and molting.

- Recommend measures to mitigate or avoid adverse impacts on critical habitat areas and disturbance to waterbirds resulting from construction, operation and maintenance of the highway.

4.8.2 Methodology

Surveys for waterbirds were conducted along the Shakwak Highway between km 1664.5 to km 1788.5 from May 30, 1999 to September 30, 1999 (Table 4-8). The surveys were conducted in order to complement existing data on waterbirds and waterbird habitat in the area. Surveys were conducted on the ground, using binoculars and spotting scope, on all potential waterbird habitat within 500 metres of the proposed realignment, borrow pits and camps. Surveys were done on the following dates:

Table 4-8 Waterbird Survey Dates and Type

Survey #	Date	Survey Type
1	May 30-31, 1999	Spring staging / migration
2	August 3-4, 1999	Summer Brood
3	September 20-21, 1999	Fall Staging / migration
4*	September 30, 1999 *	Fall Staging / migration

* Only Sulphur Lake (WB5) and Kluane Shoreline (WB11) were surveyed on this date

Literature pertaining to waterbird and waterfowl studies in or in proximity to the study area was reviewed in addition to interviews with persons knowledgeable about the waterbird resources in the Yukon, First Nations' renewable resource personnel, and persons that work and/or live in the study area.

4.8.3 Results

4.8.3.1 Habitat

Approximately 21 ponds were surveyed (including one complex of 12 ponds) in addition to Sulphur Lake, Kluane Lake shoreline and wetted areas associated with streams and rivers (i.e. riparian habitat) in the study area. Each survey area was assigned a habitat/wetland code and is shown on Figures 4-8 to 4-13, Volume II. Most of the ponds surveyed were shallow, landlocked thermokarst formations ranging in size from 1.0 to 7.4 ha. in surface area (Table 4-9). Surface area is based on the high water mark; however, several of the ponds diminished in size from water losses throughout the summer. Most of the ponds are bordered by shrub birch, willow and spruce trees, and contained very little emergent vegetation.

Table 4-9 Habitat/Wetland Code, Size and Description

Habitat / Wetland Code	Highway Chainage	Size (surface area or shoreline length)	Description
WB1	1664+300	-	Riparian habitat at Jarvis Creek
WB2	1665+000	-	Riparian habitat at km 1666.0
WB3	1668+000	1.0 ha.	Thermokarst pond
WB4	1669+500	0.7 ha.	Thermokarst pond
WB5	1670+000	146 ha.	Sulphur Lake
WB6	1680+300	7.4 ha.	Thermokarst pond- Near Hungry Lake
WB7	1684+000	1.2 ha.	Thermokarst pond
WB8	1684+600	3.5 ha.	Thermokarst pond
WB9	1685+000	4.5 ha.	Thermokarst pond
WB 10	1685+400	1.3 ha.	Thermokarst pond
WB11	1697+200-1701+000	9.0 km	Kluane shoreline – Topham Creek to Slims River
WB12	1701+800	2.1 ha.	Thermokarst pond
WB13	1702+000-1704+000	6.4 km	Kluane shoreline – WB9 to Sheep Mountain
WB14	1704+000-1706+400	3.8 km	Kluane shoreline – WB10 to km 1709
WB15	1706+500-1723+300	37.4 km	Kluane shoreline – WB11 to Goose Bay
WB 16	1777+300-1781+500	12 ha. (total area)	12 thermokarst ponds
WB 17	1786+000	7.2 ha.	Flooded area with man-made berm

Sulphur Lake (WB5) is located on the north side of the Shakwak Highway at km 1671.5. The lake has a surface area of approximately 146 ha. The shoreline is about 200m from the highway with road access to the water's edge. The lake is obscured from the highway by a band of willow vegetation. The lake appears to be relatively shallow and very little emergent vegetation was observed at the southern portion of the lake, as the lake is over 2 km in length only the southern half of the lake was surveyed for waterbirds.

The Kluane Lake shoreline from km 1698 to 1707 (WB11) is characterized by sandy beaches, mudflats, and shallow water zones with some aquatic vegetation.

The shoreline from km 1707 to 1713.4 (WB13) encompasses the Slim's River delta which is characterized by mudflats and silt deposited from the Slim's River. Emergent vegetation is sparse throughout this zone and there is a high concentration of suspended solids in the Slim's River. A backwater zone on the east bank of the river on the south side of the highway contains relatively clear water but no emergent vegetation.

The shoreline from km 1713.4 to Goose Bay (WB14 and WB15) is characterized by rocky and gravel shore exposed to a substantial surf when wind is present.

Riparian waterbird habitat (wetlands in association with a river or stream) is found at two locations within the study area, Jarvis (WB1) and at km 1666 (WB2). Emergent vegetation occurs in the wetted areas at both locations.

4.8.3.2 Waterbird Observations

4.8.3.2.1 General

A total of 28 different species of waterbirds were identified in the study area during the surveys (Table 4-10). The greatest number and diversity of birds (Appendix VI) were observed at Sulphur Lake (WB5) and along the Kluane Lake shoreline (WB11) between Topham Creek and the Slims River. The spring survey (May 30-31) yielded the most waterbird observations with the majority occurring at Sulphur Lake. Incidental species are listed in Table 4-11.

Nine broods were observed during the summer brood survey (August 3-4). Of these, 3 were observed on the Kluane Lake shoreline (WB11) and 4 on Sulphur Lake. Sulphur Lake was also used by a group of molting ducks (i.e. scaup) during the summer.

Table 4-10 Waterbird Species Identified within the Study Area

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE
Red-Throated Loon	*Gavia stellata*	RTLO
Horned Grebe	*Podicep auritus*	HOGR
Red-necked Grebe	*Podiceps grisegena*	RNGR
Swan	*Cygnus sp.*	SWAN
Trumpeter Swan	*Cygnus buccinator*	TRSW
American Green-winged Teal	*Anas crecca*	AGWT
Mallard	*Anas platyrhynchos*	MALL
Northern Pintail	*Anas acuta*	NOPI
Northern Shoveler	*Anas clypeata*	NOSH
American Wigeon	*Anas americana*	AMWI
Canvasback	*Aythya valisineria*	CANV
Scaup	*Aythya sp.*	SCAU
Scoter	*Melanitta sp.*	SCOT
White-winged Scoter	*Melanitta fusca*	WWSC
Surf Scoter	*Melanitta perspicillata*	SUSC
Goldeneye	*Bucephala sp.*	GOLD
Barrow’s Goldeneye	*Bucephala islandica*	BAGO
Bufflehead	*Bucephala albeola*	BUFF
Merganser	*Mergus sp.*	MERG
Red-breasted Merganser	*Mergus serrator*	RBME
Northern Harrier	*Circus cyaneus*	NOHA
Lesser Yellowlegs	*Tringa flavipes*	LEYE
Red-Necked Phalarope	*Phalaropus lobatus*	RNPH
Spotted Sandpiper	*Actitus macularia*	SPSA
Solitary Sandpiper	*Tringa solitaria*	SOSA
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Bonapartes Gull	*Larus philadelphia*	BOGU
Mew Gull	*Larus canus*	MEGU
Herring Gull	*Larus argentatus*	HEGU
Arctic Tern	*Sterna paradisaea*	ARTE

Table 4-11 Incidental Species Observed During Waterbird Surveys

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE
Merlin	*Falco columbarius*	MERL
Violet Green Swallow	*Tachycineta thalassina*	VGSW
Cliff Swallow	*Hirundo pyrrhonota*	CLSW
Gray Jay	*Perisoreus canadensis*	GRJA
Black-billed Magpie	*Pica pica*	BBMA
Common Raven	*Corvus corax*	CORA
Boreal Chickadee	*Parus hudsonicus*	BOCH
Black-Capped Chickadee	*Parus atricapillus*	BLCH
Swainson’s Thrush	*Catharus ustulatus*	SWTH
American Robin	*Turdus migratorius*	AMRO
Bohemian Waxwing	*Bombycilla garrulus*	BOWA
Yellow-rumped Warbler	*Dendroica coronata*	YRWA
Yellow Warbler	*Dendroica petechia*	YEWA
Wilson’s Warbler	*Wilsonia pusilla*	WIWA
Common Yellowthroat	*Geothlypis trichas*	COYE
American Tree Sparrow	*Spizella arborea*	ATSP
Chipping Sparrow	*Spizella passerina*	CHSP
White-crowned Sparrow	*Zonotrichia leucophrys*	WCSP
Dark-eyed Junco	*Junco hyemalis*	DEJU

Sulphur Lake (WB 5)

On all surveys substantial numbers (hundreds) of waterbirds were observed at Sulphur Lake including a variety of divers, dabblers, grebes and swans (see Figure 4-9, Volume II). Approximately 400 Buffleheads were observed on the lake during the spring survey in addition to a variety of ducks and swans. At least one breeding pair of trumpeter swans use the lake during the summer in addition to large numbers of molting scaup (diving duck). The lake is also used for fall staging by a variety of waterbirds including swans (Appendix V).

Kluane Lake Shoreline - Km 1698 to 1707 (WB11)

A variety of waterbirds were observed along this section of the shoreline including arctic terns, gulls, dabbling ducks, diving ducks and shorebirds. The area was used by waterbirds mostly during the spring and fall. No breeding waterbirds were observed during the summer survey.

Kluane Lake Shoreline - km 1707 to km 1713.4 (WB13)

Few birds were observed in this zone during the surveys (Figure 4-9, Volume II); however, a consultant (S. Withers, pers. comm.) working in the area during the summer observed mew gulls and a breeding colony of Arctic terns on 9 July on the west side of the delta (Figure 4-10, Volume II) near the lake shoreline. The consultant also noted that the breeding area was submerged in water later in the summer.

Additional waterbirds were observed in this zone during the spring and summer by the Senior Staff Interpreter (Heritage Communicator) working at the Sheep Mountain Interpretive Centre (Flumerfelt, pers. comm.). This interpreter observed swans on the Slims River behind the Interpretive Centre (south side of the highway) during the spring. In addition to the swans, several duck broods were observed in the same area during June. These broods, however, moved from the area by July (possibly disturbed by a grizzly bear that was frequenting the area in June). Other species observed in the area include belted kingfishers and red-throated loons. A nesting pair of red-throated loons have been observed along the Kluane Lake shoreline in this zone for several consecutive years (Flumerfelt, pers. comm.).

Kluane Lake Shoreline - km 1713.4 to Goose Bay (WB14 and WB15)

Very few waterbirds were observed along this section of the shoreline. Mew gulls were present in low numbers. During the spring survey, a group of 32 scaup were observed at a distance (approx. 300 m) offshore.

Riparian Habitat

Riparian habitat at Jarvis Creek (WB1) and at km 1666 (WB2) was mainly used by Dabbling ducks. During the summer survey, one Bufflehead brood was observed (WB2) and one mallard brood at Jarvis Creek (WB1).

Other Ponds

Waterbirds in low numbers were observed on the thermokarst ponds dispersed throughout the study area. Most waterbirds observed on these ponds occurred during the spring survey. The pond located at the south-east corner of the Slim's River delta (WB12) had the greatest diversity of species. During the spring survey, seven species of waterbirds were observed at this location (Appendix IV). Very few waterbirds were observed on any of these ponds during the summer and fall surveys. Some of the ponds (WB7, WB8, WB9, WB17) lost much of their water during the summer.

4.8.4 Discussion

Previous waterbird surveys in the study area include: the Canadian Wildlife Services (CWS) annual waterfowl breeding population surveys (Hawkings and Hughes, 1999); the original Shakwak Highway Environmental Impact Statement (DPW 1977 and 1978); and Foothills Pipe Lines (Yukon) Ltd., 1977a and 1977b studies. The CWS surveys only included a few of the smaller ponds located immediately adjacent to the road. Waterbirds observed in the study area during the CWS surveys, but not identified during the surveys conducted for this study, are listed in Table 4-12.

Table 4-12 Additional Waterbird Species Observed in Study Area

COMMON NAME	SCIENTIFIC NAME	CODE
Canada Goose	*Branta canadensis*	CAGO
Blue-winged Teal	*Anas discors*	BWTE
Ring-necked Duck	*Aythya collaris*	RNDU
Redhead	*Aythya americana*	REDH
Common Goldeneye	*Bucephala clangula*	COGO
Common Merganser	*Mergus merganser*	COME
Dowitcher sp.	*Limnodromus sp.*	DOWI
Common Snipe	*Gallinago gallinago*	COSN
Belted Kingfisher	*Ceryle alcyon*	BEKI
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL
Rusty Blackbird	*Euphagus carolinus*	RUBL
American Dipper	*Cinclus mexicanus*	AMDI

Note: Based on Canadian Wildlife Service Spring Breeding Pair Survey, 1991 to 1999 (Hawkings and Hughes, 1999).

Waterfowl studies conducted in the Shakwak/Kluane region outside of the study area include: Johnston et al, 1985; Johnston and Eftoda, 1990; and GAIA, 1994. Yukon Government Biologists (Mossop and Egli, 1993) conducted waterfowl investigations on Kloo Lake, a large lake drained by Jarvis Creek located near km 1664.5 of the study area (Figure 4-8, Volume II). These studies identified critical waterbird habitat at Kloo Lake, and at the north end of Kluane Lake. The 1994 Shakwak Highway Environmental Assessment (GAIA, 1994) identified the Pickhandle Lake and Lake Creek Wetland complexes, located north of the study area, as important waterfowl habitat.

None of the 28 species of waterbirds identified in the study area are considered endangered or threatened according to Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Trumpeter swans, which occur in the study area, were on the threatened species list in the past (Hawkings, pers comm.)

1. Relative to other waterbird habitat in the region and in the Yukon, the study area has low waterbird habitat value. In general the area under assessment contains minimal habitat for waterbirds, except for two areas where substantial numbers of waterbirds were observed.

These areas include Sulphur Lake (WB5) and the eastern shoreline of Kluane Lake - km 1699 to km 1705 (WB11).

The original Shakwak EIS (DPW, 1977) also identified Sulphur Lake and the Slims River delta as important waterbird habitat. The study noted that the delta is used by migrants only, and for short periods. Snow geese were observed on the flats during one spring survey.

The thermoskarst ponds located in the study area are not ideal waterbird habitat. The ponds do not provide much cover (i.e. emergent vegetation) for waterbirds and thus were not used extensively for breeding. These types of ponds however tend to become ice-free first in the spring. Thus, they attract waterbirds during this season and can serve as a resting and feeding place for early arrivals and migrants. The majority of waterbirds observed using these ponds occurred during the spring survey. Pond WB12, located at the southwest corner of the Slims River delta, has shown consistent use over a number of years by a variety of species in the spring (CWS, 1999). During summer and fall surveys, few waterbirds were observed on any of the thermokarst ponds.

4.8.5 Impact and Mitigation

Highway construction has the potential to impact waterbirds through habitat loss or degradation or construction activity and its associated noise and disturbances. The proposed new alignment has the potential to impact waterbirds and their habitat at several locations. These impacts, however, can be minimized through timing of construction and/or adjustments to the proposed new alignment. Provided below is a list of locations where there is potential for impact in the study area and suggested mitigation. Options are presented when possible.

4.8.5.1 Riparian Habitat at WB1 and WB2

Care should be taken to prevent or minimize any infill of wetted areas at the two stream crossings located at Jarvis Creek (km 1664.5) and the drainage at km 1666. Disturbed side slopes should be re-vegetated in order to stabilize the banks and prevent erosion or sediment run-off into the habitat. As these areas are used by breeding waterfowl, impact can be further minimized by a fall or winter construction window.

4.8.5.2 Ponds WB3 and WB4

These ponds are surveyed on an annual basis by the Canadian Wildlife Service as part of their Cooperative Roadside Waterfowl Breeding Population Surveys (CWS, 1999). A variety of waterbirds were observed on these ponds every year since 1991. Maintaining the existing alignment should result in minimal disturbance to these ponds. The existing vegetative buffer between the road and these ponds should not be disturbed if possible. These ponds are used most heavily during the spring migration period (April 15 to May 30). Therefore, minimizing construction activities in this immediate area should occur during this time.

4.8.5.3 Sulphur Lake

Sulphur Lake is utilized extensively by a variety of waterbirds through the spring, summer and fall. Therefore, construction activity should be minimized near this location during these seasons. The vegetative buffer that currently exists between the lake and the existing highway should be maintained. Construction camps should not be placed at this location.

Option 1. Construction only occurs within the vicinity (i.e. 1 kilometer) of the lake during late fall (after freeze-up) or winter, if practical.

Option 2. Construction occurs during the summer but avoided during the spring and fall (April 15 – May 30, September 15 – freeze-up) staging periods. Since the lake is over 2.0 kilometers in length, it is possible for waterbirds disturbed by construction activities to move to the far end of the lake.

Kluane Lake Shoreline – WB11

After Sulphur Lake this is the most extensively used area by waterbirds in the study area. The potential for impact from the new proposed alignment is minimal where the road is moved further from the shoreline. However, one of the realignment options traverses a portion of the delta where a substantial number of waterbirds were observed during the spring. Construction activity in this zone should be scheduled for the summer or winter as it is most heavily utilized by waterbirds during spring and fall migration.

Option 1. Avoid re-alignment option that transects this section of the delta.

Option 2. Construct a causeway with culverts that will allow for water exchange between both sides of the highway, thereby maintaining habitat on the southeast side of the causeway.

Option 3. Maintain existing alignment.

4.8.5.4 Pond WB12

This pond is used extensively by waterbirds during spring migration. Construction activities in the vicinity of this pond should occur during the summer, fall, or winter when there is little or no utilization by waterbirds.

4.8.5.5 Slims River Delta – WB13

In general, this area is relatively poor waterbird habitat; however, a breeding colony of Arctic terns and Mew gulls were observed in close proximity of the two new proposed alignment options. Additionally, a pair of Red-Throated loons have used the area for breeding for a number of years. Swans use Slim’s River wetted areas behind the Interpretive Centre in the spring. This area is also used by breeding ducks.

Option 1. Maintain existing alignment and avoid construction between April 15 and June 30.

Option 2. Re-adjust alignment options (if necessary) to construct the new highway at least 200m from the nesting area. Construction activities should not occur between May 1 and June 30.

4.8.5.6 General Recommendations for Impact Avoidance

Toxic materials and potential habitat pollutants should not be stored in the vicinity of any of the waterbird habitat identified in this study.

Effort should be made to avoid disturbing vegetative buffers that currently exists between the highway and waterbird habitat identified in this study.

Highway camps and borrow pits should be located 500m or more away from any significant waterbird habitat.

Construction activity should be avoided in the vicinity of waterbird habitat during the spring (April 15 – May 30) when birds are migrating through the region.

Construction activity should minimize encroachment on waterbird habitat where possible. If encroachment is necessary effort should be made to minimize sediment loading into the habitat.

5.0 HYDROLOGY

5.1 INTRODUCTION

The objective of the hydrological study was to address data gaps in the original 1977 Shakwak Highway Improvement Environmental Impact Statement (EIS) for major watercourse crossings between km 1664.5 (Jarvis River) and 1788.5 (Quill Creek) on the Alaska Highway. Major watercourses considered in the study included Christmas Creek, Silver Creek, Slims River, Williscroft Creek, Congdon Creek, Mines Creek, Nines Creek, Bocks Brook, Lewis Creek, Copper Joe Creek, Burwash Creek, Duke River and Sakiw Creek. Existing hydrological data sources were reviewed and peak flows calculated for all major watercourses. The hydrological and morphological characteristics of the watercourses were investigated and assessed to describe potential impacts resulting from highway reconstruction activities. Mitigation measures are presented to minimize impacts with specific attention paid to Silver Creek, the Slims River and the Kluane Lakeshore in the Sheep Mountain area.

A summary of the watercourse crossings in the study area appear below:

DESCRIPTION	UTM EASTING	UTM NORTHING	HIGHWAY CHAINAGE
Jarvis River	669029	6758148	1664+500
Christmas Creek	649355	6766830	1668+300
Silver Creek	643339	6768118	1692+500
Slims River	634644	6765463	1702+300
Williscroft Creek	632923	6774561	1712+400
Congdon Creek	631321	6781661	1720+400
Nines Creek	624593	6787345	1730+200
Mines Creek	623253	6788487	1732+000
Bock's Brook	620988	6789893	1734+600
Lewis Creek	614029	6797740	1749+000
Copper Joe Creek	611601	6800328	1754+000
Duke River	599209	6806067	1768+000
Burwash Creek	595032	6812131	1775+500
Sakiw Creek	591793	6818547	1783+200
Quill Creek	589189	6821828	1787+500

5.2 DATA SOURCES

A review of the streamflow data and analyses available from government sources and previous reports and studies for the Shakwak Highway Environmental Assessment Update Project was carried out. Streamflow data up to 1998 have been collected where available from Environment Canada and DIAND Water Resources. For the 13 major stream crossings, catchment areas have been estimated and revised estimates prepared of 50 year and 100 year return period flood flows.

The following sources of streamflow data and previous reports and analyses were reviewed:

- Inland Waters Directorate (1978) – *Design Flows for the Shakwak Highway Project*, final report, Inland Waters Directorate, Environmental Management Service, Department of Fisheries and Environment, Ottawa, December 1978.
- Northwest Hydraulic Consultants Ltd. (1978) – *Assessment of South Yukon Flood Hydrology*, report prepared for Foothills Pipe Lines (South Yukon) Ltd., August 1978.
- U.S. Geological Survey (1994) – *Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada*, report by S. H. Jones and C. B. Fahl for the U.S. Geological Survey, Water Resources Investigations Report 93-4179, Anchorage, Alaska.
- Environment Canada – *Surface Water and Sediment Data to 1993*, HYDAT CD-ROM, Water Survey of Canada, Atmospheric Environment Service.
- Environment Canada – data for 1994-1998.
- DIAND Water Resources Division (Whitehorse) – Christmas Creek flow data 1983-1994.
- University of Ottawa – seasonal flow data for the Slims River, 1993 and 1994.

A complete listing of all reference material reviewed during the course of the work is contained in Section 10.

5.3 PREVIOUS STUDIES AND FLOW ESTIMATES

5.3.1 1978 Reports

Two reports in 1978 presented a wealth of data and analysis applicable to the Shakwak Highway. The report by Northwest Hydraulics Consultants Ltd. (NWH, 1978) presented estimates of design floods for selected river crossings along the South Yukon portion of the proposed Foothills Pipeline. The study used the available streamflow data up to 1977 reported by: Water Survey of Canada (WSC) in Yukon and B.C (total of 31 stations); DIAND in Yukon (10 stations, data since 1975 only); and U.S. Geological Survey (USGS) in Alaska (10 stations). The study focussed primarily on river crossings with larger catchment areas and, for the section of Shakwak Highway between km 1664.5 and km 1788.5, design flow estimates were presented only for the Slims River and for the Duke River. The report recommended the following:

- a 100 year return period event should be used for the pipeline design flood;
- flood discharges should be developed using a form of regional flood frequency analysis based on mapping of flood coefficients. More sophisticated methods including watershed modeling and hydrograph simulation were not felt to be appropriate given the limited data base and the non-homogeneous nature of the physiography and runoff patterns in South Yukon.

Design flood flows presented for the Slims and Duke Rivers are presented in Table 5-1:

Table 5-1 Flood Flow Estimates by NWH (1978)

River	Catchment Area (km^2)	Mean Annual Flood m^3/s	100-year Maximum Daily Flood m^3/s	Ratio of 100-year (Instant/Daily)	100-year Max. Instantaneous Flood m^3/s
Slims	2400	350	710	1.2	850
Duke	639	100	230	1.3	300

The 1978 report by the Inland Waters Directorate (IWD, 1978) estimated design flows for culvert and bridge crossings of the Shakwak Highway Project including reconstruction of the Haines Road from mile 46.6 to mile 157.4, and of the Alaska Highway from mile 1017.1 to mile 1218.2 (approximately km 1637 to km 1953). The report used three different methods to estimate design flows: the US Soil Conservation Service unitgraph, the Rational Formula, and flood frequency analysis. Recommended design values were based on the regional flood frequency analysis method. Flood frequency analyses were carried out using instantaneous peak flow data up to 1977 from 67 USGS stations in Alaska (18 on the coastal mainland and 49 in the Tanana and Yukon River basins of the Alaska interior). The method adopted was the index-flood method that involved:

1) Determining a relation between mean annual flood (MAF) and drainage basin characteristics. Drainage basin area was considered the only significant physiographic characteristic; and,

2) Constructing a composite frequency curve giving the ratio of MAF to that of the selected frequency.

Design floods for 25-year, 50-year and 100-year return period events were presented for all 13 major watercourses included in the 1999 Environmental Assessment Update. Results from IWD 1978 are presented in Table 5-2.

Table 5-2 Flood Flow Estimates by IWD 1978

Creek Name	Area km^2	Peak Flows m^3/s		
		Q_{25}	Q_{50}	Q_{100}
Christmas Creek	10.6	6.8	7.9	9.0
Silver Creek	114.0	47.6	55.2	62.6
Slims River	1696	294	340	394
Williscroft Creek	17.4	11.2	13.0	14.7
Congdon Creek	63.5	26.9	31.1	35.7
Nines Creek	63.5	26.9	31.1	35.7
Mines Creek	7.8	6.0	7.0	7.9
Bock's Brook	32.6	16.1	18.7	21.4
Lewis Creek	52.8	23.4	27.1	31.0
Copper Joe Creek	75.1	30.6	35.4	40.5
Duke River	639.7	159	185	211
Burwash Creek	176.1	66.5	77.3	87.5
Sakiw Creek	32.4	16.0	18.6	21.2

(Flows above converted from cfs quoted in Tables 12 & 13 in IWD 1978)

5.3.2 USGS 1994 Report

The comprehensive 1994 report by USGS entitled "Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada" developed

> *equations for estimating the magnitude and frequency of peak flows at ungauged sites in Alaska and conterminous basins in Canada… using multiple regression analyses of basin climatic and physical characteristics and peak flow statistics from 260 gauged locations in Alaska and 72 gauged locations in Canada.*

Alaska and adjacent areas of northern Canada were divided into five flood-frequency areas. Areas were defined based on topography, statistical cluster analyses, and regional regression analyses. Streamflow available through 1987 for Alaska and through 1984 for Canada were used in the study.

Based on Plate 1 in that report, the Shakwak Highway from km 1664.5 to km 1788.5 lies along the boundary between flood frequency Area 4 and flood frequency Area 5. With the exception of Christmas Creek, which is mostly in Area 5, the catchment areas of all the major watercourses covered by the present study are located in Area 4 of the USGS report. The report suggests that the standard errors of prediction using the regression equations at the 100-year return period level may be:

- for Area 4, +36%, -27%, average +/-32%;
- for Area 5, +55%, -35%, average +/-46%

5.3.3 Regional Streamflow Data

There are few active streamflow gauging stations in the immediate region of the 124 km length of Shakwak Highway covered by the present study. Environment Canada and DIAND Water Resources stations closest to this section of the highway are summarized in Table 5-3. The University of Ottawa collected seasonal data in 1993 and 1994 for the Slims River.

Table 5-3 Regional Streamflow Gauging Stations

Station Name	Number	Catchment Area km^2	Type of Data	Years of Record
Kluane Lake near Burwash Landing	09CA001	n/a (A)	Lake Levels	1953-1993
Kluane River at outlet of Kluane Lake	09CA002	4,950	Natural Flows	1952-1995
Donjek River below Kluane River	09CA003	12,400	Natural Flows	1979-1994
Duke River near the Mouth	09CA004	631	Natural Flows	1981-1998
Christmas Creek at Km 1687.8 Alaska Hwy	29CA005	112.5	Natural Flows(B) Regulated(1974)	1983-1997 1953-1993
Dezadeash River at Haines Junction	08AA003	8,500	Natural Flows	1980-1998
Giltana Creek near the Mouth	08AA009	194	Natural Flows	1993-1994
Slims River at Alaska Highway Bridge	(C)	2456		

(A) – station reports lake levels only
(B) – station operated seasonally by DIAND
(C) – station operated seasonally by University of Ottawa

Flow data were obtained for all the natural flow recording stations for the periods of record. Data to 1993 were obtained from the HYDAT CD-ROM. Data for the 1994 to 1998 period were obtained directly from Environment Canada and DIAND. Seasonal data for the Slims River were provided by the University of Ottawa. Appendix V-1, V-2, and V-3 include tables summarizing average monthly flows, maximum instantaneous discharges, maximum daily discharges, and minimum daily discharges for the stations shown in Table 5-3.

Catchment areas for the Kluane River, Donjek River and Dezadeash River are all significantly larger than the catchment areas of the major watercourses covered under the present study. Flow in the Dezadeash River has been regulated since 1974. The limited data available for the Slims River is inadequate for frequency analysis. Peak flow data for all these stations are, therefore, of limited direct application to the estimation of design flows for culvert and bridge crossings of the Shakwak Highway between km 1646.5 and km 1788.5.

5.3.4 Conclusions

Based on the review of the previous reports, studies and analyses and the available streamflow database described above, the following conclusions are drawn:

1) The 1978 reports by Northwest Hydraulics and by Inland Waters presented estimates of flood flows based primarily on regional analyses of streamflow data available up to the mid-1970's.
2) The 1978 report by Northwest Hydraulics presented design flow estimates only for the Slims River and the Duke River based on a form of regional flood frequency analysis.
3) The IWD 1978 report presented detailed estimates of design flood flows for culvert and bridge crossings of the Shakwak Highway between km 1646.5 and km 1788.5 (Table 5-2). Flows were estimated using the index-flood method.
4) Both 1978 reports discuss the limited availability of local climatic and streamflow data, the extremely non-homogeneous nature of the physiography and local runoff

characteristics within this area of southern Yukon, and the resulting uncertainty associated with design flow estimates.

5) The 1994 USGS report is a comprehensive study of regional flood characteristics based on all Alaskan and Canadian data available to the mid-1980's.

6) Streamflow gauging data are sparse to non-existent in the immediate study area as shown on Table 5-3. There are no long-term data available for small catchments less than 100 km^2 area, typical of most of the streams crossing the highway in the study area. Peak flow data for stations with large catchment areas shown in Table 5-3 are also of limited direct application to the estimation of design flows for culverts and bridges.

5.4 REVISED FLOW ESTIMATES

5.4.1 Methodology

Revised peak flow estimates were prepared by Dr. P. McCreath, Project Hydrologist, using:

- The regional flood frequency equations presented in the 1994 USGS report for Area 4 and for Area 5;
- Site-specific flood frequency analyses for the Duke River and for Christmas Creek.

Catchment areas were determined for all the major watercourses along the study section of the Shakwak Highway using base mapping provided for the project (Figures 5-1 through 5-7, Volume II) supplemented with information from regional 1:500 000 scale mapping and data from previous studies. Areas determined for the thirteen major watercourses are summarized in Table 5-4. Other catchment characteristics necessary to apply the USGS equations were estimated from the base mapping and from information contained in the USGS report.

5.4.2 Results

Table 5-4 presents the results of the revised flood flow analyses. The table includes, for each of the major watercourses in the study area, estimates of the 50-year and 100-year return period annual peak instantaneous flows and an estimate of the standard error of estimate associated with each flow. As shown in the table, the standard error of estimate is equal to about 30% of the flow magnitude for each return period and provides an indication of the reliability of the given flow estimates. For critical structures, it may be appropriate to conservatively design for the 100-year peak flow plus the standard error.

Table 5-4 Revised Flood Flow Estimates - Shakwak Highway km 1664.5 to km 1788.5

Creek Name	Area (km2)	Location (km)	50 year flow (m3/s)		100 year flow (m3/s)	
			Estimate	+/- Error	Estimate	+/- Error
Christmas Creek	112.5	1686.4	8.8	+/- 2.6	9.7	+/- 2.9
Silver Creek	73	1693.2	25.8	+/- 7.6	28.2	+/- 8.5
Slims River	2456	1705.0	770	+/- 230	820	+/- 250
Williscroft Creek	16.7	1715.9	5.0	+/- 1.5	5.6	+/- 1.7
Congdon Creek	63.5	1724.7	16.7	+/- 5.0	18.5	+/- 5.5
Nines Creek (no diversion)	62.5	1735.5	17.0	+/- 5.1	18.9	+/- 5.7
Nines Creek (with diversion)	2.0*	1735.5	1.0	+/- 0.3	1.1	+/- 0.3
Mines Creek (no diversion)	10.4	1736.15	4.5	+/- 1.4	5.2	+/- 1.6
Mines (with Nines Diversion)	70.9*	1736.15	18.8	+/- 5.6	21.0	+/- 6.3
Bock's Brook	41.7	1738.8	12.2	+/- 3.6	13.6	+/- 4.1
Lewis Creek	52.8	1749.1	15.7	+/- 4.7	17.5	+/- 5.3
Copper Joe Creek	75.1	1754.2	21.0	+/- 6.3	23.4	+/- 7.0
Duke River	631	1768.45	240	+/- 72	310	+/- 93
Burwash Creek	176.1	1776.25	49.2	+/- 15	54.6	+/- 16
Sakiw Creek	29.0	1783.9	9.0	+/- 2.7	10.2	+/- 3.0

NOTES for Table 5-4

1) *50 and 100 year flow estimates prepared using methodology described above*
2) *"+/- Error" is equal to +/-30% of the flow estimate, equal to approximately one standard error (USGS 1994)*
3) *"km Location" is approximate and estimated from base maps (Figures 5-1 through 5-7)*
4) *Catchment area shown for the Slims River assumes no significant area diverted south to the Kaskawulsh River.*
5) **Areas shown for Mines Creek (with Nines Diversion) and for Nines Creek (with diversion) both assume that the existing Nines-to-Mines Creek diversion will continue to operate. Areas for "no diversion" are natural drainage areas assuming possible failure of the existing diversion.*

5.4.3 Site-Specific Comments

Christmas Creek

Eleven years of seasonal flow data, including maximum daily flows, have been collected by DIAND for Christmas Creek. Due to the seasonal nature of the data collection, there is uncertainty each year as to whether the reported maximum daily flow corresponds to the actual maximum daily flow that occurred in the creek each year. Christmas Creek is the only creek in the study area located in USGS flood frequency Area 5: all other creeks are located in Area 4.

The nature of Christmas Creek at the highway crossing also differs from all the other major watercourses, except Sakiw Creek, in that the slope of the creek is low and there is a flat area of swamp and muskeg upstream of the highway. The low slope and availability of overbank storage upstream of the highway crossing suggests that peak instantaneous flows may be similar in magnitude to peak daily flows.

Flood frequency analysis of the reported maximum daily flows for Christmas Creek indicated a 100-year return period maximum daily flow of 5.4 m^3/s with an estimated peak instantaneous flow of 7.3 m^3/s. Application of the regression equation for USGS Area 5 resulted in a 100-year peak instantaneous flow estimate of 9.7 m^3/s (Table 5-4) and associated standard error of +/- 2.9m^3/s. The results from the two methods are comparable, given the general degree of uncertainty inherent in both methods. It is recommended that the more conservative (higher) flows estimated using the USGS methodology be adopted for design of a new culvert crossing at Christmas Creek.

Silver Creek

A range of catchment areas has been reported and estimated for Silver Creek: 114 km^2 (IWD, 1978); 101.7 km^2 (Environment Canada 1987); 98.7 km^2 (estimated from Figure 1 in IWD, 1977); and, 73 km^2 (estimated from Figure 2 Sawada and Johnson, 1999). The catchment area estimated from the 1999 paper has been adopted for the present study. It is recommended, however, that conservatively high estimates of design flows should be used for Silver Creek corresponding to the 50-year and 100-year flows shown in Table 5-4 increased by the estimated standard error for each flow. Recommended design flows for Silver Creek are 33.4 m^3/s and 36.7 m^3/s for the 50-year and 100-year events, respectively.

Slims River

The catchment area of the Slims River at Kluane Lake is dominated by the Kaskawulsh glacier that forms the upper portion of the catchment. As described in previous studies (NWH, 1978; Sawada, 1996), sub-glacial meltwater channels from the glacier occasionally shift and divert significant portions of the Slims River discharge south towards the Kaskawulsh River. The catchment area below the glacier was estimated by NWH (1978) and by Sawada (1996) to be about 440 km^2, or about 25% of the total area including the glacier. The total catchment area for the Slims River used in the present study was 2456 km^2, consistent with the most recent work carried out by the University of Ottawa. Peak flow estimates shown in Table 5-4 conservatively assume that the total catchment area, including the Kaskawulsh glacier, will continue to drain to the Slims River at the highway crossing.

Mines and Nines Creeks

The diversion of Nines Creek into Mines Creek was reportedly initially constructed by the Canadian Army during the 1950's. The diversion works have been maintained over the years by Highways personnel. Table 5-4 shows catchment areas and associated estimates of peak flows for the existing situation ("with diversion") wherein Mines Creek carries the largest flow including the diversion of flow from Nines Creek. Also shown on the Table are the areas and peak flow estimates that would be applicable if the existing diversion works were to fail due to an avulsion and creek flows were to revert to their natural drainage channels. Flow estimates were prepared using the USGS methodology for Area 4.

Duke River

Environment Canada have collected 16 years of annual maximum instantaneous discharges for the Duke River since 1981 as shown in Appendix V-1. The maximum instantaneous discharge of 573 m^3/s reported for 1988 was extreme: 2.5 times the next highest reported flow (1992) and 5.3 times the average maximum instantaneous flow reported over the 1981 to 1998 period. Although the rainfall event in July of 1988 produced very high flows in all the creeks along this section of the Highway and resulted in the failure of several culverts, the Duke River bridge successfully passed the peak flow from the event. The actual magnitude of the extremely high flow reported by Environment Canada for 1988 is questionable. As described by Environment Canada personnel, the peak flow reported for 1988 was estimated from the top end of an extrapolated stage-discharge curve and, during the event, there was channel "reconstruction" as a result of high sediment loads and channel bank and bed erosion/deposition. Statistically, the event is an extreme outlier. 50-year and 100-year flow estimates for the Duke River shown on Table 5-4 were based, therefore, on frequency analysis of the historical peak flows excluding the 1988 event.

5.4.4 Conclusions

Estimates have been prepared of 50-year and 100-year return period peak flood flows for the thirteen major watercourses crossing the Shakwak Highway between km 1664.5 and km 1788.5. The estimates have been made based on a review of previous reports and studies, the limited existing database of local streamflow data in the area, and estimates of catchment areas and characteristics. The revised flood flow estimates are presented in Table 5-4.

The revised estimates of maximum streamflows suffer from the same limitations and uncertainties expressed in the previous studies, due primarily to the lack of site-specific streamflow data. The application of estimated flood flows to the engineering design of culverts and bridge crossings must include assessment of local site-specific conditions and an assessment of the past performance of existing culverts and bridges. Adequate factors of safety must be incorporated in final engineering designs to allow for a significant degree of uncertainty in the flow estimates.

5.5 HYDROLOGIC CHARACTERIZATION, MORPHOLOGY ASSESSMENT & HYDROLOGIC IMPACT ASSESSMENT

Between July 21-24, 1999, a hydrological site investigation was conducted for the major watercourses within the study area. Existing data was previously reviewed, and field observations and measurements completed at each site. For each major watercourse the catchment is described, the flow data is presented, hydrological conditions and existing crossings are described, and finally, hydrological impacts are discussed and mitigation measures provided. Selected photographs of the major watercourse crossings are provided in Appendix V-4. Hydrology study maps for the major watercourses are presented in Figures 5-1 through to 5-8, Volume II. These maps outline drainage basins and possible channel avulsions. Highway kilometers referred to in the remaining hydrology sections are based on the existing Alaska Highway kilometer posts.

5.5.1 Christmas Creek (km 1686.4)

Catchment - Total Area 112.5 km^2. Drains from Boutellier Summit at elevation 1003 m to the west and from south of the highway including Hungry Lake, minor drainage from north of highway goes alongside the road to enter the creek downstream of the existing crossing. Maximum elevations may be in excess of 1800 m.

Flow Data – DIAND station 29AA005, seasonal data 1983 to 1997 generally April/May to early/mid-October. Maximum flows typically in May from snowmelt, generally declining during summer and fall with occasional rainfall-runoff peaks. Maximum flow reported 5.16 m^3/s on May 16, 1993, minimum reported 0.02 m^3/s May 7, 1984, maximum month 2.46 m3/s July 1988, minimum month 0.09 m3/s August 1987 (partial month data only). Estimated flood flows – 50-year event 8.8 m^3/s, 100-year event 9.7 m^3/s.

Description - At the Highway crossing, Christmas Creek on July 21 was very slow moving, tranquil flow, with completely clear water upstream and downstream. Two distinct channels parallel to the highway lead to the culverts. The upstream channel bottom is lined with small gravel with occasional larger cobbles covered with silt and fine sand. Channel banks appear stable, are predominantly silt in the inlet area, and heavily grassed. The right (looking downstream) approach channel is approximately 2 m wide and 0.3 m deep (variable) 6 m upstream of the culverts with a small riffle about 15 m upstream of the inlet with a mixed gravel-sand-silt bar visible. The upstream area is muskeg with thick marsh grass, standing water and dead standing spruce. Approximately 200 m upstream there are live spruce. High water marks are consistent with bank full level on the approach channels. Sediment transport at higher stages is probably minimal and limited to silt and perhaps fine sand sizes.

At the culvert outlets, there was an enlarged stilling pool and scour hole area approximately 10 to 15 m long and 0.5 m deep. Banks contain some cobble-sized material and gravel with sand and silt. The channel continues downstream through a heavily grassed, marshy area. The channel has a pool and riffle configuration with gravel control sections. The pools are tranquil and the riffle controls are 1 m to 2.5 m wide. Further downstream the creek bed is predominantly gravel with a thin covering of silt on the gravel. The right bank is lined with thick marsh grass and overlies silty material. East of the existing culverts, the highway shoulders exhibit tension cracks (50 to 75 mm wide at the running surface) and 50 to 100 mm of slumping and settlement, probably due to a combination of permafrost and the muskeg foundation. The downstream (north) highway embankment appears over-steep. The road ditch has carried flow from the road drainage and from the hillside above the curve. The topographic base mapping (Figure 5-2, Volume II) indicates the creek crosses the highway a second time about 1300 m east, however, there was no evidence of a second culvert crossing.

Existing Crossing - The twin box culverts are rectangular wood frame construction with the remnants of a circular wood stave culvert offset 3 m to the left (west) of the box culverts. The circular pipe serves as an emergency overflow. The box culverts are 48 inches high by 70 inches wide (1.22 m x 1.78 m) with a 30 cm wide central splitter wall. Flow enters the culverts from both of the approach channels. There is approximately 1.2 m of headroom available between the crown of the culverts and the crown of the road (maximum H/D = +/- 2). The left culvert is the only one carrying flow: the invert is slightly lower than the invert of the right culvert. The flow through the culvert is rapid to the outlet with a free drop at the outlet of about 0.3 m to the stilling pool. Staff gauge located on the left bank immediately upstream of the inlet reading 0.30 m. The circular pipe is partially collapsed: approximate dimensions at the outlet are rectangular 18” high by 24” wide (0.46 m x 0.61 m), at the inlet circular 24" (600 mm) diameter. The overall condition of the wood box culverts appeared good; the wood is sound and carrying the flow smoothly. The culverts showed no signs of distress except for some minor settlement. High water marks visible on the staff gauge extended to about 0.7 m, about 0.4 m higher than the July 21 water level. High water marks in the culvert based on staining of the wood indicate flow depths at the inlet of about 0.69 m in both culverts.

Potential Hydrologic Impacts - The stakes for the new highway centreline are approximately 25 m downstream of the existing culverts. The new road alignment would pass through the muskeg area and settlement problems can be anticipated. The new centreline is located near the first riffle downstream of the culverts, and will require new culverts and construction of a new road section through muskeg. The curvature starts up the hill to the east, cutting off the existing curve and extending downstream of the existing road embankment. Sediment control measures must be implemented during construction to minimize impacts on the stream and on the reported fisheries resource. There is a small pull-off on the north side of the road on the left bank and the area has been used by campers and day-trippers – this area will be lost with road realignment. Settlement problems can be anticipated for the new grade across the muskeg and for the culverts. The culverts must be designed to allow fish passage. Potential hydrologic impacts and possible mitigation measures are summarized in Table 5-5:

Table 5-5 Christmas Creek - Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Loss of muskeg and wetlands area	Minimize area of construction disturbance, remove existing road embankment and reclaim after construction
Flooding of muskeg and wetlands areas	Provide adequate culvert capacity to minimize upstream flooding during high flows
Settlement of new fill and culverts	Design requires foundation preparation to minimize settlements
Sediment generation during construction and impact on fisheries	Sediment control measures, limit construction area, careful stream diversion works
Sediment generation during highway operation	Provide vegetation along road shoulders and creek banks at crossing
Pollutants entering stream due to highway plowing and maintenance	Restrict dumping of snow and other road surface materials in crossing area
Erosion of creek channel downstream of culverts	Provide stilling pool and erosion protection at culvert outlet area
Damage to or loss of fish habitat	Limit area of construction disturbance, reclaim old crossing area after construction
Barrier to fish passage	Design new culvert(s) for fish passage at suitable flow conditions

5.5.2 Slims River Bridge (km 1705)

Catchment – Total drainage area including the Kaskawulsh Glacier is estimated to be 2456 km^2 of which about 440 km^2 is located downstream of the glacier terminus. About 55% of the catchment is glacier-covered and more than 90% of the area is higher than elevation 1200 m. Maximum elevations are in excess of 2400 m.

Flow Data – No continuous flow data exists. Seasonal data were collected in 1993 and 1994 (Sawada and Johnson, 1999). The flow regime is dominated by glacial melt from the Kaskawulsh Glacier. Periodically, significant decreases in flow occur due to changing conditions at the northern extent of the glacier: flow from the glacier area is diverted to the Kaskawulsh River, a tributary of the Alsek River (Inland Waters, 1977). This diversion impacts directly on Kluane Lake levels. As described in Environment Canada (1987), maximum annual flows typically occur in July/August with minima between February and May. Diurnal variations are pronounced and effected by daily glacial melt rates. Flow at the bridge has been estimated (Inland Waters, 1977) to range from a winter low of 0.2 m^3/s to extreme flows in excess of 560 m^3/s. Inland Waters (1977) reported that there were no records indicating that glacial lake outburst flooding had had any noticeable effects on the highway. Seasonal flows measured by the University of Ottawa in 1993 and 1994 ranged from less than 10 m^3/s in May to more than 300 m^3/s (and still increasing) in August. Estimated flood flows – 50 year event 770 m^3/s, 100 year event 820 m^3/s.

Description – The river channel upstream of the highway occupies a 2 to 3 km wide glacially-carved valley filled with outwash. The channel is a typical highly turbid braided glacial meltwater stream. Alluvial fans encroach onto and constrict the floodplain at the confluence with high gradient tributary streams such as Vulcan Creek and Bullion Creek. Most of the floodplain is composed of fine gravel, sand and silt (Environment Canada, 1987) with the finer materials predominating at the highway. The river channel is constricted through the highway bridge and is actively building a delta into Kluane Lake.

Flow on July 23, 1999, was highly turbid with darker plumes visible in the upstream flow, probably tributary waters from Bullion Creek and/or Vulcan Creek. Upstream, the channel is locally eroding laterally between the groyne and the guide bank on the right bank. Minor channel encroachment and erosion is visible between the left bank groynes, and between the first groyne and the left bank guide bank. Flow accelerates through the bridge opening from the upstream extent of the guide banks. Lake levels downstream of the bridge may have been about 45 cm higher than on July 23. The separate plumes from the two bridge openings do not join and begin to mix until at least 200 m downstream. Exposed topset bed material is visible in the central portion of the delta. Plumes of Slims River flows are visible sometimes down the east shore towards Silver City and sometimes down the west shore to and beyond Goose Bay. Wind on the lake, lake levels and river flow rates will all effect the location of the plume(s). There are back-eddies on both banks downstream which are causing some local erosion of the delta deposits. Erosion could encroach on the causeway fill in time. Fisheries resources reportedly exist at the mouth of the Slims River at Kluane Lake.

Existing Crossing - The present bridge across the Slims River was constructed in 1956. The bridge has a steel superstructure, concrete deck, concrete abutments, one mid-channel concrete pier with rounded noses upstream and downstream. The widths of the waterway openings were estimated by Sawada and Johnson (1999): 20 m for the left channel and 32 m for the right channel. The concrete running surface exhibits numerous lateral cracks and the surface is worn. Significant vibration of the steel cross-bracing under the deck was observed when a large truck went over. Some minor bridge superstructure movement has occurred towards the right abutment (right abutment downstream bridge support in Photo 23A). The comparable structures on the upstream side and on the left abutment do not show any significant signs of movement. There is a GSC survey monument #78Y543 on the downstream left abutment.

There are river training works at the highway bridge consisting of guide banks and groynes. Upstream, the right guide bank is considerably shorter than the left guide bank and flow is beginning to erode behind the right guide bank. Other erosion damage was noted on the right bank immediately upstream of the abutment. Guide banks have generally small riprap (200 to 300 mm) with occasional larger boulders.

Beneath the bridge there is a significant blockage at the left abutment. The tops of old wooden piles are visible and may be an abutment of an old bridge. The space between the old piles and the existing concrete abutment is filled with material grading from silt to large boulders (possible riprap remnants from the old bridge crossing). At the left abutment there is about 1.5 m of clearance between the fill and the underside of the bridge and less clearance at the downstream end. The old piles extend about one-third of the way out from the left abutment. Flow accelerates significantly and is quite rapid through the bridge opening. The central pier and both abutments have riprap protection - more protection visible on the left side than the on right side. Riprap downstream of the central pier may be leftovers from the old bridge or the riprap may have been moved by high flows or ice. Wooden piles for the old crossing are also visible near the right abutment. High water marks on the guide banks are about 0.45 m higher than the present water level. High water mark on an old wooden pile is 1.2 m above existing water level. It appears that a significant portion of the left bridge opening may not be usable because of fill encroachment from a previous bridge. The right opening is a more efficient, wider and unobstructed opening. The underside of the bridge was 2.7 m above the July 23 water level.

Downstream, the left bank has a short guide bank with heavy riprap extending some 20 to 25 m beyond the bridge. Some erosion has occurred recently along the left bank downstream of the guide bank. The right abutment has no downstream guide bank although some rocks were noted 10 to 15 m out from the abutment. Downstream on the right bank a strong back-flow eddy is eroding delta material back towards the toe of the road fill.

Potential Hydrologic Impacts - If the existing bridge structure is kept (regardless of other highway alignment changes on the east and west sides of the causeway), there are repair and maintenance tasks that should be carried out to secure the existing bridge and approaches and to improve the hydraulic capacity of the structure. The following remedial work should be carried out:

- Consideration should be given to removing or relocating some of the left bank and mid-channel riprap under the bridge to increase the waterway opening area and establish a greater total flow capacity. This would balance the flow capacity between the two waterway openings while maintaining or improving pier and abutment protection.
- Old wooden pilings beneath the bridge should be removed or cut off at water level.

- The right bank upstream guide bank should be repaired, realigned, and extended 50 to 100 m upstream, possibly curving it away from the bridge to assist guiding flow smoothly through the bridge opening.
- A riprapped guide bank should be constructed on the right bank downstream.
- Potential erosion encroachment on the causeway fill both upstream and downstream should be monitored on a regular basis and the road fill reinforced or groynes extended if necessary.
- The concrete decking should continue to be evaluated by Yukon Government, Community & Transportation Services inspection staff.
- Bridge deck movements noted at the right abutment should be evaluated by a qualified professional.
- Aggradation of the delta in the area of the bridge does not seem to have been significant since construction of the bridge. However, if progressive loss of flow capacity at the Slims River Bridge is a concern due to on-going delta aggradation, then other options should be investigated.

5.5.3 Williscroft Creek (km 1715.9)

Catchment - Total area is estimated to be 16.7 km^2. Drainage comes from the west with maximum catchment elevations in excess of 1800 m. Steep and flashy mountainous catchment.

Flow Data – No flow data for Williscroft Creek. Estimated flood flows – 50-year event 5.0 m^3/s, 100-year event 5.6 m^3/s.

Description - At the highway the creek channel has a very high gradient with coarse bed material and cobble sizes up to 250 mm diameter, the largest observed of all the major watercourses. This is also the steepest creek at the highway. About 300 m upstream of the highway the channel is diverted to the right (south) through an angle of about 45^o towards the existing culvert crossing by a training dyke constructed from local channel materials. The dyke is located near the apex of the aggrading alluvial fan. The total width of the fan at the lakeshore is more than 1 km and the existing culvert crossing is located at the extreme southern extent of the fan. There is a high potential for channel avulsions to the north or to the east away from the existing channel. The channel is confined laterally by gravel and cobble push-up dykes on both banks upstream of the highway with a bankfull channel width of 20 to 30 m. Coarse sediment that deposits on the fan downstream of the culverts is periodically relocated by Department of Highways personnel to keep the culvert outlet open.

Flow on July 22, 1999, was low and completely clear with a typical channel width of about 1 m and average depth of 50 to 75 mm. The low flow channel exhibits a pool and riffle approach to the culvert. The creek downstream of the training dyke is forming a coarse-material alluvial fan. The creek will carry a high sediment load of coarse material during flood flows and the existing banks will be unstable unless protected with large riprap.

Existing Crossing - The present culvert was installed after the previous small bridge filled with gravel during the 1988 flood. The culvert is a corrugated steel multi-plate with a diameter of 3050 mm (10 feet). Steel plates have been welded along the culvert invert for abrasion protection. Four steel plates each 350 mm wide extend the full length of the pipe with two plates on each side of the centre and angle iron welded along centre. Steel headwalls at the culvert are at right angles to the creek centreline. Some haphazardly placed riprap provides some erosion protection and forms nominal guide banks on both sides. Bed level downstream of the outlet is up to 1.5 m higher in places than the culvert invert, due to downstream deposition of coarse sediment during flood flows. Water ponds within the culvert at the outlet due to the high downstream bed level and much of the low flow makes its way out by seepage through the coarse cobbles in the fan. The proposed highway realignment will use the existing culvert location.

Potential Hydrologic Impacts - This creek carries very large material during high flows, is very steep, and will require constant maintenance both upstream and downstream of the highway. The potential for a channel avulsion at the apex of the fan is high. A channel avulsion could result in potential failure of the highway at any location up to about 1 km north of the culvert, near km 1717. Abrasion of the culvert invert will be an on-going concern, although the steel plates are providing suitable invert protection at present. Blockage of the culvert outlet could result from sediment deposition after high flows. A summary of hydrological impacts and mitigation measures appears in Table 5-6.

Table 5-6 Williscroft Creek - Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Channel avulsion and potential failure of highway between km 1716 and km 1717	Reinforce training dyke and channel banks upstream of culvert with heavy riprap. Schedule regular inspections and maintenance
Erosion failure of guide banks and highway fill at culvert	Reinforce upstream riprap and realign to improve inlet flow conditions.
Blockage of culvert at outlet resulting in loss of flow capacity and overtopping of highway	Excavate outlet channel invert consistent with culvert invert level. Ensure outlet channel to Kluane Lake is maintained and restored after flood events.
Potential culvert invert abrasion and failure	Continue to monitor performance of existing steel invert plates, repair as required.

5.5.4 Congdon Creek (km 1724.7)

Catchment - Total area is estimated to be 63.5 km^2. Drainage comes from the southwest with headwater elevations in excess of 1800 m at the divide with the Duke River. Air photos and base mapping indicate that a number of potential channels cross the highway. The most recent channels on the air photos originate near the pipeline right-of-way about 1 km above the highway. The apex of the alluvial fan is about 4.5 km above the highway: topographic mapping shows old channel scars leading to the highway between approximately km 1721 to the south and km 1730 at Dutch Harbour to the north. A channel at km 1724.7 presently carries all the flow. A channel near km 1724.3 is aligned with the campground access road at the highway. Another old channel scar crosses the highway about 1.0 km east of the existing culvert. At the apex of the fan the creek channel is aligned with, and reportedly had flowed through, Goose Bay in the past. There is no culvert presently at the Goose Bay crossing.

Flow Data - No flow data for Congdon Creek. Estimated flood flows – 50-year event 16.7 m^3/s, 100-year event 18.5 m^3/s.

Description – At the highway, Congdon Creek is a steep braided gravel bed stream which has formed a large aggrading alluvial fan at Kluane Lake. The channel is confined between man-made dykes upstream of the highway. There was no flow in Congdon Creek on July 22, 1999. Gravel has been pushed up from the channel to form the right bank. Two small breaches are visible in the right bank: just upstream of the culvert, and about 70 m upstream of the culvert. The left bank is formed by an older push up dyke which has been severely eroded immediately upstream of the highway. Channel maintenance has been carried out for a significant distance upstream. The bed material is finer than many of the other creeks: more sand is visible in the bed material and there is a fine gravel and small cobble armor layer on the bed. There has been ponding against the highway and silt deposition south of the culvert indicating that overflow has come from the old channel near km 1724.3.

The downstream channel bed is slightly higher than the bed within the culvert. The outlet channel is not well defined and flow has been spread over a broad area. Sediment deposition has occurred around green and healthy trees. The channel curves from right to left and there is a narrowing of the channel about 100 m downstream of the culvert - flow has spread out through the trees and gets to the Lake by several different paths. There is a dyke on the right offset about 20 m from the channel on the other side of the trees. On the other side of the dyke is an old channel of Congdon Creek that is now a borrow area with a gravel stockpile. The Congdon Creek campground is downstream of the road. Another abandoned channel (the middle channel shown on the base mapping) crosses the highway at the access road to the Congdon Creek Campground beside the Kluane National Park Reserve Parks Canada sign. Any flow coming down this old channel is diverted by the highway embankment to the present main channel. This explains the small breach in the right bank dyke at the Congdon culvert and the evidence of ponding and sediment deposition beside the highway. From the air photos, the middle channel appears to be diverted to the north by diversion works about 400 m upstream of the highway. The middle channel does not reportedly carry much in the way of sediment other than fine material so diversion is primarily a water-handling problem. The Congdon Creek Campground occupies a lot of the fan area along the lakeshore so there may be a potential public safety issue involved.

Existing Crossing - The present Congdon Creek culvert was installed after the 1988 flood and replaced a small clear-span bridge. This location will be retained with the new highway. The culvert is a circular steel multi-plate with a vertical projecting end and upstream and downstream perpendicular steel wing walls. The outlet headwall configuration is identical to the inlet. There are no upstream guide banks to train the flow into the culvert. Culvert is nominal 12 ft (3670 mm) diameter with a measured diameter of 12 ft 1 inch (3680 mm) to the inside of the corrugations. Remaining flow space is 10 ft 6 inches (3200 mm), hence the depth of sediment deposition in the culvert is about 1 ft 6 inches (460 mm). The high water mark is 450 mm above the gravel level at the inlet. There is another older high water mark 1.1m above the present gravel level. Spray marks in the pipe are 1.8m above the gravel.

Potential Hydrologic Impacts - The culvert needs better upstream guide banks on both sides to improve inlet flow conditions. The left bank has been severely eroded and could fail and should be repaired and reinforced with riprap. All the upstream diversion works on the alluvial fan should be inspected and maintained on a regular basis. Potential channel avulsions could impact the highway between km 1721 and km 1730. Additional culverts could be installed at some of the old channel crossings to minimize potential overtopping damage to the highway in case of an avulsion. On-going aggradation could result in loss of culvert capacity. The main channel upstream of the highway has been identified as a possible source of borrow material. Sediment control measures must be implemented during borrow development to minimize sediment generation. Table 5-7 summarizes potential hydrological impacts and mitigation measures.

Table 5-7 Congdon Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Channel avulsions impacting highway between km 1721 and km 1730 (Dutch Harbour)	Construct and maintain training works at the apex of the fan. Install additional culverts at old channel crossings. Carry out regular inspections and maintenance of all channel training works
Failure of the left bank upstream of the existing culvert	Reinforce left bank with riprap
Channel avulsion and overtopping of highway at campground access road	Reinforce highway embankment with riprap at all locations where embankment serves as a diversion structure. Consider raising highway grade to provide additional freeboard.
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel
Downstream sediment deposition blocking existing culvert	Continue to carry out regular downstream channel excavation to maintain channel flow capacity to Kluane Lake

5.5.5 Nines Creek (km 1735.5)

Catchment - Total area is estimated to be 2.0 km^2 with the existing Nines-to-Mines Creek diversion. Total area if the diversion fails would be 62.5 km^2. Drainage comes from the southwest. Headwater elevations are in excess of 2400 m at the divide with the Duke River catchment. The creek gradient decreases dramatically about 4 km upstream of the highway where the character changes from a steep mountain torrent to an aggrading alluvial fan.

Flow Data - No flow data for Nines Creek. Estimated flood flows in m^3/s are as follows:

	50-year	100-year
With existing diversion to Mines Creek.	1.0	1.1
No diversion to Mines Creek.	17.0	18.9

Description – Creek was completely dry on July 22, 1999 and has not recently carried any significant flow. Nines Creek used to be a major highway crossing: the Canadian Army reportedly diverted the flow to Mines Creek in the 1950's. The proposed new road centreline is about 50 m upstream of the existing road. The clearing line suggests that the new alignment may cross Nines Creek at an oblique angle (about 45^o): upstream guide banks will be needed to align creek flows with a culvert crossing. If Nines Creek is returned to its natural channel, major excavation and channel training works will be required to allow the channel to carry high flows. If the existing diversion is maintained, a culvert must be installed at Nines Creek to carry local drainage.

Existing Crossing - The culvert has carried some low flows in the past. The high water mark is about 0.3 m depth. The measured culvert diameter was 58 inches (1470 mm) - possibly a nominal 5 ft (1500 mm) diameter. There has been some minor settlement in the crown of the pipe at the road centreline. Cover is about 1 m. The culvert is out of round at the outlet end - 60 inches vertical diameter, 58 inches horizontal diameter. The culvert outlet invert is 0.5 m above the downstream channel invert and a small outlet channel has been excavated in a straight line away from the road. The outlet channel has not recently carried much flow. No riprap bed or bank protection is installed either upstream or downstream of the culvert.

Potential Hydrologic Impacts – Failure of the existing Nines-to-Mines Creek diversion could result in failure of the highway at Nines Creek due to the small existing Nines Creek culvert. Depending on road grades, costs, and maintenance considerations, it may be worth installing a large oversized culvert at the new Nines Creek crossing that would serve as an emergency overflow in case the Nines-to-Mines diversion fails. The new road grade at Nines Creek would have to be constructed at a higher elevation than at present. The potential exists for a channel avulsion at the apex of the fan: Nines Creek could flow to the south away from both the existing diversion and the existing Nines Creek crossing to cross the highway near km 1733.5. Nines Creek is a potential source of borrow material. Sediment control measures must be implemented during borrow development to minimize sediment generation (see Table 5-8).

Table 5-8 Nines Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	**Mitigation**
Failure of Nines-to-Mines diversion	Maintain and/or reinforce existing diversion works. Carry out regular inspections to maintain diversion Install oversized culvert at Nines Creek to protect highway
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel
Avulsion of channel to the south from the apex of the fan	Reinforce channel banks at fan apex to prevent avulsion. Continue to carry out regular inspections and maintenance to keep flow in existing channel
Oblique approach angle of Nines Creek to the new highway alignment	Construct upstream guide banks with riprap protection. Maintain existing Nines-to-Mines diversion

5.5.6 Mines Creek (km 1736.15)

Catchment - Total area is estimated to be 70.9 km^2 with the existing Nines-to-Mines Creek diversion. Of that total, about 60 km^2 originates from the Nines Creek catchment. Total Mines Creek area if the diversion fails would be about 10.4 km^2. The natural (no diversion) Mines Creek catchment has maximum elevations of about 1800 m with about three-quarters of the area within 3.5 km of the highway.

Flow Data - No flow data for Mines Creek. Estimated flood flows in m^3/s are as follows:

	50-year	100-year
With existing diversion from Nines Creek.	18.8	21.0
No diversion from Nines Creek.	4.5	5.2

Description - Mines Creek has been a major maintenance area for years. Major gravel-excavation has been carried out here every year with push-up dykes both sides upstream and downstream. Between the dykes the braided gravel-bed channel occupies a wide floodplain. Flow on July 22 was low and slightly turbid and the low flow channel was located along the right-centre of the floodplain. There is a trash interceptor about 100 m upstream of the road. There has been more erosion along the right bank than along the left upstream of the culvert, although there are three eroding sand and gravel vertical faces along the left bank about 400 m upstream – older vegetation-covered fan deposits. There is a stockpile of screened fine gravel on the left bank some 200 m downstream of the road. There is more sand visible in the upstream deposits than in the other creeks to the north. Department of Highways personnel report that the annual maintenance effort has generally been greater for Mines Creek than for most of the other creeks. Mines Creek was reportedly excavated in early June 1999 to a depth of 16 to 18 feet (about 5m) with a 215 backhoe between the gravel stockpile 200 m downstream of the culvert and the culvert outlet. The deposition that has subsequently happened reportedly occurred during a single flow event about the third week of June 1999 after a combination of hot weather bringing down snowmelt plus a rain event. Mines Creek has been identified as a significant potential source of borrow material.

Overall the man-made channel is unstable both laterally and vertically upstream and downstream: both banks are subject to on-going erosion and the channel bed experiences episodes of major bed-load deposition both upstream and downstream of the culvert.

Existing Crossing - The Mines Creek culvert was washed out in the 1988 flood. There was severe sediment deposition observed within the present culvert on July 22. The maximum measurable width at the inlet was 13 ft (4m). The culvert is either a 14 ft or 15 ft (4300 or 4600 mm) diameter circular culvert, or, a pipe arch (4370 x 2870 mm rise or 4570 x 3070 mm rise). There was about 1.4m of flow depth available at the inlet and less in the central and downstream portions of the pipe: from 1.4m to 3m of sediment could be deposited in the pipe depending on the actual pipe dimensions. Riprap guide-banks upstream on both sides are approximately 20 m long at an angle of 45° to 60°. No riprap bank protection was apparent at the culvert outlet due to the deposited sediment. Cover over the crown of the pipe at the road is approximately 1.5 m. High water mark within the pipe was 0.3 m above the July 22 water level, although the entire inside crown of the pipe was sediment covered. High water mark on a large boulder beside the inlet was 1.1 m above the July 22 water level. The road grade rises both ways from the culvert crossing. The realigned road may cross Mines Creek about 50 m upstream of the existing culvert.

Potential Hydrologic Impacts – The existing culvert is nearly completely blocked. To restore the culvert capacity could require the excavation of a 2 m to 3 m depth of sediment downstream over a distance of more than 1 km and width of at least 25 m. The new road alignment and culvert crossing will experience the same on-going problems as the existing crossing: lateral erosion and instability and severe bed-load deposition during single high flow events. Consideration could be given to significantly raising the level of the new road using gravel from upstream and downstream for borrow material. One or two large new culverts could be installed at or near the existing creek invert level. This may defer dredging activities for some unknown period of time but will not eliminate the problem: one major flow/sediment transport event could still bury the culvert(s). Another suggestion made was to periodically divert the drainage back into Nines Creek to distribute the sediment deposition over a larger area. This would require training works, probably 4 or 5 km from the highway near the apex of the fan, as well as installation of comparable-sized large culverts in both creeks. This alternative would require additional capital expenditures but may result in overall savings in annual maintenance costs. Mines Creek is a potential source of borrow material. Sediment control measures must be implemented during borrow development to minimize sediment generation. Table 5-9 summarizes hydrological impacts and mitigation measures.

Table 5-9 Mines Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	**Mitigation**
Blockage of existing or new culvert(s) by on-going sediment deposition	Continue to carry out regular channel excavation. Extend excavation deeper and further downstream to provide greater sediment settling volume. Maximize use of borrow material from within the channel (temporary measure only). Periodically restore drainage to Nines Creek to increase total potential area for sediment deposition.
Channel avulsion at Nines-to-Mines diversion, <u>or</u>, periodic removal of diversion (restore drainage to Nines Creek)	Less channel excavation required at Mines Creek. Larger culvert and more channel excavation required at Nines Creek. Maintain existing diversion works.
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel

5.5.7 Bock's Brook (km 1738.8)

Catchment - Total area is estimated to be 41.7 km^2. Drainage comes from the southwest. Headwater elevations are in excess of 2400 m at the divide with the Duke River catchment. The channel exits from a narrow gorge and the creek gradient decreases dramatically about 3 km upstream of the highway: the character changes from a steep mountain torrent to an aggrading alluvial fan. At that point, the creek is located at the apex of the fan, both longitudinally and laterally: from there to the highway the channel is elevated above the surrounding fan.

Flow Data - No flow data for Bock's Brook. Estimated flood flows – 50-year event 12.2 m^3/s, 100-year event 13.6 m^3/s.

Description - There was no water flowing in Bock's Brook on July 22. Extensive upstream channeling works and dyke construction upstream and downstream. The channeling work may extend 2 km to 3 km upstream. The upstream channel is 25 to 30m wide between the push-up dykes and is significantly higher than the surrounding older fan deposits. The low-flow channel has a braided pattern. The bed and bank material is typical sand, gravel, cobbles, with some small woody debris apparent. There is a line of angle iron log-catchers about 60 m upstream of the culvert. The channel has carried high flows over the full width of the upstream channel and there has been minor erosion of the toes of the confining dykes. Guidebanks extend upstream 20 m on both sides of the culvert and have heavy 600 to 800 mm diameter riprap. Downstream of the culvert there has been extensive channel widening and excavation to create push-up dykes on both sides. The channel width between the eroded toes of the confining dykes was 25 to 30 m. The channel slope is quite flat for perhaps 500 m downstream of the culvert then increases as the channel turns left leading to Kluane Lake. Station 1738+800 is at the culvert centreline.

About 1.5 km upstream of the road the right confining dyke is severely eroded. The left bank dyke has been breached further upstream. Beyond that, the creek turns left and is confined by an eroding right bank push-up dyke. Avulsions could occur at any location and along either bank up to about 3 km upstream of the highway. The Bock's Brook channel has been identified as a potential source of borrow material upstream and downstream of the culvert.

Existing Crossing - Significant sediment deposition within the culvert made it difficult to determine the culvert dimensions. Maximum width at the inlet was nominally 14 feet (4.25m): the culvert could be a 4370 mm span x 2870 mm rise pipe arch or a 4300 mm diameter circular. At present there is 2.1m (7 ft) of headroom above the deposited sediment. There may be, therefore, from 0.8 m to 2.2 m of sediment deposition within the culvert depending on actual pipe dimensions. The most recent high water mark on the pipe is 0.9m below the crown which is completely coated with silt. There are some places within the pipe where the pipe is distorted and the steel galvanizing has been damaged: oversize rocks in the culvert backfill may be the cause. The inlet has flared steel wing walls on both sides. At the outlet there is part of an end wall visible on the left bank but no apparent end treatment on the right bank.

Half a kilometer east of the main culvert is a 6 ft by 6 ft (1.8m x 1.8m) wooden box culvert. The inlet is partially blocked by two large rocks and the outlet has been extended about 3m. The approach channel has recently carried flow, probably when the right bank was overtopped immediately upstream of the main culvert or when an avulsion occurred along the right bank further upstream.

Potential Hydrologic Impacts – The proposed new highway alignment is offset 3 m downstream from the existing road centreline. If the existing culvert is retained, the outlet would have to be extended. The channel both upstream and downstream will require ongoing excavation and maintenance to maintain culvert capacity. Avulsions could develop at any location between the apex of the fan (the exit from the gorge) and the highway: flow and sediment either could go west towards Cluett Creek and Destruction Bay or could go east towards Mines Creek. Avulsions from Bock's Brook could thus threaten the highway between approximately km 1737 and km 1743. It may be worth considering installing a larger culvert to serve as an emergency overflow at the location of the existing wooden culvert. An additional culvert installed at the small creek crossing near km 1737.5 would also provide additional protection for the highway. The channel upstream and downstream of the highway has been identified as a potential borrow material source. Maximum use should be made of this source in order to temporarily re-establish channel grades and capacity. Sediment control measures must be implemented during borrow development to minimize sediment generation. Table 5-10 summarizes hydrological impacts and mitigation measures.

Table 5-10 Bock's Brook – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	**Mitigation**
Channel avulsions impacting highway between km 1737 and km 1743	Construct and/or maintain training works between the apex of the fan and the highway. Install additional culverts at old or potential channel crossings as emergency overflows. Construct new highway with designated water overflow areas. Armour embankment on both sides to prevent washouts. Continue to carry out regular inspections and maintenance of all upstream training works.
Erosion of highway fill and failure or blockage of culvert at outlet	Extend existing culvert outlet or install new longer culvert. Provide riprap protection for highway fill at culvert outlet.
Sediment deposition blocking existing or new culvert	Continue to carry out regular downstream channel excavation to maintain channel flow capacity to Kluane Lake. Maximize use of borrow material upstream and downstream (temporary measure only).
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel

5.5.8 Lewis Creek (km 1749.1)

Catchment - Total area is estimated to be 52.8 km^2. Drainage comes from the southwest with headwater elevations in excess of 2400 m at the divide with the Duke River catchment. The channel exits from a narrow gorge and the creek gradient decreases dramatically about 4.5 km upstream of the highway: the character changes from a steep mountain torrent to an aggrading alluvial fan. From that point, the creek is located towards the western portion of the alluvial fan. Air photos show a number of old channel scars across the fan.

Flow Data - No flow data for Lewis Creek. Estimated flood flows – 50-year event 15.7 m^3/s, 100-year event 17.5 m^3/s.

Description – The western-most channel of Lewis Creek is presently a borrow pit extending 50 to 60 m downstream and perhaps 500 m upstream of the road. From the air photos this channel is the largest and appears to have been the main creek channel in the past. The eastern channel now carries all creek flows with diversion works initially constructed more than 20 years ago. Major channel reshaping and dredging has taken place both upstream (300-400 m) and downstream (150 m) of the existing culvert. Low flow in the creek on July 22 with completely clear water, 1m to 1.5m wide, 50-75 mm deep, with the low flow channel generally along the right bank. High flows would be confined between gravel push-up dykes on both banks, however the dykes would be readily eroded. Bed material is similar to the other fans: sand, gravel and cobbles. Gravel sizes are smaller and there is less large material than observed in Copper Joe or Burwash Creeks - possibly a lower channel gradient at the culvert. However, the total quantity of sediment being delivered by Lewis Creek may be comparable to the larger creeks and sediment aggradation at the highway is a major problem, especially on the downstream side. Gravel bars on the downstream side are 30 to 60 cm higher than the gravel deposited within the culvert.

The new road centreline would be about 50 m upstream of the existing road. The channel upstream goes through a long but gentle bend to the left that continues to the existing culvert. 250 m upstream of the road two channels join. There is a small breach in the confining gravel dyke and another area with heavy erosion along the left bank. Approximately 2 km upstream of the highway a diversion directs the west channel into the east or main channel. The gravel diversion dyke has a triangular shape, 3 to 4 m wide at the base and generally less than 2 m high with seepage coming through in places. There is a small secondary dyke with the same narrow profile. The dyke was reportedly much larger in the past. The channel bed is higher than the surrounding ground. This area has experienced avulsions in the past when the diverted channel would relocate to the old western channel and flow through the gravel pit by the highway. There has also been a lot of dyke construction and channel excavation activity around the pipeline alignment 1 km above the highway. Overall, the channel at the highway will be unstable laterally and vertically during and after high flow events.

Existing Crossing - There was significant sediment deposition observed within the culvert on July 22. The culvert is a corrugated steel multi-plate with a protruding tapered end and nearly completely buried steel headwalls. Culvert width measured at bed level (widest part) was 15 feet (4570 mm) – the pipe is possibly a 4720 mm span x 3070 mm rise pipe arch or a 4610 mm diameter circular culvert. The available flow depth between the sediment and the pipe crown was 1.9m at the inlet, thus there was possibly 1.1 m to 2.75 m of sediment deposition in the culvert depending on actual pipe dimensions. High water mark was observed at the inlet approximately 1.0 m below the silt-covered crown of the culvert. Clearance between the sediment and the crown of the pipe decreased to 1.83 m near the middle and 1.78 m at the outlet. High water mark at the outlet of the pipe was 1.2 m below the pipe crown. The outlet also has a beveled (tapered) end treatment but no visible outlet wing walls.

Potential Hydrologic Impacts – The existing culvert or a new culvert upstream on the new highway alignment could become completely choked by gravel. Maintenance dredging either for the existing or for the new alignment must continue to be an annual priority. Avulsions originating near the apex of the fan could threaten the highway between approximately km 1747 and km 1750. Avulsions could also occur at the existing diversion point upstream of the pipeline right-of-way and at the bend to the right some 200 m upstream of the highway. Flow would then be directed to the abandoned western channel which presently terminates in a gravel pit beside the highway. Dykes along the left (west) bank of the channel have historically required the most reinforcement and maintenance. Lewis Creek has been identified as a potential borrow area upstream and downstream of the highway between approximately km 1749 and km 1750. Lewis Creek has reported fisheries value at the mouth, so any instream highway construction activities would need appropriate sediment control. A summary of hydrological impacts and mitigation measures for Lewis Creek appears in Table 5-11.

Table 5-11 Lewis Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	**Mitigation**
Channel avulsions impacting highway between km 1747 and km 1750	Reinforce the training dyke 250 m upstream of the highway. Reinforce & maintain existing diversion works 2 km upstream of the highway. Construct or reinforce training works at the apex of the fan 4 km from the highway. Install additional culverts at old or potential channel crossings as emergency overflows.
Sediment deposition blocking existing or new culvert	Continue to carry out regular upstream and downstream channel excavation. Maximize use of borrow material from existing channel (temporary measure only). Raise the new road grade above the current elevation to allow more sediment deposition.
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel

5.5.9 Copper Joe Creek (km 1754.2)

Catchment - Total area is estimated to be 75.1 km^2. Drainage comes from the southwest with headwater elevations in excess of 1800 m at the divide with the Duke River catchment. The channel exits from a narrow gorge and the creek gradient decreases dramatically about 5.5 km upstream of the highway: the character changes from a steep mountain torrent to an aggrading alluvial fan. Two channels are evident starting about 4.5 km from the highway and at least three more recent channel scars cross the road. The 1999 Burwash fire included significant portions of the Copper Joe Creek catchment.

Flow Data - No flow data for Copper Joe Creek. Estimated flood flows – 50-year event 21.0 m^3/s, 100-year event 23.4 m^3/s.

Description - The present main channel of Copper Joe Creek is the most-westerly channel. There are two lines of angle iron imbedded in the channel upstream of the culvert. These serve as log "deflectors" to align logs to pass through the culvert. The left bank is a heavily eroded near-vertical gravel bank. At the inlet heavy riprap guide banks upstream on both banks extend some 15 m upstream at a 45^o angle. Upstream channel material is sand-gravel-cobble with a surface cobble paving layer. An old push-up sand and gravel dyke along the right bank upstream used to tie in with the existing right bank guide bank but has been eroded away. Total flood plain width upstream of the culvert is about 30 m. The flow on July 22 was confined to a small single meandering channel 2 to 3 m wide with a maximum depth of 150 mm and velocity of about 1.8 m/s. Flow was completely clear, rapid and supercritical, approaches the culvert along the right bank, and turns at nearly 90^o to enter the culvert. The channel has cut down 45 to 60 cm through the gravel floodplain deposits.

The central channel of Copper Joe Creek shown on the maps is presently abandoned but has been excavated and shaped upstream as a channel with a 34 inch diameter (850 mm) culvert at the road. This culvert failed during the 1988 flood.

Woody debris has deposited on the floodplain upstream with trees up to 6 m length and 200 mm diameter. Downstream of the culvert the creek has a good gradient and the flow remains critical or supercritical with standing waves. The high gradient continues for some distance downstream. There has been maintenance dredging carried out both upstream and downstream. Debris is visible on the downstream fan and the culvert has passed large woody debris up to 3m long and 150 mm diameter. Blockages of the culvert with debris have been reported in the past.

Copper Joe Creek is diverted into a single channel about 4.5 km from the highway. A gravel training dyke on the right bank diverts all the flow into the most westerly main channel. The dyke is approximately 500 m long, 3 to 4 m high with a triangular profile. The dyke terminates in a forested area that does not appear to be significantly higher ground. Total floodplain width between the banks at the diversion structure is about 40 m. The toe of the left bank has partially eroded - a 0.6m high vertical sand and gravel bank overlain by vegetation. The right bank has minor toe erosion and some vegetation established on the inboard side and appears to have been functioning reasonably well for some time. Other channels crossing the access road are presently abandoned. About 1.5 km downstream of the diversion two small streams have escaped over, through or around the confining dyke but either disappear to local groundwater or rejoin the main channel further downstream. The eastern-most channel of Copper Joe Creek does not carry any flow at present.

Existing Crossing – The culvert is a multi-plate corrugated steel pipe, circular with a diameter of 10 feet (3050 mm). There are internal steel reinforcing bands within the culvert (4 sets of two spaced at 1.0m). Culvert invert is paved with gravel. Inlet is partially constricted by two rocks that have fallen from the bank protection and debris on the right side of the inlet. The culvert may have a flat or even slightly adverse grade: deeper ponding at the upstream end than at the downstream end. High water mark at the inlet is within 40 cm of the crown of the pipe, consistent with debris on both banks upstream. Gravel is moving through the pipe at relatively low flows. The downstream end of the culvert has been extended with a half round multi-plate flume to convey the discharge beyond the toe of the road fill. Near the culvert outlet a 150 mm x 150 mm x 600 mm long slab of rock was lying in the pipe. The flume outlet is heavily armored with large rock: individual stones up to 1m x 1m x 2.1m (3 ft x 3 ft x 7 ft). More typical sizes may be 0.6 m cubes in the plunge pool area. The flume invert is approximately 1.8 m (6 ft) above the creek level downstream of the plunge pool. Estimated depth of flow at the flume outlet was 150 mm. The flume is at a steeper grade than the main culvert, possibly in the order of 10% (0.6m drop in about 7m).

Potential Hydrologic Impacts - If the existing culvert location is retained, the riprap on both upstream guide banks should be extended further upstream to prevent an avulsion, especially at the right bank 20 to 30 m upstream of the culvert. The new alignment may be about 50 m upstream of the existing crossing: flow approach conditions will be similar to the present location and lateral confining guide banks will be required.

The potential for debris blockages at the new (or the existing) culvert will remain and, as a result of the 1999 Burwash fire, the quantity of debris coming from the catchment may increase for several years. The existing log deflectors have worked well: equivalent structures will be required upstream of the new crossing. The inlet of a new culvert should have a tapered or mitered inlet similar to Lewis Creek: debris would be encouraged to float up rather than jam against a vertical inlet. Regular inspections during higher flows should be carried out to remove minor debris blockages when they occur. Channel excavation will be required on an annual basis, primarily upstream of the highway, downstream excavation may be required periodically.

Avulsions could threaten the highway between approximately km 1752 and km 1754 due to an erosion failure of the upstream diversion works: regular inspections and ongoing maintenance will be required. Oversized materials in the channel could be screened and placed to reinforce the diversion works. The old central channel near km 1753 presently has a small 850 mm diameter culvert: an avulsion leading to this channel would likely result in highway overtopping (as occurred in 1988) and possibly major fill erosion or embankment failure. Installation of a larger culvert in the old channel would provide additional protection for the highway.

Copper Joe Creek has been identified as a potential borrow area: the mouth of Copper Joe Creek reportedly has fisheries values so any in-stream highway construction activities will need appropriate sediment control works.

Table 5-12 Copper Joe Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Channel avulsions impacting highway between km 1752 and km 1754	Reinforce the diversion works 5 km upstream of the highway works at the apex of the fan. Reinforce both banks upstream of the existing or new crossing. Install larger culvert(s) at old or potential channel crossings as emergency overflows.
Sediment deposition blocking existing or new culvert	Continue to carry out regular upstream channel excavation. For new crossing excavate channel downstream consistent with existing downstream channel. Maximize use of borrow material from existing channel (temporary measure only). Raise the new road grade above the current elevation to allow more sediment deposition.
Debris blockage of existing or new culvert(s)	Install log deflectors upstream of new culvert(s). Mitre culvert inlet. Continue to carry out regular inspections during higher flows to remove minor blockages.
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel

5.5.10 Duke River (km 1768.45)

Catchment - Total area is estimated to be 631 km^2. The Duke River catchment is a long basin along the northeast-facing slopes of the Donjek Range. Maximum elevations are in excess of 2400 m. The eastern extent of the catchment forms the divide between all the creeks crossing the Shakwak Highway between Copper Joe Creek (km 1754.2) and Congdon Creek (km 1724.7). The western extent of the catchment forms the divide with the Donjek River. About 6% of the catchment is glacier-covered and 90% of the catchment is above elevation 1200 m (Northwest Hydraulics 1978).

Flow Data - Flow data for Duke River collected by Environment Canada since 1981. Estimated flood flows – 50-year event 240 m^3/s, 100-year event 310 m^3/s. No potential for glacier outburst floods has been identified (IWD 1977).

Description – The Duke River in the area of the highway forms a wide alluvial flood plain with terraces and fan deposits and a highly braided gravel-bed channel. About 1.5 km upstream of the bridge the river goes through two severe bends where the flow impinges against and is actively eroding old fan and/or glacial deposits. The banks at this point are near-vertical. The potential floodplain width increases from about 200 m at that point to about 700 m at the bridge.

The channel bed upstream of the bridge is paved with cobbles with some sand evident in side channel and mid channel bars. 100 m upstream of the bridge the flow on July 22 was confined to a single channel 10 to 15 m wide with velocities 1.5 to 2 m/s. Flow was exclusively through the middle portion of the left (west) span: the bed of the right bank channel was 1.0 to 1.5 m higher than the left bank channel, although this could change at the next high flow event. Water was turbid so it was not possible to estimate flow depth. There has been some aggradation at the bridge crossing: the amount is impossible to determine without detailed surveys and reference to the original as-built drawings. Aggradation may be episodic or seasonal after each large flow event: temporary degradation may occur initially during high flows followed by aggradation during flow recession.

Downstream of the bridge, the active and potential floodplain increases significantly in width and a highly braided gravel channel pattern forms. Vegetation was visible on both banks downstream through the area referred to as Duke Meadows. Many full sized trees carried by the river have been deposited on the fan downstream of the bridge. Further downstream the active floodplain turns to the west and ultimately joins the Kluane River about 4 km downstream of Kluane Lake. Mapping and air photos indicate that the total Duke River delta may be more than 6 km wide with numerous old channel scars downstream of the highway.

Existing Crossing – An old bridge site is located 150 to 200 m upstream of the existing bridge. The existing bridge, a two-span structure with a single concrete pier located mid-channel, was constructed in 1955. The bridge is a steel through truss with a concrete deck. The deck shows signs of wear and repair. There are guide dykes on both banks upstream training the flow through the bridge. The left guide bank extends upstream to the high sand and gravel bluffs, has a 6 m crest width, and is heavily armored over the entire length with rock sizes up to about one meter diameter. The size and extent of riprap on the right bank is less. The right bank may have once extended further but it appeared that the upstream end has been eroded away. Air photos indicate that on-going erosion along the right bank could eventually threaten the highway east of the bridge. An old channel scar starts about 0.5 km upstream of the bridge and crosses the highway about 0.5 km east of the bridge. The central concrete pier has a rounded upstream nose. Both downstream abutments are heavily riprapped over 20 to 25 m. A faint high water mark on the central pier and silt deposited under the left abutment indicate possible extreme high water marks within 60 cm of the underside of the bridge, possibly the 1988 flood. A more prominent high water mark is about 2 m lower, at or just below the level of the guide banks. The existing Duke River Bridge may be used for the improved Shakwak Highway.

Potential Hydrologic Impacts – The bridge has reportedly performed well without hydraulic problems since 1955, including successfully passing very high flows during the 1988 flood. The central pier will be subject to local erosion during high flows: surveys should be carried out to confirm that suitable erosion protection exists around the pier and that no significant settlement has occurred over the years. The potential exists for a channel avulsion to the east starting where the channel presently goes through two forced bends about 1.5 km upstream of the highway: significant additional erosion would be required at the bends for this to occur. Avulsions occur occasionally downstream of the bridge and overland flow reaches Kluane Lake to the east of the inlet of the Kluane River. Continuing natural aggradation of the fan may increase the frequency of potential downstream avulsions in the future. The Duke River bridge superstructure, pier and abutments appear generally sound, although structural adequacy should be confirmed by qualified professionals. The upstream right guide bank needs reconstruction and re-armoring, and possibly should be extended further upstream to provide additional protection for the highway. The left bank armoring appears sound.

A summary of potential hydrological impacts and mitigation measures appears in Table 5-13.

Table 5-13 Duke River – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
On-going right (east) bank erosion and potential channel avulsion impacting highway up to 0.5 km east of the existing channel	Provide additional erosion protection on existing right (east) guide bank. Extend the right guide bank upstream about 500m with suitable erosion protection. Monitor on-going bank erosion at river bends 1.5 km upstream of highway.
Local pier erosion threatening bridge stability	Inspect erosion protection at central pier and reinforce if required. Survey bridge to determine if pier settlement has occurred.

5.5.11 Burwash Creek (km 1776.25)

Catchment - Total area is estimated to be 176 km^2. Drainage comes from the southwest with headwater elevations in excess of 1800 m at the divides with the Duke River and Donjek River catchments. The creek exits a narrow gorge about 4 km upstream of the highway. The channel gradient remains fairly constant and then begins to decrease about 1 km upstream of the road. From that point the gradient continues to decrease through the Burwash Flats until the confluence with the Kluane River 8 km downstream of the highway.

Flow Data - No flow data for Burwash Creek. Estimated flood flows – 50-year event 49 m^3/s, 100-year event 55 m^3/s.

Description – Upstream of the bridge the gravel bed channel is confined between push-up dykes constructed from sand and gravel deposited by the creek. The dykes were about 2.5 to 3 m high with a total potential channel width of about 25 m. The channel upstream appeared higher than the adjacent ground consistent with a heavily aggrading channel on an alluvial fan. Overbank areas beyond the confining dykes were heavily treed. Air photos show an old channel starting about 0.5 km upstream of the highway and crossing the road about 300 m west of the bridge. An avulsion reportedly occurred at this location in 1988: the creek flowed alongside the highway to the west over a distance of about 4 to 5 km and caused massive erosion damage to the road embankment.

At the bridge, the low flow channel splits into two channels with the larger channel along the left bank flowing through the central opening of the bridge beside the left (west) pier. The smaller channel flowed along the right bank between the abutment and the east pier. Low flow conditions approaching the bridge were supercritical in the left channel with a pool and riffle configuration in the smaller right channel. Water was slightly turbid with visibility of about 400 mm. Bed material varied from gravel and cobbles with the occasional boulder down to fine gravel and sands. Sand deposited in a side channel bar immediately upstream of the right abutment indicated recent water levels 200 to 250 mm higher than on July 22. Significant sediment deposition had occurred at the bridge, reportedly during the spring runoff in 1999.

Downstream of the bridge the flow combined into a single channel about 6 m wide with a depth of about 150 mm. Flow velocity was 1.2 to 1.5 m/s with an estimated discharge of 1 m^3/s. Channel maintenance dredging over about 1 km downstream has pushed the channel to the right (east) side of the fan with some flow escaping into the forest. There was a large abandoned man-made channel down the left (west) side.

Existing Crossing - The bridge, constructed in 1960, is concrete deck, steel girder construction with concrete abutments and two concrete piers in the channel. The bridge deck, superstructure and visible portions of the abutments appeared sound. Both piers were buried up to the bottom of the pier caps on July 22, 1999. The central and right waterway openings had a maximum of about 1.2 m (4 ft) of clearance left beneath the bridge. The span from the left abutment to the left pier was completely blocked by upstream gravel push piles. Debris had collected on the right pier about 1 m higher than the July 22 water level. The visible concrete of the piers showed no obvious signs of distress, however, there was some damage visible on the corners of the right bank pier, possibly due to bulldozer or backhoe activity excavating the channel. Large riprap was visible upstream on the right abutment and some riprap was visible on the left abutment partially buried by gravel pushed up from the channel. The approximate dimensions of the bridge are: from each abutment to the centreline of the nearest pier, 11 m; and, from pier to pier (centre span) 17 m. There is a GSC benchmark installed on the left abutment - number 78Y559 installed in 1978. The plan is to keep the existing bridge structure and location for the realigned highway.

Potential Hydrologic Impacts - The major problem with the Burwash Creek crossing has been bed aggradation. The channel was excavated in the fall of 1998 to a depth of 12 to 14 feet under and downstream of the bridge. The sediment deposition observed on July 22 happened during the 1999 spring runoff. Maintenance in the past has generally involved pushing sediment laterally upstream of the bridge and excavating beneath and up to 1 km downstream of the bridge to encourage scour and removal of sediment from the immediate bridge area by creek flows. Significant channel excavation is required (based on conditions observed on July 22, 1999) to re-establish an adequate waterway opening at the bridge. Maintenance dredging will continue to be a major ongoing problem at this crossing. Avulsions have occurred upstream in the past and caused damage to the highway between the bridge and about km 1780 to the west. The upstream guide banks must be reinforced and maintained to minimize the likelihood of a reoccurrence. Burwash Creek has been identified as a potential borrow area upstream and downstream of the highway. The mouth of Burwash Creek at Kluane Lake reportedly has fisheries values so any in-stream highway construction activities will need appropriate sediment control works. Table 5-14 summarizes hydrological impacts and mitigation measures.

Table 5-14 Burwash Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Channel avulsions impacting highway between km 1776 and km 1780	Raise, reinforce and maintain confining dykes upstream of the bridge. Extend left guide bank 0.5 km upstream beyond old channel. Maintain channel and bridge capacity with regular channel excavations. Reinforce upstream side of new highway embankment between bridge and km 1780. Install emergency culvert at low point in grade near km 1780.
Sediment deposition blocking bridge waterway opening	Continue to carry out regular upstream and downstream channel excavation. Maximize use of borrow material from existing channel (temporary measure only).
Debris blockages of bridge opening	Continue to carry out regular inspections during higher flows to remove minor blockages.
Suspended sediment generation during maintenance and/or development of borrow areas	Schedule work for low flow periods, implement diversion works and sediment control measures to limit potential sediment generation, carry out borrow excavation away from flow channel

5.5.12 Sakiw Creek (km 1783.9)

Catchment - Total area is estimated to be 29 km^2. Drainage comes from the southwest confined between the catchments of Burwash Creek and of Quill Creek with maximum elevations in excess of 1800 m. The creek gradient decreases significantly about 4 km upstream of the highway. The lower portions of the catchment are flat and marshy with heavy tree cover. Sakiw Creek joins the Kluane River about 1.5 km downstream of the highway.

Flow Data - No flow data for Sakiw Creek. Estimated flood flows – 50-year event 9.0 m^3/s, 100-year event 10.2 m^3/s. Flows increased overnight (July 21/22) due to rain the previous evening. The relatively slow catchment response to rainfall indicates the significant water-retention characteristics of the catchment upstream. Peak flows for Sakiw Creek will be less on a unit area basis than for other steeper catchments of a comparable size.

Description - Upstream of the highway Sakiw Creek was tranquil flow through a boggy area with heavy marsh grass cover, shrubs and small alder, willow, birch and spruce. The water was nearly clear with very low turbidity. The creek bed is predominantly silty material. There was a small backflow area into a side channel pond on the right bank upstream. Based on the new road centreline stakes 15 to 18 m upstream of the existing highway shoulder, the creek immediately upstream of the new alignment would approach the road at an angle of about 20^o. The outlet of a new culvert may be near the inlet of the existing culvert. The inlet area has some small cobbles and the outlet has some larger cobbles and boulders serving as erosion protection. Tailwater levels are controlled by a boulder and gravel riffle that drops about 0.6 m. The cobbles and boulders at the outlet do not influence water levels within the culvert at low flows. The gradient of the creek increases for some distance downstream from the control section with a pool and riffle configuration. Downstream overbanks are heavily vegetated. Downstream banks are composed of mixed organic and silty material showing evidence of minor erosion. Fisheries resources have been reported for Sakiw Creek.

Existing Crossing - Culvert is an old single barrel square wood box culvert 1.8 m wide by 1.8 m high (6 ft by 6 ft). Two sawed logs embedded in the channel are partially blocking the inlet. The inlet invert drops 0.3 m over a distance of 2 m. Thereafter, the pipe slope is nearly horizontal. The culvert appears to be at or very near original grade at both the inlet and outlet ends: there was settlement of about 0.3 m observed under the highway centreline as indicated by sagging of the crown. High water marks within the culvert barrel were at half full, approximately 1 m (3 ft) above the inlet. There is a small hydraulic jump at the inlet and marks on the wall indicated that that jump has been much higher at higher flows. The maximum flow depth at the inlet has been about 1.2 m above the invert. Flow depth at the outlet was 280 mm. High water marks at the outlet were 0.7 m above the present water level, 1.0 m above the outlet invert. There was slumping of the unprotected highway fill noted around the outlet of the culvert on both sides. No significant problems have been reported by the Department of Highways for Sakiw Creek.

The "*Sakiw West Crossing*" is approximately 0.5 km west of the main channel of Sakiw Creek at a low point in the road. This crossing is not part of the present study, however the existing culvert is a wood box culvert the same size as the one at Sakiw Creek. The Sakiw West culvert inlet is largely blocked by the body of a 1960's vintage Cadillac lying completely across the creek immediately at the culvert inlet. From a catchment area perspective, Sakiw West is smaller than the main Sakiw Creek crossing. The existing culvert size suggests that a comparable-sized culvert should be installed at Sakiw West for the new alignment which may cross the creek about 50 m upstream of the existing highway.

Potential Hydrologic Impacts - Settlement in the marsh area will be a concern both for the new highway alignment and for the new culvert. Upstream channel training works will probably not be necessary for this creek other than head walls and wing walls for the new culvert(s). Erosion protection must be provided at the downstream end of the culvert because of the fine grained nature of the bed and bank materials. Every effort should be made to maintain the existing marsh character and wherever possible disturbance should be minimized and limited to just the new roadway footprint if possible. Sakiw Creek has been identified as having potential fisheries resources, thus the new culvert(s) should be designed to allow fish passage. A summary of hydrological impacts and mitigation measures is presented in Table 5-15.

Table 5-15 Sakiw Creek – Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Loss of muskeg and wetlands area	Minimize area of construction disturbance, remove existing road embankment and reclaim after construction
Flooding of muskeg and wetlands areas	Provide adequate culvert capacity to minimize upstream flooding during high flows
Settlement of new fill and culverts	Design requires foundation preparation to minimize settlements
Sediment generation during construction and impact on fisheries	Sediment control measures, limit construction area, careful stream diversion works
Sediment generation during highway operation	Provide vegetation along road shoulders and creek banks at crossing
Pollutants entering stream due to highway plowing and maintenance	Restrict removal of snow and other road surface materials in crossing area
Erosion of creek channel downstream of culverts	Provide stilling pool and erosion protection at culvert outlet area
Damage to or loss of fish habitat	Limit area of construction disturbance, reclaim old crossing area after construction
Barrier to fish passage	Design new culvert(s) for fish passage at suitable flow conditions

5.6 SILVER CREEK (KM 1693.2)

5.6.1 Hydrologic Characterization and Morphology Assessment

Catchment - Drainage comes from the south starting at the divide with the Kaskawulsh River at Mt. Cairnes with elevations in excess of 2300 m. Glacial influence on flow is suspected based on diurnal flow variations observed during the summer months. Observations of the flow regime suggest a possible local microclimate with higher precipitation and runoff rates than other local catchments. Figure 3.9 in the 1987 Environment Canada Report indicates that the upper area of the Silver Creek catchment experiences higher annual precipitation (800 to 1200 mm per year) than most of the other catchments along this section of highway (typically 400 to 800 mm per year). A range of catchment areas has been reported and estimated for Silver Creek: 114 km^2 (IWD 1978); 101.7 km^2 (Environment Canada, 1987); 98.7 km^2 (estimated from Figure 1 in IWD 1977); and, 73 km^2 (estimated from Figure 2 Sawada and Johnson, 1999). A total catchment area of 73 km^2 estimated from the 1999 paper has been adopted for the present study.

Flow Data – No long-term flow data are available. Spot measurements of discharge have been carried out by Arctic Institute students during summer months. Silver Creek exhibits a distinct diurnal flow pattern during the summer months with higher flow in the evening and lower flow in the morning. This behaviour was observed on July 21 and suggested that, either snowmelt was still on going in July, and/or there was glacial-melt in the upper portion of the catchment. Although the catchment area of Silver Creek is similar in size to some of the other creeks such as Mines/Nines and Copper Joe Creeks, flow in Silver Creek was higher than any of the other creeks observed in July 1999, with the exception of the Slims River and the Duke River.

It is recommended that conservatively high estimates of design flows should be used for Silver Creek corresponding to the 50-year and 100-year flows shown in Table 5-4 increased by the estimated standard error for each flow. Recommended design flows for Silver Creek are 33.4 m^3/s and 36.7 m^3/s for the 50-year and 100-year events, respectively.

Description - Upstream of the culverts, a wide braided gravel channel and floodplain is confined along the left (west) bank by a high sand-gravel-silt bluff. Two channels led to the culverts on July 21, a main channel and a smaller secondary channel on the left side (looking downstream). Flow was directed into the culverts by a diversion dyke along the left bank with heavy (600 to 750 mm diameter) riprap armour rock on the upstream side. The dyke extends across the floodplain to the high ground, has a crest width of 6 m, and consists of sand, gravel and cobbles borrowed from the floodplain. No filter zone was visible under the riprap. The dyke was initially constructed in the mid-1970's in conjunction with the highway reconstruction. There was an armoured 1.5 m to 2 m high guide bank along the right bank extending about 200 m upstream of the culverts. The riprap on both guide banks appeared stable, although in places there has been some minor undercutting and self-launching of individual rocks. There was evidence of flow recently impinging at right angles against the main diversion dyke.

The channel slope upstream of the culverts is about 2%. Flow approaching the culverts on July 21, 1999 was rapid with standing waves on the surface and an estimated velocity of 2.5 to 3 m/sec. Water in the creek was highly turbid: very dark gray-brown almost black in colour. Gravel-sized material was moving through the culverts. Bed material upstream graded from fine sand to cobbles and boulders up to 250 mm diameter. Gravel and 25-75 mm diameter cobbles formed the dominant-sizes in the surface armour layer. Based on the gradient the stream has the power at high flows to move rocks larger than 200 to 300 mm. At the July 21 (lower) flow rates, the predominant sediment load appeared to be small gravel and sand with sand moving in suspension.

A temporary staff gauge upstream of the culverts on the left bank (installed by students of the Arctic Research Institute) read about 0.3 m. Discharge measurements are taken by the students at this section. The channel bed will be highly mobile during high flows and the local channel configuration probably changes significantly from day to day.

At the culvert outlets, large diameter riprap protects a 2 m drop from the outlet to the downstream channel. Tumbling and cascading flow was coming out of the left culvert with hydraulic jumps on the riprap. Riprap forms downstream wing walls as extensions to vertical corrugated steel walls, possibly standard Armco-style end fittings. The downstream channel consisted of the same material as upstream: sand, gravel and cobbles, boulders up to 250 mm diameter. There has been on-going maintenance in this area to encourage the channel to stay in the same general location: channel banks downstream are man-made "push-up" dykes. The channel turns left about 500 m downstream of the culverts with an eroding push-up dyke along the right bank. Flow continues to be rapid and the channel slope downstream appears constant at least to the bend. Erosion scars were visible along the left bank that extends to natural treed-covered ground. The channel slope downstream of the culverts remains at about 2% until it begins to decrease upstream of the airstrip. The channel slope decreases to effectively zero at the outlet to Kluane Lake.

The road grade crossing the creek appears nearly flat. Approximately 60 m west of the culverts (towards Kluane Lake), the road starts a steady downhill grade then flattens out before the corner at the Topham Creek crossing. From the Silver City access road, the highway is straight all the way past Topham Creek and traffic goes along this section at speeds in excess of 100 km/h.

On the lower Silver Creek fan (July 24) large push-up dykes have been constructed along more than 1 km of both banks to contain and direct the flow past the north end of the airstrip. The flow on July 21 was going down the left side of the flood plain outside (west and south of) the south dyke then turned back between the dykes that terminate just upstream of the airfield. The excavated channel does not extend all the way to Kluane Lake. Some flow goes into the trees and bush to the south and to the west and appears to infiltrate into the coarse fan material. The dykes and channel bed closest to Silver City (north side of the fan) are higher than the general surrounding level of the alluvial fan.

Existing Crossing - Consists of two large structural plated corrugated steel pipe-arch culverts. The culverts have flat to semi flat elliptical bases and semi-circular tops. There was sediment aggradation in the right barrel with most of the flow (rapid and supercritical) going through the left pipe on July 21. A small hydraulic jump was observed about 2 m into the pipe. The right culvert was the only one accessible for measurements and inspection. Cover over the culverts is about 1.0 m at the crown of the road. The estimated maximum width (span) of the right barrel is 4980 mm. The estimated rise near the centre of the pipe making some allowance for sediment deposition is 2740 mm. Measured dimensions are consistent with a standard pipe arch with 5050 mm span and 3330 mm rise. The pipes are separated at the inlet by a semicircular 1.5 m diameter corrugated metal pier. Steel inlet head walls on each side are at 45 degree angles, were partially buried, and extend upstream about 5 m.

Baffles were observed across the invert of the right culvert. The baffles were spaced about 2 m apart with a drop in the water surface of approximately 150 mm at each. The space between baffles had infilled with sand, gravel and large cobbles carried by the creek. At the outlet of the right pipe, there is a vertical corrugated plate/baffle across the invert. The baffles at the bottom of the culvert (concrete with embedded railway steel) were probably installed to encourage sediment deposition and protect the culvert inverts from abrasion. There were no apparent intermediate disturbances of the water surface in the left barrel. This observation suggests that, either, there are no baffles in that barrel, or, the baffles have failed, or, the flow is so rapid that the baffles are submerged and the spaces between baffles are filled with large immobile rock. High water marks were visible in the left culvert with mud stains extending to within about a meter of the crown of the pipe.

5.6.2 Hydrologic Impact Assessment

No impacts are expected at the highway crossing assuming the existing highway grade and culvert sizes are retained for the upgraded highway. Continual maintenance will be required to ensure the diversion dyke and upstream and downstream guide banks remain intact and functional. The baffles within the pipes should be inspected regularly to ensure adequate protection is afforded the culvert inverts by deposited sediment. The natural suspended sediment load is very high, therefore, no additional impacts are expected from highway sediment and there are no fisheries resources in Silver Creek itself; however, fisheries resources have been identified at the creek mouth. The Silver Creek floodplain upstream and downstream of the highway may be used as a source of borrow material for road reconstruction. Development of in-channel borrow sources could lead to increased suspended sediment generation downstream unless appropriate sediment control measures are implemented during construction. Table 5-16 summarizes hydrological impacts and mitigation measures for Silver Creek.

Table 5-16 Silver Creek Culverts–Summary of Hydrologic Impacts and Mitigation Measures

Potential Impact	Mitigation
Failure of upstream diversion dyke and guide banks	Maintain integrity of erosion protection measures on upstream river training works
Loss of culvert capacity due to sediment deposition	Excavate deposited upstream and downstream sediment as required. Develop upstream and/or downstream borrow areas for highway fill (temporary measures only)
Failure of culverts due to excessive abrasion of the inverts	Inspect culvert inverts each year during low flows, reinforce inverts and baffles as required
Failure of downstream guide banks with consequent channel avulsion(s) impacting lower fan and Silver City area	Maintain integrity of and erosion protection measures on downstream river training works. Excavate downstream channel as required to maintain flow and sediment deposition capacity
Suspended sediment generation during development of borrow areas	Schedule borrow development for low flow periods, implement diversion works and sediment control measures to limit potential additional sediment generation, carry out borrow excavation away from flow channel

5.6.3 Silver Creek - Hydrological Processes and Impact Mitigation Analysis

5.6.3.1 Historical Processes

The following summarizes significant events or activities that have occurred in the Silver Creek fan area of the Shakwak Highway. This information is based on a review of historical airphotos, interviews with YTG Highways personnel, and with the historic Silver City property owners. Years are estimated based on inspection of the available airphotos for the area taken between 1944 and 1989.

- The original highway was constructed during the early 1940's;
- The pipeline was installed prior to 1944;
- The Silver City airstrip was constructed between 1949 and 1954;
- The access road towards the south end of the airstrip (towards the present Arctic Institute site) was constructed between 1972 and 1977 (probably 1975);
- The new (existing) highway was constructed in the mid-1970's (1975);
- Channel excavation and maintenance of training works has been regularly carried out since the early 1950's.

Over the years, the channels of Silver Creek and Topham Creek, have flowed at various times across the entire area of the fan between the highway and Kluane Lake. Channel outlets to the lake have been at numerous locations over about a 4 km width south from Silver City. The entire alluvial fan is progressively aggrading over the long-term. Prior to construction of the airstrip, the 1944 photos indicate that the primary area of fan aggradation was located in the central and southern portion of the fan. However, secondary active channel scars were visible at that time over the entire fan area, including the northern side. After construction of the airstrip, channel maintenance was carried out to generally encourage Silver Creek to go around the north end and Topham Creek to go around the south end of the airstrip. Periodically, high flow events reportedly resulted in overflows and erosion damage to the original highway and to the airstrip. From the early 1950's to the mid-1970's, the northern channel scars of Silver Creek became more prominent on successive airphotos.

During reconstruction of the highway in the mid-1970's, Silver Creek was diverted at the new highway and thereafter has flowed primarily along the northern side of the fan. In addition, Topham Creek was diverted to flow to the south of the new Arctic Institute access road. Since that time, sediment deposition and fan aggradation has been on-going downstream of the highway as have channel dredging activities. The size (in plan) of the main Silver Creek channel along the northern portion of the fan has increased due in part to construction of containing push-up dykes at various locations: dyke construction has buried some formerly-forested areas. During extreme flow events, erosion and flooding problems have occurred in the historic Silver City area. The focus of channel training works has generally been to attempt to protect the old town, keep the creek off the end of the airstrip, and provide protection for private property on the fan.

5.6.3.2 Sediment Transport Capacity and Deposition Potential

The sediment-transporting capacity and total volume of sediment potentially deposited on the fan by Silver Creek each year cannot be estimated with any degree of accuracy due in part to data limitations. In addition, estimating the location, depth and areal extent of future deposit(s) would be at best conjecture. Data typically required for sediment transport calculations includes: a detailed flow-duration curve for the creek showing the percent of time that all flow magnitudes are equaled or exceeded; detailed grain-size distribution data for channel sediments, including bed load, suspended load, and wash load; channel geometry (slope, width, depth) measured or estimated for the full range of expected streamflows at a number of sites between the apex of the fan and the lake. Even with such data, theoretical sediment transport calculations would be only, at best, order-of-magnitude estimates of the actual conditions in a creek such as Silver Creek: stream gradients are hydraulically high (in excess of 2%), flow magnitudes and channel configurations have been and will be highly variable, and sediment sizes range from fine sands and silts up to cobbles and boulders.

Making crude and simplifying assumptions regarding creek flows and sediment gradations, the potential sediment transporting capacity of Silver Creek may range from less than 30,000 tonnes to more than 300,000 tonnes per year. Deposited volumes of sediment on the fan could range from less than 20,000 m^3/year to more than 200,000 m^3/year. A single high flow event such as a 50-year flood could yield from 1,500 m^3 to 15,000 m^3 of deposited sediment in a single day. All these volumes and tonnages of sediment must be regarded as order-of-magnitude estimates only.

5.6.3.3 Potential Mitigation Options

A concern identified for the Silver Creek fan area is the potential for further damage to and/or loss of private property on the fan downstream of the highway due to continuing sediment aggradation on the fan. A number of potential mitigation options have been identified. These are discussed following:

Option 1 - Continue to excavate sediment deposits and maintain existing channel training works on a regular basis. As part of this option, additional reinforced training and protective works could be constructed along the northern side of the channel to afford some protection against flooding and erosion to private property. Channel excavation to maintain or restore capacity would be required on at least an annual basis: more frequent work may be required as a result of flood events. Over time, it is likely that annual maintenance costs may increase, as excavated sediment would have to be moved progressively further away from the existing channel(s). Efficiencies and cost savings may be realized by using other types of equipment such as scrapers: at present excavation and dyke construction are accomplished using bulldozers. Unless excavated material is completely removed from the fan, the total area covered with relocated channel sediments will increase over time. Additional spoil disposal areas may have to be developed on areas of the fan that are presently covered with vegetation. Channel excavation should be extended as far as practical towards the lake to increase as much as possible the channel outlet slope and potential deposition volumes. Dredging carried out in recent years appears to have stopped at the old highway crossing upstream of the airstrip.

Option 2 – Create a sediment trap. The purpose of this option would be to decrease the total potential volume of sediment depositing each year on the fan downstream of the Highway. The option would involve the excavation of a large sediment trap or traps upstream and/or downstream of the existing culverts. Excavated material could be used, initially at least, for construction of the upgraded highway. Conceptually, a volume of between 200,000 m^3 and 1,000,000 m^3 could be excavated from the floodplain upstream of the culverts. Assuming an excavated length of about 1500 m, width of 150 m and average depth of 1 m, approximately 200,000 m^3 of granular material could be excavated. Extending the length to 2500m and depth to 2.5m could provide an additional 800,000m^3 of material. Based on the order-of-magnitude estimates of sediment transport capacity discussed previously, such a sediment trap volume could be filled over a one to ten year time frame. Regular re-excavation of the sediment trap and consequent disposal of the spoil somewhere, may be required to maintain the effectiveness of the trap.

The sediment trap may decrease the rate of sediment aggradation on the downstream fan for some period of time. However, the impact of a sediment trap in the short-term may be, in fact, an increased rate and volume of transport of sediment downstream of the trap. The flow regime would not change; however, flow leaving the trap would not be carrying as much sediment as under present conditions. Downstream channel erosion and degradation would result due to mobilization of previously deposited sediment on the fan. This type of behaviour (downstream channel degradation due to removal of sediment from the flow) has been observed downstream of many reservoirs around the world. Material from channel degradation would deposit in the lower areas of the fan near the Lake where the channel slope decreases. Continued downstream channel excavation (as in Option 1) would still be required.

Option 3 - Remove the diversion dyke and restore the entire flow of Silver Creek to the older channel parallel to the highway. The purpose of this option would be to relocate the active deposition area of the fan away from the Silver City area. The new channel would go parallel to the Highway to the bend at or near Topham Creek and then would pass under the highway through new culverts at that point. Outlet to the lake would be south of the airstrip. Sediment deposition would occur within the triangle of land south of the Arctic Institute access road, north of the existing highway, and east of the lake.

This option would require excavating a new and deeper pilot channel along the old channel, raising the Highway along the long straight section, and providing erosion protection on the uphill side of the road along a 2 km to 3 km length. A new culvert installation would be required to cross the Highway. Overall, this option results in a longer and hence lower gradient channel than the existing channel: it may not be possible to maintain the sediment transporting capacity of the flow all the way to the new culverts. The new channel will become a braided gravel-bed channel: on-going and regular channel excavation would likely be required alongside the Highway. Downstream of the new culverts, the existing fan deposits appear to be much flatter than the fan near Silver City. The area available for sediment deposition is less than for the existing situation, and there is private property ownership in the area. Thus, even if sediment can be conveyed through the culverts, downstream deposition and fan aggradation may be more rapid and extensive than with the present configuration. Continued downstream channel excavation between the Highway and the Lake would still be required, and there would be impacts on private property.

Option 4 - Split the existing channel and spread the discharge of both water and sediment over several channels between the Highway and the Lake. This option would require the construction of several kilometres of new channel complete with training works to distribute flow and sediment between the various channels. Some new channels would have to go through what is predominantly forested land at present, although some of the old channel scars could possibly be used to minimize impacts on existing vegetation. The overall concept would be to spread the annual deposits of sediment over a larger area.

Ongoing maintenance would be required to remove deposited sediment from each channel and to maintain channel training works to divide and contain the flow. Flood events could result in channel avulsions at unexpected locations. Splitting or dividing the flow on the fan below the highway on a permanent and reliable basis does not appear to be technically feasible because of the dynamic nature of Silver Creek. In this vein, any option that would involve construction of a channel with a lower overall slope (i.e. a longer channel than the existing configuration) would likely be counterproductive. Lower-slope channels will have less sediment-transporting capacity and would likely fill more rapidly with sediment.

Option 5 – Divide flow between the existing channel and one new channel. An alternative to Option 4 may be to periodically "switch" the Silver Creek flow between the existing channel configuration and a new channel constructed as described in Option 3. Diversion works at the present culvert crossing would be periodically breached or re-constructed as required to direct flow to the desired channel. On-going maintenance as described under both Options 1 and 3 would be required. The total area impacted by this option over the long term would be greater than the area impacted by either Option 1 or by Option 3.

The implementation of any of the options discussed conceptually above must include detailed evaluation of the following:

- Technical feasibility;
- Degree of protection for the Highway and highway users;
- Performance reliability over the long term;
- Environmental impacts, both short-term and long-term;
- Impacts on private property and/or historical resources;
- Capital costs for initial implementation;
- Potential for, and magnitude of, recurring capital expenditures;
- Annual maintenance costs; and,
- Overall benefits compared to existing situation, including financial, environmental and social

None of the options discussed above will provide a permanent structural solution to the on-going problem of sediment deposition on the Silver Creek fan. Continued maintenance involving sediment excavation and disposal and channel training works will be required, regardless of the option finally selected. This being said, the most attractive alternative may be Option 2 (create a sediment trap) combined with Option 1 (On-going channel excavation and maintenance) for the following reasons:

1) Space is available on the Silver Creek floodplain upstream of the existing culverts to construct a large sediment trap. A minimum settling volume of more than 200,000 m^3 should be feasible, with volumes upwards to 1,000,000 m^3 possible. This volume may fill with sediment over a one to ten year period;
2) Large quantities of borrow material will be required for the new Highway construction and material excavated for the sediment trap could be used for this purpose. The maximum possible volume of material should be removed from Silver Creek upstream for use as borrow material. Further design detail would be required to determine sediment trap design configurations, number of traps, grades, and outlet control structures;
3) Monitoring of the performance of the trap (rate of filling) will allow valuable data to be collected regarding the annual volume of sediment transported by Silver Creek. Streamflow data should be collected and sediment grain-size distributions determined periodically as part of the monitoring program;
4) Construction of a sediment trap may decrease the rate of long-term sediment aggradation on the downstream fan, although short-term behaviour may be erratic due to channel degradation downstream of the sediment trap;
5) Channel excavation and maintenance of training works will be required in the downstream fan area regardless of the option implemented. This area could also be developed as a source of borrow material for Highway construction.

5.7 KLUANE LAKE HYDROLOGIC IMPACTS AND MITIGATION MEASURES

This section addresses potential impacts to Kluane Lake that may result from infilling of the lakeshore, from temporary construction activities near the existing lakeshore, and from possible construction of new causeways across the Slims River delta. Infilling may be required to improve the road alignment, eliminate tight curves, increase roadway/shoulder width, and improve highway safety by moving the alignment away from areas where potential rockfalls or landslides could threaten the safety of highway users. Infilling may be used in the Sheep Mountain area (km 1706) and at some locations up to km 1722 north of Williscroft Creek. The potential new causeway alignments are shown on Figure 5-8, Volume II. South and east of the existing Slims River bridge, a new causeway could start near km 1700 and extend some 2.5 km across the delta to rejoin the existing causeway prior to the bridge crossing. North and west of the existing bridge, two alternative alignments have been proposed, both of which would involve major causeway construction across the delta and lake. The two alternative alignments would begin just north of the existing bridge and could rejoin the existing highway between km 1707 and km 1709 below Sheep Mountain. The primary purpose of the new causeway alignments would be to improve safety by relocating the highway away from areas of potential rockfalls or landslides. Other environmental resources occur in the vicinity, including a significant population of Dall sheep. Fisheries resources (lake trout) are known to exist along the lakeshore.

In the Slims River delta and the Sheep Mountain area, the existing shoreline of Kluane Lake and the proposed causeway alignments were assessed in the field by the project hydrologist during July 1999. Photos of the existing highway and lakeshore are included in Appendix V-4.

5.7.1 Kluane Lakeshore

Hydrologic impacts on Kluane Lake as a result of shoreline infilling and temporary construction activities near the lakeshore could include: fine sediment generation during or after fill placement; erosion by wave action of new fill material placed in the lake or along the shoreline; and, sediment or pollution generated from construction laydown areas or temporary construction access roads or activities near the lake. Impacts could be minimized or eliminated by: adjusting the proposed new highway alignment where possible to minimize lakeshore encroachments; using appropriate sediment and erosion control measures during construction; prompt reclamation and stabilization of temporarily-disturbed areas; and, specification of clean, durable and erosion-resistant fill materials for all areas where new fill would encroach into the lake. Table 5-17 summarizes potential impacts and possible mitigation measures.

Table 5-17 Near-shore Activities on Kluane Lake - Potential Impacts and Mitigation Measures

Potential Impact	Mitigation Measures
Sediment generation from fill material: - during construction, and/or - during highway operation.	- Revise highway alignment to minimize lakeshore encroachments. - Use clean select granular fill for infilling and construction of highway fill at and below lake level. Minimize or eliminate use of fine (sand, silt, and clay) material for construction below water level or along the lakeshore. - Schedule construction activities to minimize impact on fisheries resources along shoreline. - Use sediment control measures during construction (silt fences, straw bails, vegetation barriers, limit lakeshore construction during wet periods) - Re-vegetate finer shoreline fill material promptly after construction to stabilize surface, or, - Place a stable erosion-resistant surface layer over finer fill materials. Layer could be clean rock, geofabric, or biomat. - Maintain low vegetation barriers (grass, shrubs) along lakeside road shoulder to intercept sediment runoff from highway surface. - Use only clean sand and fine gravel for sanding highway during winter. Eliminate/minimize use of salt or other chemicals along highway sections close to the lake.
Erosion of fill material by wave action on the lake.	- Place clean, hard, heavy rock riprap for erosion protection of fill material. - Extend riprap vertically to provide erosion protection over a suitable range of lake levels. Filter layer (granular, geofabric) may be required under riprap.

Potential Impact	Mitigation Measures
Generation of sediment or pollution from construction laydown areas or temporary access roads near the lake.	- Use sediment control measures around all areas of temporary disturbance. Measures could include silt fences, straw bails, vegetation barriers, drainage control measures directing site drainage to sedimentation ponds, minimize use of fine materials (sand, silt, clay) for grading temporary roads or laydown areas. - Locate laydown areas away from lakeshore. - Develop contingency plans for hazardous material spills.

5.7.2 Slims River Causeway

The proposed causeway alignment along the east and south side of the Slims River delta is located up to about 600 m out from the existing lakeshore. About 130 ha of river delta and about 4 km of existing lakeshore would be isolated behind 2.5 km of new causeway constructed largely over existing river delta deposits. Along the north and west side, about 30 to 60 ha of lake and 2 km to 3 km of existing lakeshore could be isolated, depending on the selected causeway alignment. Most of the new causeway(s) would be constructed on exposed delta deposits and portions would be constructed through deeper water that likely overlies fine delta deposits of unknown thickness on the lake bottom. No geotechnical or topographic data are presently available for the proposed causeway alignments. Foundation conditions, permafrost extent if any, and volumes of fill required will all be critical in establishing the feasibility of constructing the new causeway(s). Detailed field investigations should be undertaken to collect the required data if the causeway(s) remain under serious consideration. Once estimates of required fill volumes have been prepared, potential sources of borrow material may be identified and subsequent impact assessments carried out for the development of the borrow areas and construction of the causeways.

The existing causeway across the Slims River delta is a straight stretch of highway about 3 km long between the south shore and the entrance to the Visitor's Centre. The proposed alignments could result in total causeway lengths of 5 km to 7 km with two horizontal curves (joining the existing highway so as to utilize the existing Slims River bridge) located on the delta deposits. As with the existing alignment, there will be increased safety concerns for the new causeway(s), especially on the curves, during conditions when driver visibility is hampered (winter whiteout from blowing snow, summer dust plumes from exposed delta deposits).

Vehicle collisions during such conditions or at any time on the causeway could result in injury or loss of life and possible direct pollution of Kluane Lake from fuel or other hazardous material spills. An intersection would be required just north of the bridge to allow continued access to the Sheep Mountain Visitors Centre.

Culverts or other openings (small bridges, pervious causeway fill) would be required through the causeway(s) to convey local runoff to the lake from the creeks above the existing road and to equalize water levels on each side of the causeway.

Construction of the new causeway(s) would require the placement of huge volumes of fill material directly onto the delta and into the lake. Although this portion of Kluane Lake is highly turbid due to the high suspended sediment load carried by the Slims River, fill placement would result in additional sediment inflows to the lake. The magnitude and possible impacts of increased sediment loads on fisheries resources are not known.

Numerous highway access points along the south and east side would have to be kept and maintained for recreational and/or First Nations access after causeway construction. Similarly, existing highway access points along the north and west side would have to be retained and maintained to allow access to the Parks Canada Visitors Centre and to Soldier's Summit.

Table 5-18 summarizes potential impacts and possible mitigation measures.

Table 5-18 Construction of New Causeway(s) across Slims River Delta - Potential Impacts on Kluane Lake and Mitigation Measures

Potential Impact	Mitigation Measures
Isolation of portions of lake	- Use existing alignment.. - Use new alignment(s) closer to existing shore to minimize extent of isolated areas. - Install culverts and/or bridge openings to hydraulically connect isolated areas with existing lake.
Loss of access to existing shoreline for recreational use	- Provide access to shoreline areas along new or existing alignment.
Loss of fish, wildlife or waterfowl habitat	- Use existing alignment. to prevent fisheries habitat loss. - Use new causeway to protect sheep populations. - Minimize damage to existing shoreline and reclaim after completion of construction. - Reclaim new causeway; fill to develop new shorelines with suitable fisheries/wildlife/waterfowl habitat.
Settlement of new causeway(s)	- Carry out geotechnical investigations to define foundation conditions. Design and construct new causeway to minimize settlements, or, carry out regular maintenance to maintain road grades as fill settles. - Locate new causeway closer to shore to minimize depth of weak delta deposits beneath fill.
Erosion of causeway(s) by wave action	- Construct erosion protection measures on causeway fill (riprap, vegetation etc.).
Loss of access to Sheep Mountain Visitor's Centre, Soldier's Summit	- Provide for local access. Intersection(s) and local improvements (i.e. rockfall protection) required.
Sediment generation during construction	- Use sediment control measures and local containment around active construction areas

Most of the potential impacts on Kluane Lake identified in Table 5-18 could be avoided or minimized if the existing highway alignment was essentially kept, although other potential impacts are not addressed with the existing alignment option.. The existing alignment would not satisfy the desire to upgrade overall highway safety by improving the horizontal alignment, visibility, and moving away from potential hazardous rockfall, landslide or debris torrent areas. Potential concerns with wildlife collisions are also not addressed. Options that could be considered include:

- Use the existing causeway and Slims River bridge crossing;
- Complete geotechnical investigations on the delta to determine the stability and constructability of the various new causeway alignment options;
- Investigate potential alignments or alignment modifications close to the existing highway but further away from debris hazards on Sheep Mountain and along the south and east shore. In places, relocation of the highway tens of metres away from unstable slopes may provide the desired level of alignment improvement and enhanced protection.
- Investigate other structural measures to locally protect the highway from rockfalls or landslides. Such measures could include deflector dykes or landslide "sheds" (equivalent to snowsheds) similar to structures used in avalanche-prone areas such as the Coquihalla Highway in British Columbia; however, this option could be cost prohibitive.
- Stabilization of slopes by removal of unstable material, installation of rock-bolts and/or welded wire mesh reinforcement, construction of rockfall collector benches, and,
- Continuation of regular inspections and maintenance of all structural measures and regular assessments of the stability of potentially dangerous slopes above the highway, if the existing alignment is not modified.

5.8 SLIMS RIVER HYDROLOGIC IMPACTS AND MITIGATION MEASURES

This section addresses potential hydrologic impacts to the Slims River drainage that may result from possible construction of new causeway(s) across the existing river delta. The potential new causeway alignments are shown on Figure 5-8, Volume II.

The proposed causeway alignments were assessed in the field during July 1999. Photos of the existing highway and lake shore in the area are included in Appendix V-4. Details of the existing bridge crossing of the Slims River are presented in Section 5.5.2, including recommendations to improve the hydraulic capacity of the bridge openings. Potential impacts of causeway construction on Kluane Lake were discussed in Section 5.7.2.

The existing bridge and causeway largely control the river regime, flow patterns, and sediment transport/deposition behavior upstream of the bridge. Potential new causeways would be constructed downstream of the existing bridge. As such, impacts to the river regime upstream of the bridge due to causeway construction are expected to be minimal to non-existent.

Downstream, causeway construction would impose some degree of lateral restriction on the potential width of the delta and the total area within which river sediments could be deposited. Depending on the selected alignment, the maximum lateral restriction could vary from about 900m (30%) 0.5 km downstream of the bridge to 0% about 2 km downstream. Some modifications to flow and sediment deposition patterns across the delta would result from new causeway construction. Flow and sediment deposition patterns on the delta are at present highly variable on a seasonal basis and strongly influenced by the combined effects of lake levels, wind strength and direction on the lake, and flow conditions in the river. Lateral restriction of the delta could potentially result, over the long term, in an increase in the rate of longitudinal growth of the delta deposits out into the lake: some potential sediment deposition areas would be isolated by causeway construction. However, the seasonal and the long-term rate of delta growth are determined primarily by the total quantity of sediment delivered by the river from the upper portions of the Slims River drainage area. An important variable and unknown is the potential for periodic diversion of flow from the Kaskawulsh Glacier drainage area away from the Slims River to the Kaskawulsh River. Precipitation patterns in the upper drainage areas, and runoff and sediment delivery rates from the numerous steep tributary creeks will also strongly influence the development of the delta deposits in Kluane Lake. Due to the dominating influence of all these upstream factors, it is unlikely that construction of new causeways across the Slims River delta downstream of the existing bridge would result in measurable impacts to the extent of the delta over the long term.

6.0 VEGETATION

6.1 INTRODUCTION

The vegetation component of the Shakwak Project Environmental Assessment updates Section 3.4 of the Environmental Shakwak Highway Improvement Environmental Impact Statement by Public Works Canada, Volume 2, 1977.

Terms of reference for this component of the Environmental Assessment Update are presented in Section 1.3.

6.2 ECOLOGICAL SETTING

The km 1664.5 - 1788.5 section of the Shakwak Project falls within the Ruby Range Ecoregion (Ecological Stratification Working Group 1995). The climate of this ecoregion is characterized by short, cool summers and long, cold winters. Winter temperature inversions are common, resulting in milder temperatures at higher elevations. Maritime air from the Gulf of Alaska periodically invades this ecoregion during the winter to produce mild spells with near-thawing temperatures. The mean annual temperature for the area is approximately -3^{0}C with a summer mean of 10^{0}C and a winter mean of -17^{0}C. The mean annual precipitation throughout the area ranges from 250 to 300 mm.

The terrain consists of rolling to undulating hills above 900 m asl. The most common soils in the ecoregion are Eutric Brunisols on sandy loam morainal or colluvial materials. The regosolic soils of the region are associated with active deposition of gravely fluvioglacial outwash materials on braided floodplains. Volcanic ash from the 1,300 year old White River eruption is up to 100 cm thick on lower slopes. In these cases, the soil is classified as either Regosols or Regosolic Turbic Cryosols, depending on the presence or absence of permafrost. Permafrost is extensive and discontinuous over most of the ecoregion.

Northern boreal forests occupy the lower slopes and valley bottoms of the Shakwak Trench. Extensive forests are formed from open white and black spruce and occasionally lodgepole pine in a matrix of willow, dwarf birch and ericaceous shrubs. Black spruce, willow, birch and often a thick carpet of mosses are found on poorly drained sites. Alpine fir, dwarf birch and willow occur in the subalpine zone. Sparsely vegetated alpine communities are dominated by ericaeous shrubs, mountain avens, graminoids, mosses and lichens.

6.3 PREVIOUS VEGETATION STUDIES

The vegetation component of the current Shakwak Environmental Assessment Update is based, in part, on previous vegetation inventories carried out in the area by a number of agencies and individual researchers.

6.3.1 Public Works Canada

- In 1977, Public Works Canada submitted an Environmental Impact Statement with respect to the Shakwak Highway Improvement Project. The vegetation component of this two-volume report (Section 3.4 prepared by Douglas Ecological Consultants Ltd.) describes the major vegetation zones along the entire Shakwak Highway route. Ten vegetation zones were identified - four of which are found in the current study area.

- The status of several rare plants species along the Shakwak route northwest of Haines Junction are described in a 1980 report prepared for Public Works Canada and the U.S. Department of Transportation by Douglas Ecological Consultants Ltd.

6.3.2 Parks Canada

- In 1974, George Douglas completed a reconnaissance survey of the vegetation of Kluane National Park. His report for the Canadian Wildlife Service includes descriptions of the montane vegetation of the Sheep-Wallace Mountain complex and the unique communities of the Slims River Delta.

- In a 1975 report prepared for Parks Canada, Donald Blood and Associates describes the vegetation resources of five potential corridors in Kluane National Park, including vegetation along routes into the park east and west sides of the Slims River Delta.

- The Slims River Valley and its vegetation are further described in a 1978 mode-access feasibility study of the proposed Slims Kaskawulsh Parkway prepared by Hunter and Associates for Parks Canada.

- In 1980, Douglas Ecological Consultants included accounts of vegetation in the Slims River - Sheep Mountain area as part of a two-volume biophysical inventory of Kluane National Park for Parks Canada.

- A 1980 environmental screening of the Kluane National Park Management Plan by the Resource Conservation Division of Environment Canada summarizes the potential impacts of access road construction on the vegetation of Slims River Delta, Vulcan Mountain and Sheep Mountain.

- The ecosections of the Slims River Valley, including their vegetation, are described in a 1983 area plan summary by Parks Canada.

- An ecological analysis of the Slims River Valley was prepared by the Natural Resources Division of Parks Canada in 1983.

- Volume Two of the Resource Description and Analysis of Kluane National Park Reserve (1985) reviews previous inventories of the montane and floodplain vegetation in the Slims River Delta - Sheep Mountain area.

6.3.3 Foothills Pipelines

- A 1978 report by Vaartinou and Sons Enterprises describes grasses, legumes and shrubs along the Alaska Highway, including the Alaska Highway portion of the Shakwak Project route, for Foothills Pipelines (Yukon) Ltd.

- Foothills Pipelines (Yukon) Ltd's two-volume Environmental Impact Statement for the Alaska Highway gas pipeline project (1979) describes the plant communities in seven major vegetation sections of the Yukon portion of the proposed gas pipeline route. Two of these vegetation sections are included in the current Shakwak Project study area.

- Walter Stanek of the Canadian Forestry Service described the vegetation types and associated environmental factors associated with the proposed Foothills gas pipeline route in 1978. The 25 vegetation types that were characterized and mapped in his 1980 report included the current Shakwak Project study area, except for the section between Boutellier Summit and Congdon Creek.

6.3.4 Kluane Land Use Plan

- The 1998 update of the Kluane Land Use Plan broadly characterizes the climate, soils and vegetation of the planning region, which includes some 66,000 square kilometers of the southwestern Yukon.

6.3.5 Individual Research Papers

- A 1975 Ph.D. thesis by Manfred Hoefs of the Yukon Fish and Wildlife Branch provides a phytosociological analysis and vegetation map of the Sheep Mountain area, including the northwestern portion of the Slims River Delta.

- An assessment of the saline soils of the Slims River Delta by Stuart Harris of the University of Calgary in 1990 includes a characterization of the Delta's halophytic plant associations.

- A status report on the Yukon Aster (*Aster yukonensis*), endemic to the Slims River Delta area, was prepared by Stuart Harris in 1996 for the Committee on the Status of Endangered Wildlife in Canada.

6.4 APPROACH TO THE CURRENT VEGETATION ASSESSMENT

The vegetation resources along the km 1664.5 - 1788.5 section of the Shakwak Highway route were evaluated through the following methods:

6.4.1 Preliminary Vegetation Mapping

A preliminary vegetation map of the study area was prepared from the following documents:

- 1: 50,000 scale vegetation maps covering the proposed Foothills gas pipeline route. These maps, prepared by Stanek (1980) for the Canadian Forestry Service, cover a six kilometer wide belt along the Alaska Highway, except for the section between Boutellier Summit and Congdon Creek (Foothills Pipelines Ltd. had proposed to lay the pipeline under Kluane Lake from Fox Point to Congdon Creek, and therefore by-pass the Slims River Delta - Sheep Mountain area).

- 1:6,200 scale vegetation map of Sheep Mountain and the northwest portion of the Slims River floodplain prepared by Hoefs *et al*.(1975).

- 1:10,000 scale aerial photographs of the proposed Shakwak highway alignment from km 1699 -1738.8. These air photos were taken in 1998.

The resulting preliminary vegetation maps (1:60,000 CAD) depicted the vegetation community delineations within a two-kilometer wide corridor centred approximately on the proposed highway alignment. These maps are presented in Figures 6-1 through to Figure 6-7, Volume II.

6.4.2 Ground-truthing

Ground-truthing of the preliminary vegetation map covering the proposed Shakwak highway alignment focused primarily on the following areas:

- The section of the Alaska Highway not covered by either Stanek's 1980 vegetation map of the proposed gas pipeline route or Hoef's 1975 Sheep Mountain vegetation map. The area not covered by these maps is essentially the segment of the highway between Boutellier Summit and the Slims River Delta.

- Areas of proposed off-highway development: field camps, borrow pits and major realignments.

- Areas of known sensitivity, such as the Slims River Delta and the lower slopes of Sheep mountain.

Ground-truthing of vegetation communities between Boutellier Summit and the Slims River Delta was carried out through a series of walking transects and survey plots. The percent vegetation cover of the overstorey (trees > 3.0 meters), understorey (trees and shrubs 0.3 - 3.0 meters) and ground cover (shrubs, forbs, graminoids, bryophytes and lichens < 0.3 meters) was estimated inside ten-meter radius plots randomly positioned within homogeneous stands in each of the vegetation communities surveyed. Plants that could not be identified in the field were collected and pressed for later identification. No attempt was made to catalogue all plant species observed in the study area. This ground-truthing survey was carried out on July 5-6, 1999.

The 'micro-communities' of the Slims River Delta were monitored through a series of walking transect surveys carried out at various times between early June and mid October 1999.

Site visits were made to each of the areas pre-identified for potential off-highway development (field camps, borrow pits and major realignments) on July 6-8, 1999. At each site brief floristic surveys were carried out and the vegetation type was compared with that described by Stanek (1980).

6.4.3 Plant Community Descriptions and Revised Vegetation Mapping

Plant communities within a two-kilometer wide corridor centered approximately on the proposed highway alignment were delineated and described. Figures 6-1 through 6-7, Volume II show the vegetation maps for the study area. Where applicable, community names and descriptions were taken from Stanek (1980).

The revised 1:60,000 scale vegetation maps (Figures 6-1 to 6-7, Volume II) show a mosaic of polygons, each depicting either one or a group of several vegetation types. These map delineations are derived primarily from Stanek (1980) or Hoefs, et al, (1975). Elsewhere they have been modified through air photo interpretation and ground-truthing.

Slims River Delta plant community descriptions were taken from Douglas (1974), Hoefs, et al, (1975) and Harris (1990). These vegetation types have been mapped at a scale of 1:23,500, and are found in Figure 6-7, Volume II.

6.4.4 Rare Plant Species Inventory

A preliminary list of rare plant species potentially occurring in the study area was prepared from an annotated catalogue of Yukon rare plants by Douglas, et al, (1981) and an unpublished ranking of Yukon rare plant species by Bennett (1999). Species peculiar to habitats not found in the highway corridor (e.g. high alpine species) were deleted from the list.

Floristic surveys were carried out at sites with a known potential for rare plant species such as wetlands, lakeshores and alluvial streambeds. The Slims River Delta was given particular attention because of the endemic plant species known to occur there.

6.5 SURVEY RESULTS

6.5.1 Vegetation Communities

Eighteen major vegetation types were identified within the two-kilometer wide Alaska Highway corridor, most of which were recognized by Stanek (1980). Each vegetation type consists of one or more homogeneous sub-types or phases; compositional gradients may occur in others.

The variations within communities and the transition zones between communities are not described in this report. The characteristic combination of species found in each vegetation type is found in Appendix VI-1 (Major Vegetation Types). These descriptions are based on Stanek (1980) and have been modified through ground-truthing accounts from the current survey (plot data is found in Appendix VI-3). Vegetation community characteristics are summarized in Table 6-1. The unique ‘micro-communities’ of the Slims River Delta are described in Section 6.5.2.

Major vegetation communities have been mapped for the project study area at 1:60,000 scale (Figures 6-1 to 6-7, Volume II). These maps do not include the Water Sedge wetland vegetation type. Although the Water Sedge (*Carex aquatilis*) community is ubiquitous throughout much of the study area, it occurs in the form of small wetlands, meadows and lakeshores and is not feasibly mapped at a scale of 1:60,000.

6.5.2 Slims River Delta

The Shakwak Highway Improvement Environmental Impact Assessment (EIS) (Public Works Canada, 1977) described the Slims River Floodplain as “undoubtedly the most sensitive section with respect to vegetation”. The uniqueness of the floodplain’s plant communities results from their adaptation to the flooding that occurs during periods of high discharge in late summer and to the adverse saline soil conditions. The vegetation of the 11 km^2 Slims River Delta is characterized by a sparse cover of vascular plants on fine textured (water and wind deposited) soils. Although the distribution of vegetation on the delta indicates the approximate area of saline soils (salt efflorescence dominated by magnesium sulfate), the plant associations appear to be influenced more by soil moisture than by salinity (Harris, 1990). The salinity of the Slims River Delta soils are not thought to influence Dall sheep requirements or movements to mineral licks.

Table 6-1 Major Vegetation Types and Associated Site Conditions

Vegetation Type	Related Stanek Type (1980)	Permafrost	Aspect	Slope	Drainage
White Spruce - Rhododendron	5	complete	variable	gentle	moderate
White Spruce - Bearberry	7	frequent	level to SW	moderate	moderate
White Spruce - Kinnikinick	9	rare	variable	gentle	moderate
White Spruce - Woodland Sedge	8	occasional	north	gentle	moderate
Black Spruce - Labrador Tea	7i	complete	north	moderate	moderate
Trembling Aspen - Common Yarrow	9iii	rare	south to southwest	moderate	high
Balsam Poplar - Broad-leaved Willowherb	-	none	variable	low	high
Balsam Poplar - Arctic Lupine	9i	rare	variable	low	moderate
Bluegreen Willow	6	occasional	level to N	gentle	impeded
Tall Blueberry Willow	6iii *	occasional	level to N	gentle	impeded
Alaskan Willow	3 *	frequent	variable	moderate	impeded
Mountain Alder	2ii *	rare	variable	moderate	moderate
Sagewort - Purple Reed Grass	11	none	south	steep	excessive
Drummond's Mountain Aven	10	none	variable	gentle	impeded
Water Sedge	-	none	neutral	level	wet
Alluvium (unvegetated)	-	none	variable	gentle	impeded
Boulder Fields	-	none	variable	steep	excessive

Notes: major vegetation types (km 1664.5 – 1788.5)

* Stanek (1980) did not map these communities within the current study area

The delta's vegetation has been described by several researchers, including Douglas (1974), Hoefs (1975) and Harris (1990). Seven of the eight plant communities described by Douglas (1974) were identified during the current survey. One additional vegetation type was also noted. The resulting eight Slims River Delta vegetation types that were identified and mapped during the current survey include:

Carex aquatilis
Salix brachycarpa - Carex parryana
Juncus balticus
Deschampsia caespitosa
Puccinellia nutalliana
Taraxacum ceratophorum
Aster yukonensis
Eurotia lanata

The distribution of these plant communities has been mapped at a scale of 1:23,500 (Figure 6-7, Volume II).

A total of 31 plant species were identified on the Slims River Delta during the current survey (Appendix VI-2A). Additional colonizing weedyspecies, such as *Crepis elegans* and *Sonchus arvensis* ssp. *uliginosus* have invaded the sides of the causeway crossing the delta. Seven Slims River Delta plant species are considered to be Yukon rarities (see Sections 6.4.4 and 6.5.4).

6.5.3 Borrow Pits / Field Camps

The major vegetation types occurring at potential sites for off-highway development (field camps and borrow pits) are shown in Table 6-2. Many of these sites are within existing clearings or pits, and are in early seral stages of natural revegetation. The only concerns regarding the disturbance of vegetation on these sites are aesthetic in nature, such as the disruption of the *Dryas drummondii* community in the Silver Creek alluvium (see Section 6.5).

Table 6-2 Major Vegetation Types at Potential Off-highway Development Sites

Site #	Location	Highway Chainage	Potential Use	Comments
1	NW of Sulphur Lake	1673+900	field camp	old borrow pit
2	NW of Sulphur Lake	1674+600	field camp	old borrow pit
3	NW of Sulphur Lake	1675+500	field camp	old borrow pit
4	NW of Sulphur Lake	1674+500	borrow pit	white spruce with trembling aspen
5	E of Christmas Cr	1684+000	borrow pit, field camp	old borrow pit with bluegreen willow
6	Christmas Cr d/s hwy	1686+000	borrow pit	white spruce and trembling aspen
7	Silver City pit	1692+100	borrow pit, field camp	currently used borrow pit with crush pile; electrified landfill
8	Silver Cr d/s hwy	1693+000	borrow pit	active stream channel bed mostly unvegetated
9	Silver Cr u/s hwy	1692+300	borrow pit	active stream channel bed mostly unvegetated
10	Williscroft Cr u/s hwy	1712+500	borrow pit	old borrow pit; stream bed mostly unvegetated
11	Williscroft cr d/s hwy	1712+500	borrow pit	old borrow pit; stream bed mostly unvegetated
12	Congdon Cr d/s hwy	1719+300	borrow pit, field camp	old borrow pit; balsam poplar and Bebb's willow
13	Congdon Cr u/s hwy	1720+200	borrow pit	alluvium with balsam poplar and soapberry
14	Nines Cr d/s hwy	1731+100	borrow pit	stream channel partially willow with balsam poplar
15	Nines Cr u/s hwy	1730+900	borrow pit	stream channel partially willow with balsam poplar
16	Mines Cr d/s hwy	1732+000	borrow pit	old borrow pit
17	Mines Cr u/s hwy	1732+000	borrow pit	stream channel mostly bluegreen willow with some balsam poplar
18	current hwy W of Mines Cr	1732+700	borrow pit	current highway alignment
19	Bock's Cr d/s hwy	1734+600	borrow pit	stream bed mostly unvegetated
20	Bock's Cr u/s hwy	1734+600	borrow pit	stream bed mostly unvegetated
21	E of Lewis Cr	1748+500	field camp	old borrow pit; now scrap metal dump

Site #	Location	Highway Chainage	Potential Use	Comments
22	Lewis Cr d/s hwy	1749+300	borrow pit	some balsam poplar on alluvium
23	Lewis Cr u/s hwy	1749+300	borrow pit	alluvium is partially white spruce and partially unvegetated
24	Copper Joe Cr d/s hwy	1754+000	borrow pit	stream channel unvegetated
25	Copper Joe Cr u/s hwy	1754+000	borrow pit	stream channel unvegetated; streambank vegetation recently burned
26	SE of Burwash	1758+700	field camp	old borrow pit; surrounding forest recently burned
27	across hwy from Burwash airport	1763+200	borrow pit	old borrow pit - has mostly escaped recent burn
28	E of Duke R	1766+500	borrow pit	white spruce-kinnikinick has all burned; willow escaped burn
29	NW of Duke R	1772+000	borrow pit, field camp	old borrow pit and previous hwy alignment with old bridge
30	Burwash Cr d/s hwy	1775+800	borrow pit	old borrow pit and staging area; creek bed has been rechannelled
31	Burwash Cr u/s hwy	1775+800	borrow pit	old borrow pit and staging area
32	NW of Burwash Cr	1779+600	borrow pit	older growth white spruce
33	SE of Sakiw Cr	1782+800	field camp	old borrow pit
34	SE of Sakiw Cr	1783+100	borrow pit	older growth white spruce
37C	Before Kluane River Overlook	1783+500		
35	Quill Cr u/s hwy	1786+100	borrow pit	old borrow pit near mine access road

6.5.4 Rare Plant Species

Of the rare Yukon plants catalogued by Douglas, et al, (1981) and Bennett (1999), 56 species could be expected to occur within the area potentially affected by the Shakwak highway realignment. See Appendix VI-2B for the habitats and rarity rankings of these species. A rare plant species is defined as one that occurs in a limited geographical area and/or in low numbers (Douglas *et al*. 1981). Rare Yukon plants are Yukon-Alaskan endemics, Amphi-Beringian species, or species that occur in the Yukon at the northern limit of their range. These species are not necessarily imperiled. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) does not currently consider any of these plant species to be at risk. They are not, however, demonstrably secure within the territory.

It should be noted that the floristic surveys carried out during the current site assessments did not result in an exhaustive inventory of the area's flora. The following rare plant species were observed:

Artemisia dranunculus is a Eurasian species found uncommonly in North America, including southwestern Yukon. During the current survey it was found on the lower slopes of Sheep Mountain near Soldier's Summit as well as in a disturbed area of the highway right-of-way east of Christmas Creek.

Aster yukonensis is endemic to the Kluane Lake area (small populations also occur in the Brooks Range of Alaska and the in Mackenzie Mountains). A salt-tolerant species, it occurs primarily on the Slims River Delta where it makes up to 30 percent of the plant cover. It is represented by at least a few isolated plants in most plant associations. It occurs on both sides of the current highway and has colonized the sides of the causeway (see Section 6.5 for mitigation options). *Aster yukonensis* also occurs as scattered plants on outwash fans northeast to Silver Creek. The status assigned *Aster yukonensis* by COSEWIC in 1996 was "not at risk" (Harris 1996).

Astragalus nutzotinensis is endemic to Alaska and the Yukon. Locally common, it occurs on numerous gravel outwashes and scree slopes in the Slims River and Silver Creek areas.

Carex maritima occurs on floodplains in the Kluane Lake area. Normally a coastal species, it is found on both sides of the highway across the Slims River Delta.

Carex microglochin is a sporadically occurring, low-arctic circumpolar species. During the current survey, it was found by a spring near the southern limit of the Slims River Delta.

Carex parryana is a western North American species with a disjunct population in the southwest Yukon. It occurs on both sides of the highway across the Slims River Delta, primarily on the southeast side of the river.

Comandra umbellata* ssp*. pallida is a North American native plant that is at the northern limit of its range in the southern Yukon. It was located in the Cultus Bay area during the current survey. This is outside the Shakwak highway corridor.

Eleocharis uniglumis is a circumpolar species with rare occurrences in the southern Yukon. It was found during the current survey in wetlands in the Hungry Lake area.

Eurotia lanata is North American species with a small disjunct population on the slopes of Sheep Mountain. It was found during the current survey on the Slims River Delta west of the highway.

Plantago maritima is a coastal species known in the Yukon only from the alkaline flats of the Slims River Delta. It occurs on both sides of the highway crossing the Slims River delta.

Puccinellia nuttalliana is a western North American species rarely found in the Yukon. It is adapted to alkaline situations and is a common species on the Slims River floodplain.

Rumex maritimus* ssp*. fueginus is a North American species occurring in low numbers throughout the south-central Yukon. During the current survey, it was found in a small wetland east of Christmas Creek.

The following plant species have recently been observed by Kluane Lake area residents but were not found during the field surveys:

Artemisia rupestris* ssp. *woodii is endemic to the southwestern Yukon. It has recently been observed on the lower slopes of Sheep Mountain.

Townsendia hookeri is a North American native species that occurs disjunctly in the southwestern Yukon. It has recently been observed on the lower slopes of Sheep Mountain.

6.6 POTENTIAL CONCERNS AND MITIGATION OPTIONS

The primary concerns with respect to vegetation during the Shakwak highway realignment project are the disturbance of small populations of rare plant species and, in a few cases, the disruption of areas with aesthetically pleasing vegetation. Silver Creek alluvium, with the *Dryus drummondii* plant community, is considered an aesthetically pleasing area by many local residents (see Section 7 for concerns regarding aesthetics). Potential impacts include the direct alteration of vegetation during the construction phase of the project and the indirect effects on vegetation resulting from the modification of drainage patterns.

Mitigation options for these concerns focus on areas of highest sensitivity. General protection measures include:

- Off-highway traffic should be minimized in the more sensitive areas, such as wetlands, floodplains, lakeshores and stream crossings (see below).

- Rigorous, site-specific floristic surveys should be carried if sites are to be developed in these more sensitive areas. If populations of rare plant species are found, their locations should be noted and reported to the Habitat Management Section of the Yukon Fish and Wildlife Branch.

- The salvage of rare plants may be an option, after consultation with the Habitat Management Section of the Yukon Fish and Wildlife Branch. This should be done during periods of plant dormancy (early spring or late fall).

- The natural drainage patterns on floodplains, wetlands and stream crossings should be maintained where possible in order to preserve existing hydrological conditions.

Recommendations related to revegetation are presented in Section 6.7.

Areas with specific sensitivity are discussed in the following sections.

6.6.1 Slims River Delta

As noted in Section 6.4, seven rare plant species (*Aster yukonensis*, *Carex maritima*, *Carex microglochin, Carex parryana*, *Eurotia lanata*, *Plantago maritima* and *Puccinellia nuttalliana*) and several unique plant communities are found on the Slims River Delta. Each of the proposed highway alignments across the delta will impact at least some of these rare plants.

Line A (existing alignment) southeast of bridge (see Slims River Delta map – Figure 6-7, Volume II): A population of *Carex parryana*, occurring very close to the roadway southeast of the bridge, would probably be disturbed by any upgrading of the existing alignment.

Line A (existing alignment) northwest of bridge: *Aster yukonensis*, *Carex maritima* and *Plantago maritima* occur very close to the existing roadway, and in some places have colonized the sides of the causeway. These plants would be directly impacted by any upgrading of the existing alignment northwest of the bridge.

Line B southeast of bridge: Populations of *Aster yukonensis*, *Carex maritima* and *Carex parryana* will be disturbed if this route is chosen.

Line B northwest of bridge: If this route is selected, populations of *Aster yukonensis*, *Carex maritima, Plantago maritima* and *Puccinellia nuttalliana* will be impacted.

The small population of *Eurotia lanata* which has colonized the Slims River floodplain northwest of the river (behind the Sheep Mountain Interpretive Centre) should not be impacted by either of the proposed highway alignments.

A population of *Carex microglochin* occurring to the west of the highway near the southern limit of the delta should not be affected by the highway upgrading.

Upgrading the existing highway alignment would have the least impact on the rare plant species of the Slims River floodplain. Other mitigation measures include the salvage of rare plants that would otherwise be destroyed and revegetating the roadsides with species native to the delta.

6.6.2 Sheep Mountain

Rare Yukon plant species such as *Eurotia lanata*, *Townsendia hookeri, Artemisia dranunculus* and *Artemisia rupestris* ssp. *woodii* are known to occur on the lower slopes of Sheep Mountain. Populations of these and potentially other species would be least impacted if the current highway alignment is maintained or if highway alignment line B (causeway) is chosen. Any construction activity that involves excavation of the mountain slope would be the most disruptive to these plant species. Other mitigation options include the salvage of rare plants that would otherwise be destroyed and revegetating disturbed areas with species native to the area.

6.6.3 Kluane Lakeshore

The Kluane Lakeshore from Silver Creek to Goose Bay is potentially habitat for a number of rare Yukon plant species, including *Aster yukonensis* and *Carex maritima*. This habitat could be impacted in a number of locations along the proposed highway realignment, as a result of road widening and reconstruction. Mitigation options include minimizing construction traffic on the lakeshore during highway reconstruction.

6.6.4 Duke River Meadows

The *Artemisia frigida* - *Poa glauca* plant community of the Duke River Meadows is uncommon in this region. Although no rare plant species were identified during the current survey, species such as *Helictotrichon hookeri* are known to occur in the area. Maintaining the current highway alignment at the Duke River would minimize the impact on the meadows; however, it is recognized that minor impacts will occur due to road widening and reconstruction. During the vegetation surveys, the highway alignment in this area was inspected for rare plant species and none were observed within the proposed reconstruction right-of-way. The critical mitigation measures in this area include limiting off-highway traffic during highway reconstruction.

6.6.5 Wetlands

Numerous small wetlands, ponds and lakeshores in the Shakwak highway corridor support wetland and aquatic vegetation. These areas are potentially habitat for rare plant species. The spike-rush *Eleocharis uniglumis* was noted in a wetland near Hungry Lake, and *Rumex maritimus* was found in a wetland east of Christmas Creek. These habitats could be affected by the proposed highway realignment, particularly between Jarvis River and Christmas Creek. Mitigation options include minimizing the disturbance of these wetlands and maintaining natural drainage patterns.

6.6.6 Streambeds

The alluvium of numerous streambeds in the highway corridor are colonized by vegetation such as the *Dryas drummondii* plant community and are potentially habitat for rare plant species, although no rare plants were noted on these streambeds during the current surveys. Some of these habitats will be affected by highway reconstruction, no matter which routing is selected. Mitigation options include limiting the use of streambeds as borrow sources and maintaining existing drainage patterns. However, it is expected that these plant communities will naturally revegetate with time.

6.7 REVEGETATION

The terms of reference for this component of the Shakwak Project Environmental Assessment Update include the following with respect to revegetation:

- *The proponent shall develop seed mixes and fertilizer application rates for use in revegetation programs on disturbed lands within the study area. Mixes and fertilizer configurations must be developed with consideration given to terrain, soil conditions, climate, wildlife interactions, desired results, and availability of seed. Mixes must contain alternative species selections and must address concerns over the introduction of non-native species in the vicinity of Kluane National Park.*

6.7.1 Objectives of Revegetation Program

The primary objective of the reclamation initiatives for this section of the Alaska Highway is the mitigation of environmental impacts such as soil erosion, the loss of wildlife habitat and the invasion of noxious plant species. Secondary objectives include the rehabilitation of off-road development areas such as exhausted borrow pits and construction camp sites for specific purposes such as recreation sites, livestock grazing areas, or the enhancement of wildlife habitat. Only the aforementioned primary objective will be addressed in this report.

6.7.2 Specific Concerns

Two specific issues have been raised with respect to the use of non-native plant species as part of the Shakwak Project reclamation initiatives:

- Parks Canada has expressed concerns regarding the introduction of invasive non-native plant species along the highway alignment in the proximity of Kluane National Park. This includes the Alaska Highway right-of-way between Slims River and Congdon Creek.

- The Yukon Government, Department of Renewable Resources, is concerned about the use of high quality forage plant species in roadside revegetation and, in particular, the potential for attracting the Kluane caribou herd to the roadside during migration seasons in the Copper Joe and Sakiw Creeks area, and therefore predisposing animals to vehicle collisions.

Both of these issues will be addressed through the development of appropriate seed / fertilizer mixtures for these specific areas.

6.7.3 Revegetation Options

Prior to any attempt at reclaiming disturbed sites on this section of the Alaska Highway, more information will be required on the chemical and physical properties of the growth media which require revegetation. The preferred growth habit of components of recommended seed mixtures must be consistent with existing properties of the media requiring revegetation. It is also necessary to be cognizant of the nutrient status of the various growth media along the route before planning a realistic fertilizer program. The following suggested revegetation seed and fertilizer specifications are based primarily on recommendations by Kennedy (1993) and Vaartnou (1993 and 1995).

The revegetation specifications for the portion of the highway from Jarvis River to Silver Creek were taken directly from those recommended for linear projects from Haines Junction to Kluane Lake, and from Silver Creek to Slims River for white spruce communities in the southwest Yukon (Kennedy 1993). An alternative to these specifications is based on results from the five year (1991-1995) Yukon revegetation demonstration project. Pursuant to this study, Vaartnou (1995) has revised the seed and fertilizer prescriptions for roadside revegetation for much of the southern Yukon, including the Alaska Highway east of Haines Junction. Although these modifications do not apply directly to the Shakwak segment of the Alaska Highway, they could be extrapolated (with caution) for use between Jarvis River to Slims River, since Kennedy's (1993) specifications for linear development revegetation from Whitehorse to Haines Junction is nearly identical to those for linear development from Haines Junction to Kluane Lake.

If this option is chosen, the revised agronomic seed mixture for Jarvis River to Slims River would be:

species	**cultivar**	**% by weight**
Agrostis gigantea	Common	5
Agropyron pauciflorum	Revenue or Adanac	10
Festuca ovina	Durar or Common	5
Festuca rubra	Boreal	20
Medicago savita	Drylander or Rangelander	30
Phleum pratense	Climax, Engmo or Korpa	5
Poa compressa	Canon, Reubens or Common	5
Trifolium hybridum	Dawn, Aurora, Tetra or Common	20

Alternatively, if native seeds become available, the combined native/agronomic seed mixture for this section of the highway would be:

species	**cultivar**	**% by weight**
Agropyron pauciflorum	Native	
or		10
Agropyron violaceum	Native	
Festuca saximontana	Native	5
Festuca rubra	Boreal	15
Medicago savita	Drylander or Rangelander	30
Phleum pratense	Climax, Engmo or Korpa	5
Poa glauca	Native	10
Trifolium hybridum	Dawn, Aurora, Tetra or Common	20

It should be emphasized again that these seed mix options are extrapolated from the results of trial plot located outside the current project area.

Seed and fertilizer specifications for these sections of the highway alignment are presented in Tables 6-3 to 6-8. Modifications to these specifications will be required as information on site-specific soil characteristics is obtained.

Jarvis River to Silver Creek (Table 6-3)

The suggested agronomic seed mix, native seed alternatives and fertilizer specifications are from those recommended for linear development projects from Haines Junction to Kluane Lake (Kennedy 1993).

Silver Creek to Slims River (Table 6-4)

The suggested agronomic seed mix, native seed alternatives and fertilizer specifications are from those recommended for white spruce communities in the southwest Yukon (Kennedy 1993).

Slims River Delta (Table 6-5)

In order to address concerns regarding the introduction of invasive non-native plant species to the unique vegetation of the floodplain, only native seeds are recommended for revegetation on the Slims River Delta. The selected species are currently found on the delta and are adapted to the saline soil conditions. Fertilizer specifications are those for saline soils in the southwest Yukon (Kennedy 1993).

A further option for roadside revegetation on the Slims River Delta would be to allow it to revegetate naturally. The wind dispersal of native plant seeds should serve to revegetate this relatively small area of floodplain disturbance and the road shoulders.

Slims River to Horseshoe Bay (Table 6-6)

The suggested native seed mix and fertilizer specifications are from that recommended for sage-grassland communities in the southwest Yukon (Kennedy 1993). In order to address the concerns regarding the introduction of invasive non-native plant species to the dry grassland slopes of Sheep Mountain, only native seeds are recommended for revegetating disturbed sites on this section of the highway alignment.

Horseshoe Bay to Duke River (Table 6-7)

The suggested agronomic seed mix, native seed alternatives and fertilizer specifications are from those recommended for linear development projects between Kluane Lake and Pickhandle Lake (Kennedy 1993).

The revegetation specifications for the portion of the highway from Horseshoe Bay to Duke River were taken from those recommended for linear projects from Kluane Lake to Pickhandle Lake (Kennedy, 1993). As mentioned above, an analysis of the roadside growth media in this area following highway reconstruction would be beneficial prior to the final selection of seed and fertilizer mixes.

Vaartnou (1995) has recommended that if the seed of *Hedysarum mackenzii* should become available in sufficient quantities, it should be included in all seed mixes at a rate of ten percent by weight. Concurrently, *Medicago savita* and *Trifolium hybridum* should be decreased by five percent each in all seed mixtures.

Duke River to Quill Creek (Table 6-8)

The suggested agronomic seed mix and native seed alternatives are those recommended for linear development projects between Kluane Lake and Pickhandle Lake (Kennedy 1993), but have been modified to accommodate concerns regarding the attraction of caribou to roadside forage. As a result legumes have been eliminated and grass species percentages have been adjusted accordingly. Fertilizer rates have also been altered (nitrogen rates have been doubled).

Stream Crossings

Native plant species should be allowed to naturally revegetate areas disturbed at the numerous stream crossings along the highway alignment. In particular, the *Dryas drummondii* plant community is an active colonizer of the coarse alluvium of these high gradient streams. In order to eliminate the eutrophication of streams from fertilizer build-up, it is recommended that fertilizer not be used in the immediate proximity of stream crossings.

Table 6-3 Seed and Fertilizer Specifications - Jarvis River to Silver Creek

agronomic selections			native alternatives	
species	**cultivar**	**kg/ha**	**species**	**kg/ha**
Agropyron riparium	Sodar	4	*Agropyron yukonense*	2
Agropyron trachycaulum	Revenue	8	*Agropyron violaceum*	8
Festuca rubra	Boreal	6	*Festuca saximontana*	3
Festuca ovina	Common	8	*Festuca ovina*	3
Medicago savita	Drylander	6	*Oxytropis campestris*	2
			Oxytropis splendens	1
			Lupinus arcticus	1
*Poa secunda**	Sherman	2	*Poa secunda*	1
Poa compressa	Canon	6	*Poa glauca*	3
Total		40		24

*family known as *Poa ampla*

Expected nutrient requirements:	Nitrogen (100 kg N / ha) Phosphate (120 kg P_2O_5 / ha) Potash (60 kg K_2O / ha)

Table 6-4 Seed and fertilizer specifications - Silver Creek to Slims River

agronomic selections			**native alternatives**	
species	**Cultivar**	**kg/ha**	**species**	**kg/ha**
Agropyron riparium	Sodar	6	*Agropyron yukonense*	3
Agropyron trachycaulum	Revenue	6	*Agropyron violaceum*	4
Festuca rubra	Boreal	8	*Festuca saximontana*	2
			Poa glauca	3
Poa pratensis	Nugget	5	*Poa pratensis*	3
Poa palustris	Common	5	*Poa palustris*	4
Phleum pratense	Climax	4	*Hedysarum mackenzii*	2
Trifolium hybridum	Aurora	3		
Total		37		21

Expected nutrient requirements: Nitrogen (25 kg N / ha)
Phosphate (250 kg P_2O_5 / ha)

Table 6-5 Seed and fertilizer specifications - Slims River Delta

native species	
species	**kg/ha**
Deschampsia caespitosa	5
Puccinellia nuttalliana	7
Hedysarum mackenzii	3
Total	15

Expected nutrient requirements:	Nitrogen (150 kg N / ha)
	Phosphate (100 kg P_2O_5 / ha)

Table 6-6 Seed and Fertilizer Specifications - Slims River to Horseshoe Bay

native species	
species	**kg/ha**
Agropyron yukonense	2
Agropyron violaceum	4
Festuca saximontana	4
Festuca ovina	2
Poa glauca	4
Oxytropis campestris	2
Hedysarum mackenzii	2
Total:	20

Expected nutrient requirements:	Nitrogen (25 kg N / ha)
	Phosphate (200 kg P_2O_5 / ha)

Table 6-7 Seed and fertilizer specifications - Horseshoe Bay to Duke River

agronomic selections			native alternatives	
species	**Cultivar**	**kg/ha**	**species**	**kg/ha**
Agropyron riparium	Sodar	8	*Agropyron yukonense*	3
			Festuca saximontana	3
Agropyron trachycaulum	Revenue	8	*Agropyron violaceum*	5
Festuca ovina	Common	5	*Festuca ovina*	3
Festuca rubra	Boreal	6	*Poa glauca*	4
Phleum pratense	Engmo	6	*Deschampsia caespitosa*	2
Poa compressa	Canon	3	*Poa compressa*	2
Trifolium hybridum	Tetra	2	*Lupinus arcticus*	1
Medicago savita	Drylander	2	*Hedysarum mackenzii*	1
Total		40		24

Expected nutrient requirements:
Nitrogen (50 kg N / ha)
Phosphate (200 kg P_2O_5 / ha)
Potash (25 kg K_2O / ha)

Table 6-8 Seed and fertilizer specifications – Duke River to Quill Creek

agronomic selections			native alternatives	
species	**Cultivar**	**kg/ha**	**species**	**kg/ha**
Agropyron riparium	Sodar	8	*Agropyron yukonense*	3
			Festuca saximontana	3
Agropyron trachycaulum	Revenue	8	*Agropyron violaceum*	5
Festuca ovina	Common	6	*Festuca ovina*	4
Festuca rubra	Boreal	7	*Poa glauca*	4
Phleum pratense	Engmo	7	*Deschampsia caespitosa*	2
Poa compressa	Canon	4	*Poa compressa*	3
Total		40		24

Expected nutrient requirements:
Nitrogen (100 kg N / ha)
Phosphate (200 kg P_2O_5 / ha)
Potash (25 kg K_2O / ha)

6.7.4 Availability of Native Seed

Only native plant species have been recommended for reseeding the roadside along the Slims River Delta and Sheep Mountain area. Following is the current availability of these native seeds from a local seed supplier:

Deschampsia caespitosa - not available as a native northern seed. Agronomic cultivars of this grass species are available.

Puccinellia nuttalliana - not currently available.

Agropyron yukonense - not currently available.

Agropyron violaceum - currently available as a native Yukon seed (original seed collected at Stewart Crossing, Yukon) in commercial quantities.

Festuca saximontana - currently being developed as a northern native seed (original seed collection at High Level, Alberta).

Festuca ovina - currently being developed as a Yukon native seed (original seed collection location at Whitehorse, Yukon).

Poa glauca - currently being developed as a Yukon native seed (original seed collection at Whitehorse, Yukon).

Oxytropis campestris - not currently available.

Hedysarum mackenzii - not currently available.

7.0 AESTHETICS

7.1 OVERVIEW

The reconstruction of the Shakwak Highway between Jarvis Creek and Quill Creek will upgrade a portion of the Alaska Highway that passes through some of the most spectacular scenery in the world, with tremendous vistas and opportunities for scenic enjoyment. The long and uninterrupted driving periods typically undertaken by the travelling public through this remote wilderness setting tend to foster an intimacy with the natural surroundings that shapes the travelling experience. Indeed, in contrast with many other Canadian highways, the travelers' pursuit of scenic vistas during the drive on this highway is often as important as their pursuit of the destination at the end of the road. This portion of the Alaska Highway also presents the best visual appreciation of Kluane National Park and Kluane Game Sanctuary that the vast majority of the public will ever see. For these reasons, the consideration of, and proposed mitigation for the potential impacts to, these aesthetic values is of key importance.

It is expected that the improvements to the surfacing and alignment characteristics will enhance this experience by affording a more safe and relaxed travelling experience, particularly for the Sheep Mountain/Kluane Lake areas, thereby allowing the driver to appreciate the scenery while maintaining appropriate attention to the road.

Nevertheless, construction techniques and alignment features can be adopted to enhance the opportunity to capitalize on the inherent aesthetic values.

The aesthetics impact studies involved the following four critical components:

- viewpoint identifications,
- vulnerable area identification,
- borrow pit and field camp assessment, and
- tourist viewpoint assessment.

In addition, through defining the above four components, it was determined that alignment considerations themselves could eliminate conflicts between different interests and needs.

Examples presented in this section include the retention of tree screens where the foreground view would be negatively impacted (such as at borrow site locations), and removal of tree screens where the middle and background vistas can be incorporated (such as views of Kluane Lake). Also, existing tourist viewpoints are identified and discussed with respect to recommended modifications to enhance their positive aspects, and new potential viewpoints are suggested.

Throughout this study, an effort has been made to integrate the considerations of the aesthetic component with other study components, notably socio-economic impacts and current land use. In this manner, it is expected that the mitigation measures identified for aesthetic impacts, as proposed in this report, will incorporate features that are beneficial to these other components.

The map-based identification of the aesthetic component is presented in Figures 7-1 through to 7-6, Volume II.

7.1.1 Study Approach

The approach to the study was threefold. Initial contact was made with a number of stakeholders including: Yukon Government (YTG) Heritage Branch (Heritage Branch), YTG Department of Renewable Resources, Parks Canada and Champagne and Aishihik First Nation (CAFN), and Kluane First Nation (KFN). Discussions were also held with YTG Community & Transportation Services (C&TS) personnel, and a meeting was held with YTG Heritage Branch. Highway interpretive plans and signage strategies were reviewed for various other Yukon highways. A field reconnaissance was organized with YTG Heritage Branch, Parks Canada, and YTG C&TS, to field document important viewpoints, vulnerable areas, tourist viewpoints and discuss stakeholder’s concerns and or interests. The existing and proposed highway alignment was viewed with airphotos and base maps.

A second follow up field survey was conducted to further delineate important areas for aesthetics considerations and to ground truth borrow pit and field camp locations. Meetings were also held with CAFN and KFN to discuss aesthetic issues. The present roadway and proposed alignments in key areas was assessed. This field inspection also included a site visit of a portion of the highway under construction as well as an area previously constructed and reclaimed to review existing design measures for roadway construction and borrow pit and waste area reclamation. All sites were geo-referenced, photographed, documented, and are presented on the Aesthetic maps, Figures 7-1 to 7-6, Volume II.

The third study component was to integrate the results of the various discipline-specific studies, to acknowledge and recommend specific areas vulnerable to possible aesthetics damage, and outline mitigation options to address potential impacts. Integration of aesthetic considerations is discussed in Section 9, Mitigation Strategy, and appears in Tables 9-1 and 9-2.

Existing tourist and viewpoint areas, as well as vulnerable aesthetics areas within the study area (impact area), were documented and mapped. The following summary, along with Table 7-2, highlight the important resources that may be potentially impacted as a result of highway construction realignment activities.

Table 7-2 identifies aesthetic sites of concern as a result of this study. This table identifies the type of site (scenic or tourist viewpoint, vulnerable area, or potential borrow sources), the existing site condition and a mitigation strategy to address potential impacts to the site from highway reconstruction. Aesthetic sites are mapped on Figures 7-1 to 7-6, Volume II.

7.1.2 Viewpoint Identification

Many of the existing tourist viewpoints, and some of the existing informal viewpoints, are recommended for continued existence or upgrading to better facilitate vehicular traffic (Table 7-2). YTG Department of Tourism, in conjunction with YTG C&TS, should ensure that the Kluane Regional Tourism Plan is incorporated into the construction design considerations for the highway. YTG Heritage Branch, is planning to develop the West Alaska Highway Interpretation Strategy (S. Robinson, pers. Comm.). The “Interpretative Highway Strategy” prepared for Heritage Branch should be referred to for detailed development of a signage strategy for the Alaska West Highway. It is recommended that Heritage Branch develop an Alaska Highway West Interpretation Plan and discuss the plan with YTG C&TS prior to road reconstruction.

For the purposes of this study, from discussions with Heritage Branch, it is recommended that the existing identified viewpoints and tourist pulloffs be retained. These existing tourist viewpoints include the Kluane Lake overlook, Sheep Mountain Visitor's Facilities and viewpoint, Soldier's Summit, Destruction Bay Historic Signage Pull-off, Destruction Bay Rest Stop, Burwash Historic Signage Pull-off, and Kluane River Overlook. Locations of these areas are shown in Figures 7-1 through to 7-6, Volume II. Some of these viewpoints should also be upgraded to provide better highway access and rest stop accommodation facilities.

A number of other informal viewpoints with poor site access and/or public rest stop facilities exist along this section of the road. Formalizing some of these viewpoints should be considered, however concerns have been raised by stakeholders that expanded viewpoint pulloffs will decrease local business opportunities. In addition, if the number of formalized view points increases, it is expected maintenance requirements will also increase. This is also a potential concern to highway maintenance staff.

Safety too is of utmost importance when considering existing formal and informal viewpoint locations. Because of the nature of this highway, two user groups are typically in conflict:

- Express through traffic – is made up of a variety of vehicle types and drivers/passengers, all of whom are mostly concerned with reaching their destination to the north or to the south: transport truck traffic, commuting Alaskans, local area traffic and commuting Yukoners. This group typically requires or desires unfettered, safe progress at highway (90 km/hr to 100 km/hr) speeds.
- Tourist and sightseeing/nature traffic – is comprised of travelers who are more inclined: to slower speeds, to pull over at predictable or unpredictable locations, to cross the road for photographic or vista opportunities, or to investigate wildlife/plant-life or recreational encounters.

Because of the curvilinear nature of the existing road, with very limited stopping/passing and crossing sight distances there are portions of this road that, while affording the greatest scenic opportunities, also provide the greatest hazards to both user groups. Crossing vehicles and pedestrians are often unable to anticipate oncoming traffic in order to cross back to their side of the road after leaving a viewpoint. Likewise, express through traffic seldom prepares adequately for crossing people and vehicles, despite signage in these areas.

7.1.3 Impact Assessment and Mitigation Proposals

The two main issues that arise from Section 3 Current Land Use, that are applicable to aesthetics impact assessment and mitigation are as follows:

1. **Existing Businesses Access:** (Highway lodges, private and government campgrounds) those that require continued access: without special treatment, some portions of the proposed road alignment may isolate these businesses from the travelling public for certain alignment options.
2. **Local Land Use Access:** Private residential access and current land use access (hunting, fishing, recreation, tourism) to local areas and some specific sites that have been used by locals for many years, and may be interfered with due to the raising of the highway centerline and wide, coarse rock shoulders.

In the first scenario, the businesses located along the Alaska Highway depend on traffic literally driving by their doorstep to attract customers. These are not 'destination' sites for tourism; therefore, the tourist traffic will stop only if the site is considered useful and convenient upon discovery. Construction design for the project must take into consideration potential impacts to these businesses due to “orphaning” the site from the highway due to horizontal/vertical alignment changes. That is, the newly constructed highway must continue to provide for the “discovery” of existing businesses.

One concept that has been developed to address the concern is the creation of “scenic routes”. See Figure 7-3, Volume II for the location of the two potential scenic routes.

Basically, the concept entails the retention of certain portions of the old highway alignment, with a reduced speed limit, and seasonal summer usage for access to these businesses. The new highway alignment would be constructed as planned, with appropriate signage and intersections for the businesses and the scenic route. Identification of these routes could be accommodated in the highway interpretive strategy and at existing interpretive centres.

Some potential benefits from this concept could include:

- Conflicting user groups (“express through traffic” and “tourist and sightseeing nature traffic”) will be separated in the more hazardous areas, providing additional safety to both groups.
- Enhanced appreciation of Kluane Park through photographic opportunities of the park side will be afforded from the “old highway”/scenic route than from the new highway in many locations. People will be less inclined to wander into the Park and interfere with wildlife resources, as the scenic routes are actually further from the Park in all cases.

It is interesting to note that the 1979 Environmental Impact Statement for the Shakwak project, recommended a slower (80 km/hr) design speed for the Kluane Lake Section (Slims River to Williscroft Creek) of the project, with curve radii of 230m.

These portions of the highway that are proposed for the consideration of the Scenic Route treatment include the vicinity of the Bayshore Inn (km 1708 to 1713.5), and Cottonwood Campground (km 1710 to 1717.5). They are arguably among the most scenic parts of the Kluane Lake experience, and are, at the same time, areas where significant alignment shifts are proposed by C&TS. They are presented on the 1:60,000 scale corridor maps (Figure 7-3, Volume II).

In the second scenario, the local residents are accustomed to being able to use multiple choices of roads off the highway to access special places for fishing, hunting, berry picking, and many other forms of recreation.

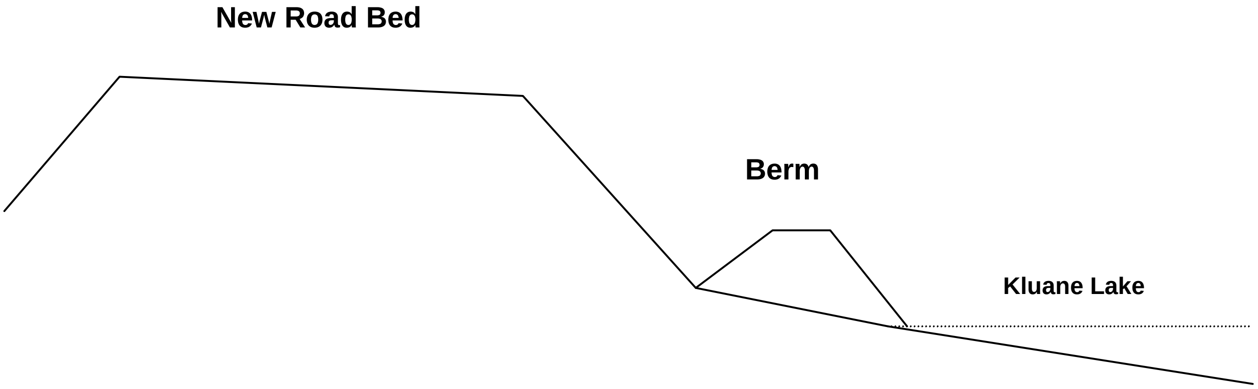
The construction method to be employed for the Shakwak Highway Project consists of a wide-pad that both broaden and raise the road surface. Additional berm-type shoulder treatment methods are used only in permafrost areas. Depending on local topographic relief, the new road surface will be from 1.5 to 2 meters higher than the existing surface, along with an approximate doubled width of the roadbed footprint. This will have the effect of isolating the new highway from the current local road access at most locations, requiring a prioritizing of the access points that will be given special intersection treatments to retain access. At these points, Yukon Government, Community & Transportation Services, will construct access intersections to Transportation Association of Canada (TAC) personal residence standard.

7.1.4 Vulnerable Areas Identification

Several areas have been identified as vulnerable to aesthetic impacts resulting from the highway reconstruction. A number of these vulnerable areas were previously identified in the original Environmental Impact Statement conducted in 1978, and were also identified as areas of concern for possible impacts as a result of the other discipline specific studies (Table 7-2). Critical areas previously identified include the Slims River Delta/Sheep Mountain area and the Duke River Meadows.

Other areas identified as vulnerable as a result of this study include Sulphur Lake, the Silver Creek floodplain, downstream to the residences and airstrip location near the Kluane lakeshore, the Goose Bay area along Kluane Lake and the Kluane Caribou crossing corridors (km 1780-1790). The recent 1999 fire along the highway near Burwash Landing may also be considered vulnerable from an aesthetics perspective. For each vulnerable area specific mitigation options were developed to address potential environmental impacts resulting from highway reconstruction activities. These mitigation options address potential impacts to other resources including archaeology, hydrology, current land use, vegetation, wildlife and socio-economics. Details of these mitigation option strategies appear in Table 9-2.

Areas where the new alignment is immediately adjacent to Kluane Lake may provide environmental hazards in the event of a roll-over into the lake. Of concern is the possibility of a tanker of dangerous goods or hazardous waste overturning into the lake, or onto a beach area. A possible mitigation strategy is to construct a rock berm below the new road bed and the lakeshore. Three potential berm sites have been identified for possible rollover protection berm treatment, at km 1707+800, 1715+100 and 1716+700. These three sites represent locations where the road is immediately adjacent to the Kluane Lake shore, where there is not enough distance or natural barrier to prevent a vehicle rollover from entering the water. This berm treatment would protect against environmental hazards, as well as road embankment erosion protection.



Road cross section looking north, showing possible berm treatment

Another potential aesthetic impact is the possible obstruction by trees of Kluane Lake vistas that are currently available from the highway, due to a horizontal alignment shift away from the lakeshore. For the most part, the increased highway right-of-way clearing, coupled with relatively steep downhill slopes in the direction of the lake, will ensure that the views of the lake are not lost between km 1704+900 and km 1723+300. If the right-of-way clearing in any particular area is not sufficient to maintain lake views, consideration should be given to removal of the tree screen between the highway and the lake in those areas. This is obviously a site-specific treatment that would have to take into consideration local factors such as existing land use, wildlife habitat values, and other issues on a case by case basis.

7.1.5 Borrow Sources

Thirty-five borrow sources have been identified along the portion of the highway (km 1664.5 to km 1788.5) corridor as potential sources for granular material. These sites were investigated as part of the discipline specific studies. Potential borrow pit and field camp locations with potential aesthetic impacts are listed in Table 7-2.

Streambed Quarries

An interesting challenge from an aesthetics standpoint is the development of granular quarries within and adjacent to many of the glacial fed streams which cross the highway, as these sites are clearly visible (Mines Creek, Nines Creek, Bock’s Brook, Lewis Creek, Burwash Creek, Copper Joe Creek). A possible mitigation strategy is to develop these potential borrow sources in a manner to address aesthetics concerns while ensuring long term stream maintenance requirements.

It is important to note that most of these creeks are subject to serious erosion and stream bed movement through natural occurrences, with hundreds of thousands of tonnes of granular material being transported yearly. Annual efforts by YTG, Highway Maintenance Branch, are ongoing, in order to prevent the washing out of sections of the Alaska Highway in many locations. Even the trained eye may not be able to determine the streambed movement, which has occurred naturally or through maintenance/prevention efforts by YTG C&TS.

It is reasonable to suggest that these annual maintenance operations can be reduced considerably for many years to come, by initiating a well-thought-out and engineered quarrying design which, while providing the granular materials required for some years, will also introduce proper channel definition that will better complement human needs in the vicinity.

A similar, and apparently very successful, approach has been undertaken previously by YTG C&TS at the Edith Creek (km 1843) borrow source, located north of the study area.

7.1.5.1 Conventional Gravel Quarries

Other, more traditional quarry borrow sources have also been identified within the study area. These are identified on Figures 7-1 through 7-6, Volume II, and can be typified as planned excavations of alluvial fans and gravel deposits, not as parts of existing streambeds.

Aesthetic considerations for borrow sources of these types have been historically addressed and developed by YTG C&TS (and Public Works Canada before them) through their many years of construction and maintenance activity in the area. These observations, together with years of interaction with regulatory agencies, have been used to guide the development of the Granular Resource Management Plan (2nd Edition, August, 1996).

The objectives of that plan are to:

1) *"Establish a procedure for consultation and information exchange with affected groups as part of the pit development process;*
2) *Identify potential environmental effects at each stage of the pit development and provide methods to mitigate or reduce these effects;*
3) *Establish a format for pit development plans to ensure the regulatory requirements are met and applicable environmental concerns are addressed. Also to ensure that final use and reclamation of the pit area is considered at the beginning of the development and throughout the development process;*
4) *Identify various reclamation methods that can be used and outline procedures to be followed from initial pit development to enhance the success of the reclamation effort;*
5) *Outline procedures to monitor pit development activities to ensure the pit development plan is being adhered to."*

Each potential borrow pit development for granular source is subject to a federal land use permit. The application for this permit is detailed as to site specific conditions, environmental and aesthetic issues, and mitigation measures; but generally the practices are guided by the overall concepts described in the granular resource management plan.

The more important and more current practices, which must be discussed from an aesthetic perspective, are:

- Maintaining minimum (>30m) tree screens between the highway right-of-way and the quarry;
- Maintaining minimum (>30 m) buffer between watercourses and drainage;
- Incorporation of only one access/haul road into each quarry site;
- Employing curvilinear characteristics in haul road design to provide further screen between the traveling public and the quarry;
- Developing, where possible, excavations of no greater than 5m in height, with slopes not steeper than 2H:1V;
- Stockpiling of stripped organic soils and waste for later distribution, contouring and (if required) seeding operations, as part of a reclamation program;
- Development of quarries in a progressive, as-found basis. Where limits cannot be absolutely determined prior to initial development, clear and strip in stages, so as to avoid over-clearing and over-stripping;
- Developing quarry plan(s) that avoid water table, where possible and where desirable;

- Where the water table cannot or should not be avoided (such as where wetlands are to be created), consult with other beneficiaries/parties and interest groups for optimum end use;
- Employing adequate soils testing to properly delineate stripping/quarry horizons and quantities, and to properly design an efficient and aesthetically pleasing finished quarry;
- Avoid, where reasonable, quarry locations on hillsides that can be seen from the new highway alignment. Where unavoidable, exercise additional and accelerated reclamation measures as aesthetic compensation; and,
- Avoid, where possible, quarry locations located near, or conflict with, sensitive environmental resources (for example – Kluane Caribou corridors and archaeological and traditional land use areas).

Table 7-1, Potential Borrow Pit and Field Camp Locations, provides a list of thirty-six sites identified at the time of this study as potential granular resource sites or camp locations. Final determinations as to which sites are chosen will be made by Yukon Government, Community & Transportation Services, based primarily on results of field investigations and a geotechnical testing program to be undertaken prior to development. There are no aesthetic impacts specific to any one of these sites in relation to the entire list. Figure 7-1 presents a schematic view of the proposed development scheme at potential borrow/camp location #29, at km 1772. This site was chosen only because it offered the expression of many of the practices described in the Granular Resource Management Plan ("GRMP"). In any case, the mitigative measures and management strategies that are presented in the aforementioned GRMP will be followed on a case by case basis.

Table 7-1 Potential Field Camp and Borrow Pit Locations

Site #	General Location	Highway Chainage	Potential Use	Comments
1	NW of Sulphur Lake	1673+900	field camp	old borrow pit, area may limit camp size
2	NW of Sulphur Lake	1674+600	field camp	old borrow pit, area may limit camp size
3	NW of Sulphur Lake	1675+500	field camp	old borrow pit, area may limit camp size
4	NW of Sulphur Lake	1674+500	borrow pit	New site, access from field camps, develop according to “GRMP”
5	E of Christmas Cr	1684+000	borrow pit, field camp	old borrow pit, good camp siting
6	Christmas Cr d/s hwy	1686+000	borrow pit	New site, develop according to “GRMP”
7	Silver City pit	1692+100	borrow pit, field camp	currently used borrow pit with crush pile; electrified landfill; Heritage site to the north
8	Silver Cr d/s hwy	1693+000	borrow pit	active stream, channel bed mostly unvegetated; consider sediment trap and borrow development
9	Silver Cr u/s hwy	1692+300	borrow pit	active stream, channel bed mostly unvegetated; consider sediment trap and borrow development
10	Williscroft Cr u/s hwy	1712+500	borrow pit	old borrow pit; stream bed mostly unvegetated; consider sediment trap and borrow development
11	Williscroft Cr d/s hwy	1712+500	borrow pit	old borrow pit; stream bed mostly unvegetated; consider sediment trap and borrow development
12	Congdon Cr d/s hwy	1719+300	borrow pit, field camp	old borrow pit; maintain adequate buffer between campground and lakeshore
13	Congdon Cr u/s hwy	1720+200	borrow pit	old alluvium stream channel; consider sediment trap and borrow development
14	Nines Cr d/s hwy	1731+100	borrow pit	old stream channel; develop according to “GRMP”; possible grizzly bear habitat conflicts
15	Nines Cr u/s hwy	1730+900	borrow pit	old stream channel; develop according to “GRMP”; possible grizzly bear habitat conflicts
16	Mines Cr d/s hwy	1732+000	borrow pit	old borrow pit; develop according to “GRMP” within stream channel confines
17	Mines Cr u/s hwy	1732+000	borrow pit	stream channel; develop according to “GRMP” within stream channel confines
18	current hwy W of Mines Cr	1732+700	borrow pit	current highway alignment; develop according to “GRMP” within stream channel confines
19	Bock's Cr d/s hwy	1734+600	borrow pit	stream bed mostly unvegetated; consider sediment trap and borrow development within channel confines
20	Bock's Cr u/s hwy	1734+600	borrow pit	stream bed mostly unvegetated; consider sediment trap and borrow development within channel confines
21	E of Lewis Cr	1748+500	field camp	old borrow pit; now scrap metal dump
22	Lewis Cr d/s hwy	1749+300	borrow pit	new site; consult Kluane First Nation; develop according to “GRMP” within stream channel confines
23	Lewis Cr u/s hwy	1749+300	borrow pit	new site; consult Kluane First Nation; develop according to “GRMP” within stream channel confines
24	Copper Joe Cr d/s hwy	1754+000	borrow pit	stream channel unvegetated; possible sharptail grouse lekking area (however, recent fire)
25	Copper Joe Cr u/s hwy	1754+000	borrow pit	stream channel unvegetated; streambank vegetation recently burned; possible sharptail grouse lekking area
26	SE of Burwash	1758+700	field camp	old borrow pit; surrounding forest recently burned; development concern for Kluane First Nation
27	across hwy from Burwash airport	1763+200	borrow pit	old borrow pit - has mostly escaped recent burn; ensure tree screen
28	E of Duke R	1766+500	borrow pit	white spruce-kinnikinick has all burned; willow escaped burn; consult Kluane First Nation; limit development north of highway; possible sharptail grouse lekking
29	NW of Duke R	1772+000	borrow pit, field camp	old borrow pit and previous hwy alignment with historic site (bridge); see Figure 7-1 for potential development scheme
30	Burwash Cr d/s hwy	1775+800	borrow pit	old borrow pit and staging area; creek bed has been rechannelled; Heritage resource concern
31	Burwash Cr u/s hwy	1775+800	borrow pit	old borrow pit and staging area; placer mineral claim upstream of potential borrow area
32	NW of Burwash Cr	1779+600	borrow pit	new borrow pit; development concern for caribou (see Section 4); Kluane First Nation traditional use concerns
33	SE of Sakiw Cr	1782+800	field camp	old borrow pit; development concern for caribou (see Section 4); consider alternative site
34	SE of Sakiw Cr	1783+100	borrow pit	new borrow site; Kluane First Nation traditional use concerns
37C	Before Kluane River Overlook	1783+500	field camp	old borrow pit; development concern for caribou; consider alternative site
35	Quill Cr u/s hwy	1786+100	borrow pit	old borrow pit near mine access road; development according to “GRMP”

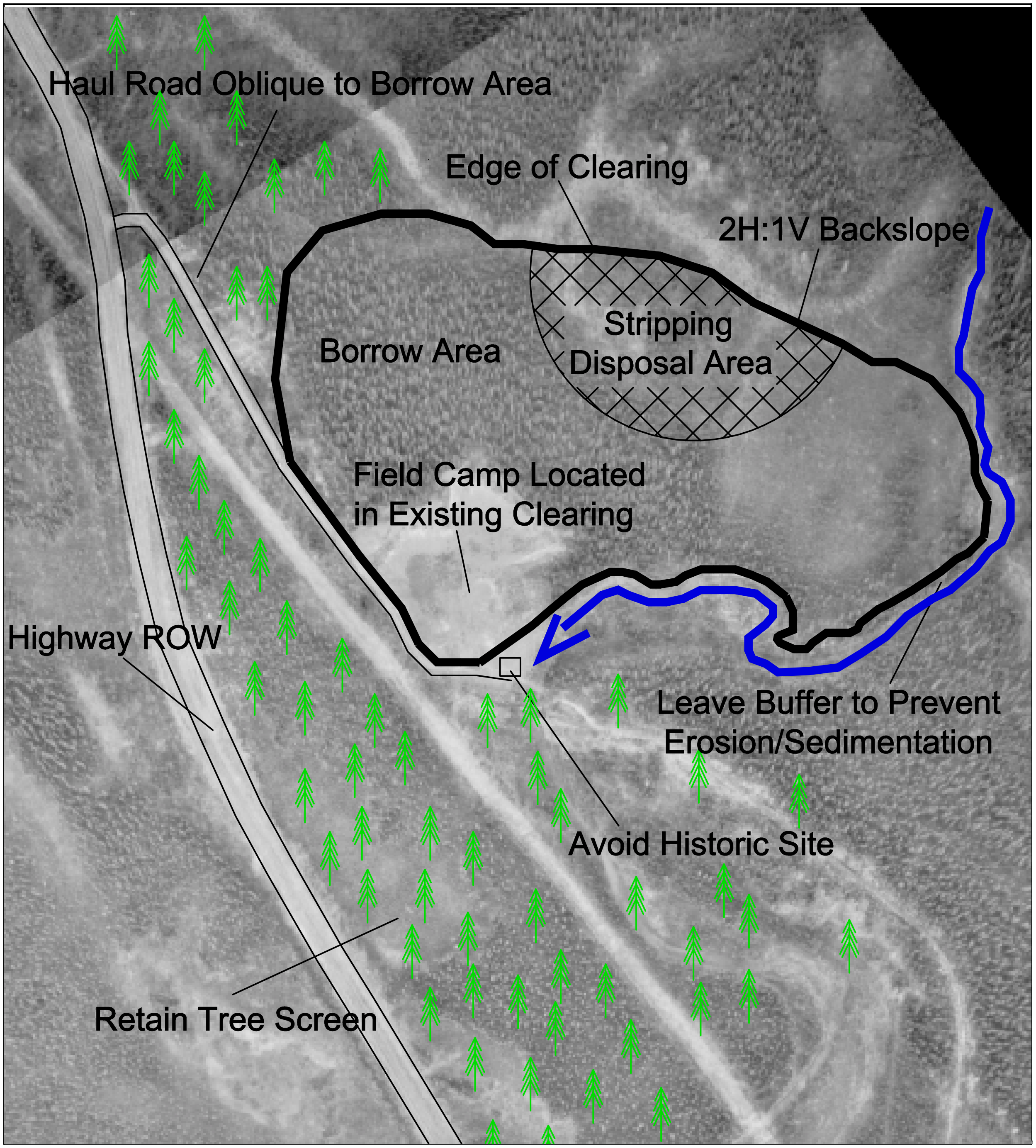
Note: “GRMP” – Granular Resource Management Plan, Yukon Community & Transportation Services, Transportation Engineering Branch, August 1996

Table 7-2 Aesthetics Impact Assessment

SHAKWAK HIGHWAY PROJECT – JARVIS RIVER TO QUILL CREEK – AESTHETICS IMPACT ASSESSMENT	AESTHETIC SITE TYPE				SITE CONDITION			MITIGATION STRATEGY			
AESTHETIC SITE	VIEWPOINT	VULNERABLE AREA	TOURIST VIEWPOINT	BORROW SOURCE	EXISTING SITE	POTENTIAL NEW SITE	IDENTIFIED * STUDY IMPACTS	PROTECT VIEW POINT OR TOURIST AREA	DEVELOP NEW TOURIST SITE	AVOID VULNERABLE AREA **	MITIGATION REQUIRED ***
Jarvis River Alaska Hwy Bridge Pull out (1666 + 400)	✓				✓			✓	✓		
Sulphur Lake Pullout & Viewpoint (1670 + 500)	✓	✓	✓		✓		✓	✓			
Christmas Creek Pullout & Viewpoint (1685 + 400)	✓				✓			✓			
Boutallier Summit (1687 + 400)			✓			✓			✓		
Kluane Lake Pullout (1671 + 000)	✓		✓		✓			✓			
Old Silver Creek Floodplain & Rd ROW (1694 + 500)		✓					✓				✓
Kluane Lake Pullout (1697 + 900)	✓		✓			✓			✓		
Slims River Delta (1702 + 500)		✓					✓			✓	✓
Sheep Mountain/Solder's Summit/Kluane Lake (1703 + 700) (1705 + 000)	✓	✓	✓		✓		✓	✓		✓	✓
Kluane Lake (km 1709 – 1714)	✓				✓		✓				✓
Williscroft Creek/Cottonwood Area (1712 + 400)	✓			✓		✓			✓		✓
No Name Creek Area (1716 + 800)	✓		✓			✓			✓		
Goose Bay Area (1723 + 300)	✓	✓	✓		✓		✓	✓		✓	✓

SHAKWAK HIGHWAY PROJECT – JARVIS RIVER TO QUILL CREEK – AESTHETICS IMPACT ASSESSMENT	AESTHETIC SITE TYPE				SITE CONDITION			MITIGATION STRATEGY			
AESTHETIC SITE	VIEWPOINT	VULNERABLE AREA	TOURIST VIEWPOINT	BORROW SOURCE	EXISTING SITE	POTENTIAL NEW SITE	IDENTIFIED * STUDY IMPACTS	PROTECT VIEW POINT OR TOURIST AREA	DEVELOP NEW TOURIST SITE	AVOID VULNERABLE AREA **	MITIGATION REQUIRED ***
Nines Creek (1730 + 200)				✓			✓				✓
Mines Creek (1732 + 000)				✓			✓				✓
Bock's Brook (1734 + 600)				✓			✓				✓
Destruction Bay Historic View Stop (1742 + 800)			✓		✓			✓			
Destruction Bay Rest Stop (1743 + 100)			✓		✓			✓			
Lewis Creek (1749 + 000)				✓			✓				✓
Copper Joe Creek (1752 + 900)				✓			✓				✓
Burwash Area Fire along ROW (1751 + 000 to 1767 + 600)		✓		✓			✓				✓
Burwash Historic View Stop (1759 + 500)			✓		✓			✓			
Duke River Meadows (1768 + 000)	✓	✓					✓	✓		✓	✓
Burwash Creek (1775 + 600)				✓			✓				✓
Kluane River Overlook (1784 + 600)	✓		✓		✓			✓			

* Identified Study Impacts – indicates other discipline specific studies have also identified potential impacts to this area as a result of highway reconstruction.
** Avoidance is a possible mitigation strategy. See Table 9-1 and 9-2 for mitigation strategies and options for these areas.
***See Table 9-1 and 9-2 for mitigation options



ACCESS CONSULTING GROUP

Yukon
Community and Transportation Services
Transportation Engineering Branch

Shakwak Project Environmental Assessment
Update 1999 Km 1664.5 - Km 1788.5

Typical Arrangement - Borrow Pit
Development Scheme

DRAWN BY: LDR
CHECKED BY:
DATE: 14/12/99
NOT TO SCALE

Figure 7-1

8.0 SOCIO-ECONOMIC

8.1 COMMUNITY SOCIO-ECONOMIC PROFILES

The following brief description provides a baseline of social and economic factors for the communities most directly impacted by this portion of the Shakwak Highway Project (Haines Junction, Destruction Bay, Burwash Landing and Beaver Creek).

8.1.1 Haines Junction

The population of Haines Junction increased steadily through most of the nineties, from 621 in 1991, to a high of 854 in 1997. In 1998 the population declined, totaling 797 at the end of the year. Those of working age (15 to 64 years) made up 70% of the population at the end of 1998, slightly below the Yukon average of 73%. Approximately 40% of the population is aboriginal. The population in Haines Junction is slightly older than that of the Yukon average, with almost 15% being 55 years or older, compared with 12% in that age category for the Yukon. Population estimates are based on Yukon Health Care Statistics.

Table 8-1 provides some insight into the economic make-up of the community of Haines Junction as of 1996.

Table 8-1 Haines Junction Economic Profile

Type of industry	Approx. number employed	% share of the local economy
Agricultural and related service industries	0	-
Fishing and trapping industries	0	-
Logging and forestry industries	10	2.9%
Mining (including milling), quarrying and oil well industries	0	-
Manufacturing industries	15	4.4%
Construction industries	25	7.4%
Transportation and storage industries	25	7.4%
Communication and other utility industries	10	2.9%
Wholesale trade industries	0	-
Retail trade industries	25	7.4%
Finance and insurance industries	0	-
Real estate operator and insurance agent industries	0	-
Business service industries	0	-
Government service industries	115	33.8%
Educational service industries	35	10.3%
Health and social service industries	10	2.9%
Accommodation, food and beverage service industries	45	13.2%
Other service industries	25	7.4%
Total	340	100%

Statistics Canada, 1996. Yukon Census data.

Table 8-1 provides an approximate distribution of employment by industry due in large part to the technique of random rounding used in compiling census data. Random rounding is used to protect confidentiality in small communities. No number less than ten is reported and all numbers are rounded either up or down to a multiple of five (and not necessarily the nearest multiple). The figure of zero for agriculture shown for Haines Junction therefore, could actually be any number from zero to nine. Similarly, the figure of 25 for construction might represent any number from 20 to 30. The smaller the community (and therefore the numbers employed in any industry) the greater the potential distortion of the numbers this technique introduces.

8.1.1.1 Employment and Unemployment

The patterns of employment and unemployment in Haines Junction, like other small towns, is often difficult to discern accurately from the statistical record, as small changes can appear large when expressed in percentages. The 1996 census showed the town to have a labour force participation rate of 82%, slightly higher than the Yukon's 80%, but an unemployment rate of 17.6%, far above the Yukon's 1996 average of 9.6%. Approximately 14% of those working in Haines Junction were self-employed in 1996, compared to the Yukon average of approximately 13% (Statistics Canada, 1996, Yukon census data).

As in the rest of the Yukon, employment varies considerably on a seasonal basis in Haines Junction. The town had an average of 62 Employment Insurance (EI) claimants throughout 1998. This represents 2.8% of the EI claimants for the Yukon for the period, which is slightly greater than the town's 2.5% share of the Yukon's total population.

8.1.1.2 Family Income

The source of incomes for families in Haines Junction is generally similar to the sources of income of families in the Yukon in general. In both cases employment accounts for the bulk of income (84% in Haines Junction versus 86% in the Yukon). Direct government transfers account for 11.5% of income in Haines Junction as compared to 9.2% in the Yukon with the remainder being classified as "other income." The proportion of the adult population with no income at all is also similar, 4.7% in the Yukon and 3.6% in Haines Junction (based on 1996 census data).

Family income in Haines Junction however, tracks well behind the Yukon average. Overall average family income in the Yukon was $61,807 in 1996. In Haines Junction the average was almost $10,000 less at $51,995. Haines Junction families then, earn 84% of the Yukon average.

Lone-parent families earn on average only 70% of the Yukon lone-parent average ($25,283 versus $36,193).

Social assistance rates in the community show that Haines Junction is less dependent on social assistance than is the average for the Yukon. In Haines Junction social assistance payments are approximately $192.00 per capita per year as compared with $275.00 per capita per year for the Yukon.

8.1.1.3 Poverty

Although there is no consensus on where poverty begins, the percentage of families with incomes below $20,000 has been used for the purposes of this report as a measure of the poverty line. On this basis, Haines Junction has approximately 20 families (or 13.5% of all Haines Junction families) with a total income of less than $20,000. This compares to 12% of all Yukon families being below this "poverty line" (based on 1996 census data).

8.1.1.4 Cost of Living Compared with Whitehorse

The YTG community price survey shows that consumer prices in Haines Junction are approximately 3% higher than prices in Whitehorse. In October 1998 a “basket” of goods costing $100.00 in Whitehorse would be $103.20 in Haines Junction. The health and personal care and household operations portions of the “basket” were particularly expensive when compared to Whitehorse prices, while meat, bread, and cereals were cheaper in Haines Junction (Yukon Bureau of Statistics data).

8.1.1.5 Education

Overall, the level of education in Haines Junction is roughly comparable with that of the Yukon. For example, approximately 73% of townspeople age 25 and over have completed high school compared with the Yukon average of 77%. In Haines Junction, 51% of those over 25 have some post-secondary education (including trades training) while in the Yukon as a whole that number stands at 57%. Of those aged 15-24 in Haines Junction, approximately 56% are still attending school either full or part-time, closely matching the Yukon wide number of 57%. It is notable, however, that 11.6% of those 25 and over in Haines Junction have less than a grade nine education, compared with an average of 6.4% territory wide (based on 1996 census data).

8.1.1.6 Crime

The Haines Junction detachment of the Royal Canadian Mounted Police (RCMP) covers both the community and the Alaska Highway north as far as the Donjek River. The detachment's occurrence reports cover the communities of Haines Junction, Destruction Bay and Burwash Landing. Occurrences in the latter two communities are not reported separately. Although the numbers shown are not necessarily statistically valid (and do not give number of charges or convictions), the following table gives an insight into crime in Haines Junction/Destruction Bay/Burwash Landing and how it compares with the Yukon as a whole (based on RCMP Occurrence Reports).

Crime Type	Yukon	Haines Junction, Destruction Bay, Burwash Landing	Share of total (%)
Sexual assault	127	8	6.3
Non-sexual assault	820	13	1.6
All assaults	947	21	2.2
Break & enter	615	12	1.9
Car theft	234	6	2.6
Theft over $5,000	98	2	2.0
Theft under $5,000	1,178	21	1.8
Total property crime	2,313	45	1.9

Note: The three communities combined population is approximately 2.9% of the Yukon's total population.

For most types of crime, the three communities have a lower share of occurrences than their share of the Yukon’s population.

8.1.2 Destruction Bay

8.1.2.1 Population

The population of Destruction Bay has been dropping slowly but steadily from 52 in 1991 to 37 at the end of 1998. Those of working age (15 to 64) make up 92% of the population, well above the Yukon average of 73%. Those over 55 years of age make up 22% of the population, but the health care records show no current residents over the age of 65, based on Yukon Health Care statistics.

8.1.2.2 Economic Generators

No detailed data is available for economic generators in Destruction Bay, but the community’s economy centres on the Yukon Government’s road maintenance station and on the tourist facilities in the community.

8.1.2.3 Other Indicators

Destruction Bay’s very small population means that almost all census data for the community is suppressed to ensure confidentiality. In addition, separate employment and cost of living data is not available for the community. Therefore no figures on employment, family income, poverty, cost of living, or education levels can be presented. Crime statistics (as noted under Haines Junction above) are rolled in with Haines Junction and Burwash Landing.

8.1.3 Burwash Landing

8.1.3.1 Population

The population of Burwash Landing has fluctuated somewhat over the past decade, with the figure varying between 73 and 89. The estimated population at the end of 1998 is 79. Approximately 70% of Burwash Landing's population is aboriginal. The population in Burwash Landing is considerably older than that of the Yukon average with 30% being 55 years or older compared with 12% in that age category for the Yukon. Those of working age (15-64) make up 73% of the population, which exactly matches the Yukon average (based on Yukon Health Care statistics).

8.1.3.2 Economic Sectors

While the 1996 census does give approximate numbers of residents employed by type of industry, the random rounding technique used to ensure confidentiality in small communities makes a detailed breakdown largely meaningless for Burwash Landing. The numbers do, however, indicate a strong bias toward employment in government and other service industries. Tourism also provides a certain amount of employment for the community, based on 1996 census data.

8.1.3.3 Employment

To an even greater extent than Haines Junction, the very small population of Burwash Landing makes employment data highly variable. The 1996 census found the community to have a labour force participation rate of approximately 80% (closely matching the Yukon average) but gave no employment rate. The number of Employment Insurance claims in Burwash Landing is often low, low enough to be suppressed to protect confidentiality. No figure is available for 1998, but there were 6 Employment Insurance claims in 1997 and 7 in 1996, based on Statistics Canada and 1996 census data.

8.1.3.4 Other Indicators

The 1996 census suppressed all income data for Burwash Landing and there is no cost of living data for the community. There are numbers on education levels in the community from the 1996 census but the random rounding problem for small populations introduces far too much distortion for them to be useful.

8.1.4 Beaver Creek

8.1.4.1 Population

The population of Beaver Creek has varied somewhat during the 1990s, reaching a high of 140 in 1996 and a low of 115 in 1992. The population at the end of 1998 was 120. Approximately one quarter of the community is of aboriginal ancestry. Beaver Creek has a higher percentage of aged persons than most Yukon communities, with 22% of the population being 55 or older (compared with the Yukon average of 12%). Only two thirds of the population is working age, less than the Yukon average of 73%, based on Yukon Health Care statistics.

8.1.4.2 Economic Sectors

Table 8-2 provides some insight into the economic profile of the community of Beaver Creek as of 1996 (based on 1996 census data), and gives only an approximation of the distribution of employment by industry due in large part to the technique of random rounding used in compiling census data.

Table 8-2 Beaver Creek - Economic Make-up

Type of industry	Approx. number employed	% share of the local economy
Agricultural and related service industries	0	-
Fishing and trapping industries	0	-
Logging and forestry industries	0	-
Mining (including milling), quarrying and oil well industries	0	-
Manufacturing industries	0	-
Construction industries	0	-
Transportation and storage industries	10	11%
Communication and other utility industries	10	11%
Wholesale trade industries	0	-
Retail trade industries	10	11%
Finance and insurance industries	0	-
Real estate operator and insurance agent industries	0	-
Business service industries	0	-
Government service industries	35	39%
Educational service industries	0	-
Health and social service industries	0	-
Accommodation, food and beverage service industries	15	17%
Other service industries	10	11%
Total	90	100%

8.1.4.3 Employment

The 1996 census found a labour force participation rate of 85% in Beaver Creek (versus 80% for the Yukon) and an unemployment rate of approximately 12% (versus 9.6% for the Yukon). About 12% of those working in the community are self-employed. Beaver Creek had a total of 13 EI claims in 1998, amounting to 0.6% of the Yukon's total for the year. This is a slightly larger share than the community's 0.4% proportion of the territory's population, based on Statistics Canada and 1996 census data.

8.1.4.4 Education

Beaver Creek appears to have a somewhat higher level of education than the rest of the Yukon. Approximately 82% of Beaver Creek's population aged 25 and over have completed high school, compared with the Yukon average of 77%. Approximately 65% of the same age group in Beaver Creek have some post-secondary education, including trades training, compared with 57% in the rest of the Yukon (based on 1996 census data).

8.1.4.5 Crime

Although the numbers shown are not necessarily statistically valid (and do not give number of charges or convictions), the following table gives an insight into crime in Beaver Creek and how it compares with the Yukon as a whole (based on RCMP Occurrence Reports).

Crime type	Yukon	Beaver Creek	Share of total (%)
Sexual assault	127	2	1.6
Non-sexual assault	820	2	0.2
All assaults	947	4	0.4
Break & enter	615	3	0.5
Car theft	234	0	0
Theft over $5,000	98	0	0
Theft under $5,000	1,178	5	0.4
Total property crime	2,313	10	0.4

Note: Beaver Creek's population is approximately 0.4% of the Yukon's total.

Generally Beaver Creek's crime statistics seems to match very closely its share of the population.

8.1.4.6 Other Indicators

As with the other small communities, all income data for Beaver Creek has been suppressed.

8.2 LOCAL ECONOMY

8.2.1 Baseline Information

As with other regions in the Yukon, the prime economic generator of the Kluane region's economy is government. Tourism is also a major economic generator, while an assortment of natural resource industries play lesser roles. The level of subsistence activities is not reported in this overview of the regional economy because of the lack of reliable information. Subsistence hunting, fishing, and gathering all continue to be important contributors to the economic life in the region, particularly among First Nations.

8.3 GOVERNMENT

8.3.1 Baseline Information

Four levels of government (federal, territorial, municipal, and First Nation) provide the majority of jobs in the Kluane region. The jobs tend to be full-time and often year-round, and provide a stable base for a variety of services in the area. Federal government employees are concentrated in Haines Junction, the location of Kluane National Park Headquarters, and Beaver Creek, where the customs station operates. Territorial government employees include those employed in the schools, health clinics, highway maintenance crews and others. The municipal government in Haines Junction generates employment in the delivery of municipal services. The region's three First Nations, Champagne-Aishihik in Haines Junction, Kluane in Burwash, and White River in Beaver Creek, also employ people to deliver services to their members.

From data gathered in the 1996 census, it appears that at least 60% of those working in the region are employed by government. This compares to a Yukon wide average of approximately one third. It should be noted that the Yukon wide figure does not include those employed by First Nations.

8.4 TOURISM

8.4.1 Baseline Information

Tourism is the second most important economic generator in the Kluane region. According to the 1994 Visitor Exit Survey the Yukon had 206,800 visitors between June and September 1994, 136,496 (66%) of whom passed through the Kluane region. Of those passing through the region, 100,496 (74%) stopped at least once, though not necessarily to stay overnight. These visitors spent a total of $7.35 million in the region, averaging about $73 each. In 1994, approximately 3.5% of visitors to the area stayed for 3 nights or longer while 35% did not overnight at all. Kluane is clearly not seen as a destination for the vast majority of visitors. The majority of tourism business is focussed on those who are travelling through the region.

In 1998 the Yukon received 240,465 visitors. Assuming the visiting patterns have not changed since the 1994 survey, and using the percentages developed as a result of the 1994 survey, it is estimated that the Kluane region likely had approximately 116,000 of these 1998 visitors travel through the area spending a total of approximately $8.54 million.

8.4.2 Construction Phase

8.4.2.1 Impacts

Many of the local residents, in particular those living along the northern portion of the Highway study area, have had recent experience with highway reconstruction activities, and therefore hold firm views about potential impacts and possible mitigative measures. Interviews were therefore carried out with local residents, business owners, tourism operators, and First Nations, to gather their concerns about construction and operations impacts, and their suggestions for mitigation. Appendix VII contains an example of the questionnaire that was used during the interviews; the comments below represent a synopsis of local residents' concerns and their suggested mitigation options.

1) Locals are concerned that the location of construction camps can have a negative impact by limiting access of construction workers to local businesses.
2) Locals are concerned that dust from the construction will impact on local residents making their lives uncomfortable. As well, it is anticipated that dusty conditions will make it less likely that tourists will stop.

3) Locals are concerned that pilot cars may move groups past local facilities, thus preventing local businesses from benefiting from related service business opportunities.
4) Locals are concerned that tourists will inundate local toilet facilities after they have had to wait to move through construction stretches.
5) Locals are concerned that there will be loss of business as tourist travelers learn of previous problems associated with road construction and thus avoid coming to the Yukon or avoid the Alaska Highway by re-routing to the Top of The World Highway.
6) Locals are concerned that there will a continuation of previous construction practice that will see long construction stretches. It is feared that these long stretches tend to frustrate travelers and make it less likely that they will stop at local businesses.
7) Locals are concerned that construction activities will generally prevent tourists from having access to local communities and businesses (can't get off the highway easily) or will prevent tourists from enjoying their stop thus shortening the stop (blasting will make a restful stop difficult).

8.4.2.2 Mitigation

1) Local residents have suggested that wherever possible, locate the construction camps close to existing communities or visitor facilities. This recommendation is contrary to the EARPGO Panel report regarding overloading of local communities facilities. Similar concerns were expressed by Kluane First Nation members regarding the possibility of locating a construction camp near Burwash Landing. Consultation with local residents and First Nations about the location of camps prior to location decisions is recommended.
2) Ensure effective dust suppression should be required of all contractors.
3) Wherever feasible and appropriate, construction stretches should be designed so as to maximize the possibility that pilot cars can pick up and drop groups near local communities and facilities.
4) Wherever possible toilet facilities should be made available at locations where tourists will wait for pilot cars.
5) Tourism marketing should anticipate these possibilities and present the construction period in as favourable light as possible.
6) Wherever possible make the construction stretches as short as feasible thus avoiding the "frustration potential" associated with long construction stretches.

7) Wherever possible inform travelers with effective signage and comfortable turn-offs about the opportunities to stop and enjoy the surroundings. It is further recommended that there be early and continuing consultation with business owners about optimal approaches to construction activities, such as blasting, that will minimize impacts on local businesses as much as possible.

8.4.3 Operations Phase

8.4.3.1 Impacts

1) Locals were concerned that a new high-speed highway will reduce business. In particular, locals are concerned that it will be difficult to identify places to stop, it will be difficult to leave the highway (because of the steepness of the embankment, and because of the difficulty of leaving a high speed highway) and it will be difficult to see Kluane Lake, thus reducing the likelihood of stopping.
2) Locals are concerned that there may be a long term loss of traffic because of travelers fears that there will be more delays and more construction.

8.4.3.2 Mitigation

1) High quality, visible and attractive signage should be placed sufficiently in advance of any attraction (or group of attractions) in order that travelers can safely leave the highway. Turn off design should facilitate safe and convenient exit from and access to the highway from secondary roads and tourism attractions. Pullouts should be designed and made available so that travelers can safely stop and see Kluane Lake and other attractive vistas, see information about attractions, and have a safe break from the high speed highway.
2) It is recommended that marketing the new road, both its’ safety and comfort and its’ provision for access to attractions along the route, should be aggressively undertaken.

8.5 CONSTRUCTION

8.5.1 Baseline Information

As with other areas of the Yukon, the construction industry is fairly strong in the study area. The 1996 census indicates 25 people were employed in construction in Haines Junction, with suppressed data in the other three communities on the North Alaska Highway. The local area also sustains a number of small contractors potentially capable of undertaking small subcontracts.

The Yukon has a well developed and internationally competitive road and highway construction industry. In addition to conducting most of the extensive highway construction in the Yukon, the locally based industry has undertaken contracts in Alaska and British Columbia. Construction of the highway is well within the capacity of the Yukon industry.

8.5.2 Construction Phase

8.5.2.1 Impacts

The budget of the current project is estimated at $110,753,200, distributed as presented in Table 8-3.

Table 8-3 Distribution of Project Budget

Type of work	Estimated budget
Design & supervision	$ 12,061,700
Highway construction	83,375,000
Bridges	14,700,000
Rehabilitation	616,500
Total	**$ 110,753,200**

Experience with the northern portion of the Shakwak Project indicates that highway reconstruction, bridge construction and rehabilitation contracts generated an average of 1.207 person days of employment per $1,000, and that direct labour costs were 23.8% of contract value. Direct labour costs need to be increased by 12% to account for supplementary labour income items such as vacation pay and employer contributions to payroll taxes (EI, CPP, Workers' Compensation). This means that the percentage of total labour cost in contracts is about 26.6% of contract value. These numbers are averages and will vary considerably from contract to contract. Nevertheless, by applying these percentages to the estimated costs, an estimate of direct employment generated by this project can be made.

Highway construction, bridge construction and rehabilitation contracts associated with the project are likely to generate about 1,040 direct person years of employment, primarily in the construction sector. Rehabilitation contracts will result in a small measure of employment in the agricultural industry. An estimated additional 130 person years of employment will be created in the construction services industry (engineering, surveying, etc.) through the design contracts. This amount of jobs, even when spread over a number of years, is fairly substantial in relation to 1,185 people employed in the construction industry in the Yukon in 1996.

The local North Alaska Highway labour market is too small to provide the labour force needed to build this portion of the highway. Previous experience has shown that most of the labour force will be recruited in other parts of the Yukon. Depending on the successful contractors, some of the labour force might come from other parts of Canada. Given much lower Yukon wages and the low Canadian dollar, it is unlikely that American citizens would work on the project.[1]

According to the 1996 census, there were 220 people employed in industrial and heavy construction in the Yukon. In that same year, there were 80 people working as heavy equipment operators in construction, and another 280 employed in other industries, mainly mining. The census showed 85 Civil Engineers and 25 Land Surveyors, as well as 160 heavy

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[1] Grader, Dozer and Scraper operators earn between $US18.37 -$US28.33 per hour in Alaska with an average of $US22.50 ($CDN33.23), translating to a range in Canadian dollars $CDN27.13 to $CDN41.84 (Source: Alaska Department of Labor). This compares to the Yukon fair wage schedule rates, which are a benchmark for contractors and workers, of $CDN22.50 and $CDN20.11 per hour for different types of equipment operators.

equipment operators and mechanics, 20 drillers and blasters, and 35 truck drivers. Although these statistics have declined because of the closure of the Faro mine, the qualified Yukon labour force appears to be sufficient to build this project.

8.5.2.2 Mitigation

While the local and regional benefits for the construction industry are likely to be high, the major concern of locals are likely to be over job opportunities and contract opportunities. The specific mitigation measures that could be used include:

- Impact Benefits Agreements between successful contractors and Kluane First Nation and Champagne/Aishihik First Nation on local hiring with First Nations Governments. If Impact Benefit Agreements are contrary to the Shakwak Project International Agreement, then other options should be investigated with contractors and First Nations.
- Creating a hiring list of local construction workers to be provided to bidders.
- Creating a list of local small contractors to be provided to bidders.
- Requiring some level of participation by local contractors as a condition of tendering.
- Increasing the level of contract components to encourage the participation of small local contractors in the tendering process.

8.5.3 Operations Phase

8.5.3.1 Impacts

The level of highway maintenance may increase in the initial post construction years due to permafrost settlement patching. Long-term road maintenance costs are expected to stay the same, with the lower maintenance costs of a better quality highway being offset by increased snowplowing costs due to the greater road surface.

8.5.3.2 Mitigation

No mitigation measures required.

8.6 MINING

8.6.1 Baseline Information

Mining and mineral exploration have historically contributed significantly to the economy of the study area. The 22,015 km^2 Kluane National Park and Reserve represents the largest parcel of land removed from mineral exploration and mine development in the region. It is not anticipated that the Shakwak Highway Project will represent a further reduction in the land base available for exploration or mining activities in the region. There are currently a number of placer gold operations in the area. The discovery of gold in these creeks created a small gold rush in the early part of this century. Most creeks in the region have been mined to some degree. By 1997, only three creeks were producing placer gold, and only one of those was doing so in significant quantities. Fourth of July and Burwash Creeks produced a reported 64 and 94 ounces of gold, respectively, in 1997. Gladstone Creek produced 1,454 ounces in 1997. At the 1997 average gold price of $457.84 (CDN), the total output had a gross value of approximately $738,000.

The region also supports hardrock mineral exploration and development. In 1997 three mineral properties, Canalask, Wellgreen, and Klu/Burwash, were actively explored. Canalask is a nickel-copper deposit about 5 km south of Koidern. Wellgreen is a past producer of nickel, copper, and the platinum group elements approximately 32 km northwest of Burwash. The Klu/Burwash claims are near the headwaters of Nines Creek approximately 6 to 12 km south of Destruction Bay.

Most of the exploration activities consisted of geological and geochemical investigations, with a minor amount of diamond drilling and underground work being carried out at Canalask and Wellgreen, respectively. In 1998 the Canalask and Klu/Burwash properties were inactive, while Wellgreen saw some geological and geochemical work. Three other properties, however, did become active in 1998. They were Az (about 19 km west of Koidern), Arn (11 km southwest of Koidern), and Wash (approximately 24 km north-west of Burwash). All saw geological and geochemical work with some trenching at Wash and some diamond drilling at Az.

8.6.2 Construction Phase

8.6.2.1 Impacts

The construction phase is unlikely to have any impact on mining or mineral exploration activities in the region.

8.6.2.2 Mitigation

No mitigation measures are required.

8.6.3 Operations Phase

8.6.3.1 Impacts

The operations phase is unlikely to have any negative impacts on the mining or mineral exploration industries. There are a few existing mining road access points along the corridor that will be retained (see Section 3 – Current Land Use for a discussion of the treatment of access intersections).

Positive impacts will be generated by reducing potential transportation costs through a better quality highway.

8.6.3.2 Mitigation

No mitigation measures required.

8.7 FORESTRY

8.7.1 Baseline Information

There is very little active forestry in the Shakwak corridor study area between Haines Junction and Beaver Creek. Most logging in the region occurs to the south and east of Haines Junction. In the 1998/1999 logging season, only about 60% of the total permitted volume of timber allotted for the region was logged. Approximately 8,000 m^3 of sawlogs were harvested out of a permitted volume of about 13,000 m^3. The permitted amount was considerably higher than usual to allow for the harvest of stands of timber damaged by the spruce beetle infestation.

The harvest of sawlogs in 1998/99 was approximately 8,000 m^3. At an estimated \$85/m^3 of raw logs, the gross value of the harvest was approximately \$680,000. The reported fuelwood harvest was 974 m^3, or about 260 cords which, at \$110/cord, would have a gross value of \$28,600. The total gross value of the timber harvest in the Haines Junction area is therefore estimated to be in the \$700,000 range. The Champagne/Aishihik First Nation (CAFN) did most of the harvesting in 1998/99 and has plans to continue to develop forestry as a generator of jobs and economic activity in the region. The CAFN has a sawmill and is expanding its wood processing ventures with the addition of a kiln and other related equipment.

8.7.2 Construction Phase

8.7.2.1 Impacts

The construction phase is unlikely to have any negative impact on forestry activities. The increase in safety, and reduction in transportation costs from highway improvements resulting from the project, should result in positive impacts. There may be the harvesting of a small volume of commercial timber resulting from a new corridor and widening of the existing corridor, which will also provide positive impacts.

8.7.2.2 Mitigation

The Yukon Government, Department of Community & Transportation Services (YTG C&TS), consults with Department of Indian Affairs & Northern Development, Department of Forestry, regarding timber harvest within the highway right-of-way. If commercial timber is to be cleared, it should continue to be made available to the local forestry industry, as is presently done by YTG C&TS.

8.7.3 Operations Phase

8.7.3.1 Impacts

The operations phase is unlikely to have any negative impacts on the forest industry. There is little evidence of stands of commercial grade timber on the existing or new road alignment.

Positive impacts will be generated by reducing potential transportation costs with a better quality highway, and an increase in highway safety.

8.7.3.2 Mitigation

No mitigation measures required.

8.8 FISHING

8.8.1 Baseline Information

There is a commercial fishery for lake trout on Kluane Lake, with a total annual allowable catch of 3,050 kg distributed between 7 licence holders. The full quota is rarely filled, and the landed catch in the late 1990s has usually been between 1,500 and 2,000 kg. Whitefish are a frequent by-catch when netting trout, and there is no quota on them. Fishers who fill their trout quota, however, are not permitted to continue to fish for whitefish. Between 400 and 500 kg of whitefish have been landed annually on average in the past few years. With lake trout valued at approximately $14/kg, and whitefish at about $9/kg, the gross value of the catch is estimated to be approximately $28,000 annually. Much of the annual catch is sold locally to lodges catering to the tourist trade.

8.8.2 Construction Phase

8.8.2.1 Impacts

The construction phase is unlikely to have any impact on fishing activities.

8.8.2.2 Mitigation

No mitigation measures required.

8.8.3 Operations Phase

8.8.3.1 Impacts

The operations phase is unlikely to have any impact on fishing activities.

8.8.3.2 Mitigation

No mitigation measures required.

8.9 TRAPPING

8.9.1 Baseline Information

Although trapping constitutes an important cultural activity in the region, it is currently a small economic generator in the Shakwak corridor. Over the 1996/97 and 1997/98 trapping seasons, the reported value of fur harvested between Haines Junction and Beaver Creek has averaged

$7,750 per year. This is a total figure for the approximately 20 traplines bordering the highway between the two communities.

While seemingly very low, the value of the fur harvest in the region has actually risen substantially from a low in 1995/96, when the total value harvested in the region was $762. The value of the fur harvest and the level of trapping activity in this region follows the 10 year population cycle of its primary target species, the Canadian lynx.

8.9.2 Construction Phase

8.9.2.1 Impacts

There is currently one trapper utilizing the road for access to the trap line, which runs roughly along the northern margin of the road corridor. The trap line is small in area but, generally speaking, is quite productive. The concession holder speculates that the road corridor “channels” both target animals and prey because of ease of movement along the corridor. The construction activities may negatively impact trapping activities by interrupting, or otherwise reducing, the use of the road corridor by animals.

The trapping season is form November 1 to February 28, with December and January constituting the peak months. Since there will be little construction activity in January and February, it is anticipated that there will be minimal direct impacts on trapping during the construction phase.

An increase in highway pullouts may provide a positive impact to trappers, allowing for additional access points to their concessions.

8.9.2.2 Mitigation

No mitigation measures required.

8.9.3 Operations Phase

8.9.3.1 Impacts

1) The concession holder currently accesses the trapping concession by following creek beds that are comfortable points of entry along the road corridor. It is possible that such creek beds will be filled to smooth the grade along the road. This could make the use of these access points more difficult. There are fears that animals will not continue to follow creek beds because of the awkwardness in negotiating the steep slopes.
2) The majority of the sets currently used by the concession holder are within 100 m of the existing road corridor, with most of them as close as 50 m. Lynx are a species which are often caught at traditional spots, such as licks and scenting posts. It is not always possible to simply move trap sets. It is possible that a reduced catch may result until new trap set locations are discovered.

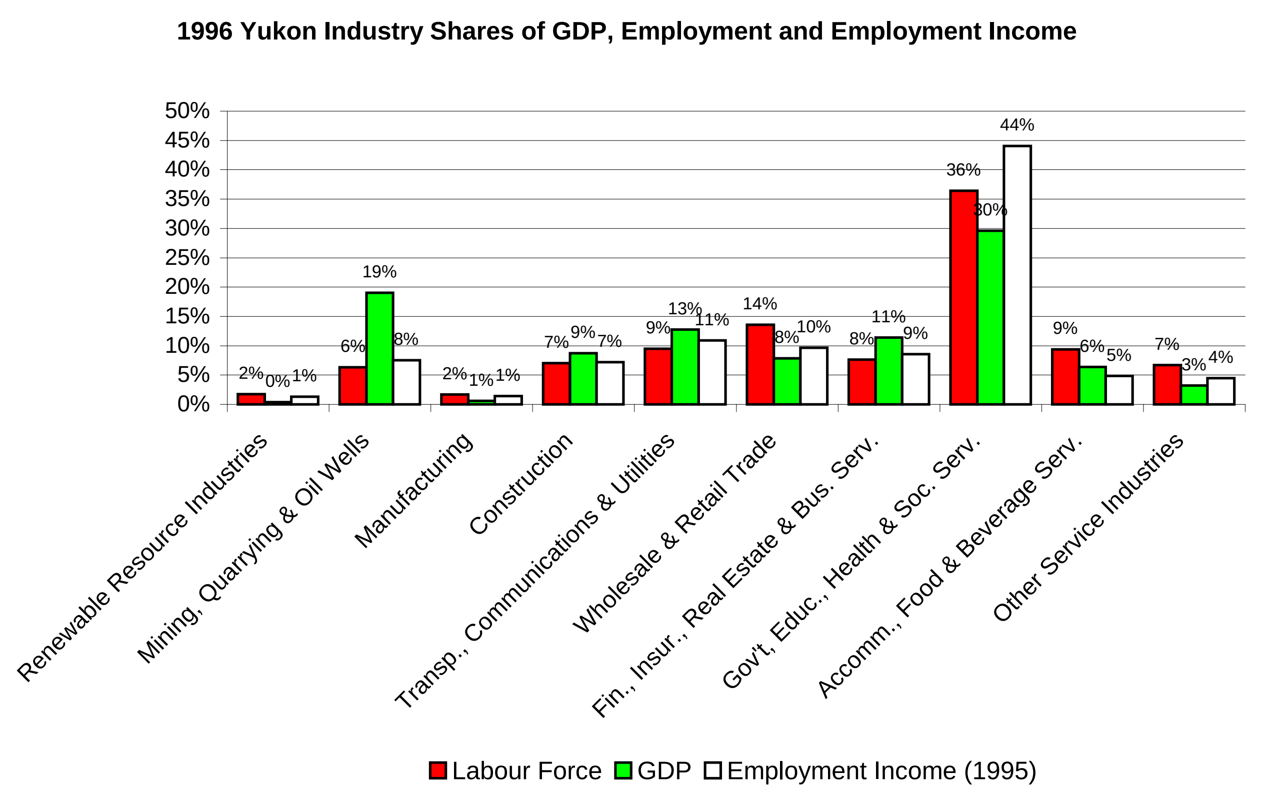
8.9.3.2 Mitigation

1) A gentler slope could be constructed at traditional access points along the road corridor to maintain present access points for the concession holder. In addition, strategically placed pullouts could be constructed to minimize traffic conflicts with a parked trapper vehicle.
2) The displacement of traditional trap set locations may result in a decreased catch, until new trap set locations are determined. As this project is a Yukon Government sponsored project, it falls under the Yukon Government's "Trapper Compensation Program". Mitigation should be determined through this Program.

8.10 OVERALL IMPACT ON YUKON ECONOMY

8.10.1 Baseline Information

Total Gross Domestic Product (GDP) of the Yukon amounts to about $1 billion in 1992 dollars and total employment was 14,900 in August 1999. The Yukon is currently in the midst of a downturn. The primary economic generators for the Yukon are government, mining and, tourism. The following chart presents the employment and GDP structure of the Yukon economy in 1996, the last year for which employment by industry data was available. It is important to note that this style of presentation of economic data ignores the critical dependency linkage between the service sectors and the primary economic generators, such as government, mining, and tourism. Note that employment income is presented as wages and salaries and does not include income from self employment. (Source: Labour Force & Employment Income Estimate–Statistics Canada, 1996 Census, GDP–Yukon Bureau of Statistics)


1996 Yukon Industry Shares of GDP, Employment and Employment Income

8.10.2 Construction Phase

8.10.2.1 Impacts

The largest single socio-economic impact of the Shakwak Highway Project is the positive economic injection into the region.

The construction of this portion of the Shakwak Project is likely to have a significant positive impact on the Yukon economy. The project will directly inject over $110,000,000 in the Yukon economy. Even when spread over a number of years, this will still have a measurable effect on GDP, employment, labour income, and will help offset the slow-down in other sectors. Assuming the dollars for the Shakwak Project are spent evenly over five years, it will result in a direct increase of $22,000,000 per year to the Yukon's GDP. This amounts to more than 2% of total Yukon GDP and does not take into account indirect impacts.

The average annual impacts on the Yukon economy, resulting from this portion of the Shakwak Project, are presented in Table 8-4. The impacts are estimated on the assumption that the construction is spread over 5 years. The multipliers used to arrive at these figures come from the 1991 Statistics Canada Input-Output model of the Yukon Economy, which produces the latest available source of information.

It is also anticipated that the project will result in a positive impact to the engineering construction sector.

Table 8-4 Average Annual Impacts on the Yukon Economy from Shakwak Project

AVERAGE ANNUAL IMPACTS	Direct impact	Total impact (Direct, indirect and induced)	Percent increase to the Yukon economy created by project
GDP	$ 22,150,640	$ 26,795,186	2.4%
Employment (person years)	234	279	n/a
Labour Income	7,466,316	8,843,926	1.3%

8.10.2.2 Mitigation

It is anticipated that the overall impacts to the Yukon economy will be positive in nature, and no additional mitigation is suggested here.

8.10.3 Operations Phase

8.10.3.1 Impacts

The road reconstruction will only have a minimal impact on the Yukon economy in the post construction phase.

It is anticipated that the costs of maintaining the road will remain the same. An increase in snow clearing costs resulting from a wider road will be offset by reduced maintenance costs resulting from a higher quality road.

Higher road quality may lead to increased traffic, as freight from the continental U.S.A. to Alaska is re-routed from marine to road transportation. This would result in increased road tax and fuel tax revenues for the Yukon Government.

The project will benefit the highway users by reducing travel time and cost, and by increasing highway safety. It will also benefit the small number of residents living on the Alaska Highway north of Haines Junction (Destruction Bay, Burwash Landing, and Beaver Creek). It is projected that in the long term, residents and communities of the region will experience positive impacts resulting from highway reconstruction.

8.10.3.2 Mitigation

No mitigation measures required other than those specified in the sections above.

8.11 UMBRELLA FINAL AGREEMENT, AND THE CHAMPAGNE AISHIHIK FIRST NATION FINAL AGREEMENT

The Umbrella Final Agreement (UFA) and the Champagne Aishihik First Nation Final Agreement (CAFN-FA) were signed on May 29, 1993. The Kluane First Nation (KFN) has not yet reached a final agreement with the other levels of government; however, interim land selections have been made.

The UFA and the CAFN-FA provide the framework for the development of direct First Nation involvement in the management of renewable and non-renewable resources, as well as the assessment of project impacts including socio-economic impacts. The Yukon Surface Rights Board, the Yukon Territory Water Board, local Renewable Resource Councils, the Fish and Wildlife Management Board, and the Development Assessment Process are UFA Boards and processes designed to ensure First Nation participation in the resource management and decision making processes.

It is expected that the various provisions of these agreements will enhance the benefits flowing from the Shakwak Highway Project to First Nations. Increased employment and contracting possibilities resulting from construction and operations and maintenance of the highway will be welcomed in the region.

Some more specific provisions pertinent to the Shakwak Highway Project are as follows:

- The UFA and the CAFN-FA set out provisions regarding the contract tendering process in Section 22.5. This section ensures that First Nations are included in Yukon Government tendering processes through notification (22.5.1), and advisement on the tendering process (22.5.8).

  Subsection 22.5.10 of the UFA and CAFN-FA requires the Yukon Government make best efforts to structure contracts so that they are of a size manageable by small businesses.

- The UFA and the CAFN-FA in section 18.2 lays out the procedures for the development of quarries on First Nation land after a final agreement has been signed. This section lays out the requirements for compensation to be determined between the Yukon Government and the affected First Nation.
- Yukon Surface Rights Board: Chapter 8 of the UFA and CAFN-FA outlines the roles, responsibilities and composition of the Board. One-half the members of the Board are to be nominated by the Council for Yukon First Nations (CYFN). Section 8.2.0 outlines the jurisdiction of the Board.
- Yukon Territory Water Board: Chapter 14 of the UFA and CAFN-FA outlines the roles responsibilities and composition of the Board. One-third of the members of the Board are nominated by the CYFN.
- Local Renewable Resource Councils (RRC) and the Fish and Wildlife Management Board (FWMB) are discussed in Chapter 16 of the UFA and CAFN-FA. Section 16.6 outlines the composition, and the powers and responsibilities of local RRC's. Section 16.7 outlines the composition, and the powers and responsibilities of the FWMB.
- Development Assessment Process: Chapter 12 of the UFA and CAFN-FA outlines the scope (section 12.4) of assessments, and outlines a framework for the creation of the Development Assessment Process (DAP). The DAP is designed to include the assessment of socio-economic impacts, and the recommendation of mitigative measures. The DAP has not been proclaimed at the time of this writing. The assessment and mitigation of socio-economic impacts is not directly accommodated by the current project assessment regime. Mitigative socio-economic impact agreements may be reached outside of the current project assessment process.

9.0 MITIGATION STRATEGY

9.1 BACKGROUND

This section presents an overall mitigation strategy for the environmental assessment update for reconstruction and operation and maintenance of the Shakwak Highway between km 1664.5 and 1788.5. The intent of this section is to recognize the potential environmental impacts identified by each discipline specific study and integrate the mitigation options into an overall mitigation strategy for the project study area.

Various potential impacts to environmental resources have been identified within each discipline specific study and mitigation measures or options have been recommended to address these impacts. The reader is referred to the following discipline specific study sections for a detailed description and analysis of potential impacts and mitigation measures:

• Archaeological and Traditional Use	Section 2
• Current Land Use	Section 3
• Wildlife and Waterfowl	Section 4
• Hydrology	Section 5
• Vegetation	Section 6
• Aesthetics	Section 7
• Socio-economic	Section 8

The overall study area mitigation strategy has been divided into two major components. These components include general mitigation guidelines that provide mitigation measures that apply to all segments of the highway and prominent features mitigation strategies that apply to unique or vulnerable areas along the highway.

9.2 GENERAL MITIGATION GUIDELINES

Table 9-1 summarizes the various environmental resources that require mitigation along the highway corridor. These highway sections or areas have been specifically identified and summarized from the discipline specific studies. This table identifies the particular highway segment, the potential resource concern and mitigation options. Current land use concerns are not summarized on the table as mitigation is generally related to access maintenance requirements. Similarly, socio-economic concerns are not addressed directly in the table.

General guidelines that are applicable to all highway construction segments are provided in Section 9.2.1.

9.2.1 General Guidelines

As noted earlier, there are potential environmental impacts to environmental resources as a result of the construction, operation and maintenance of the highway realignment. These may include, but are not limited to, disturbances of heritage resources, and current land use access points, soil and water contamination, habitat destruction and wildlife disturbance, and/or the accumulation of refuse and other waste by-products of highway reconstruction.

General guidelines for the mitigation of these impacts are described below. These mitigation guidelines have been extracted from the discipline specific studies and typical highway/roadway development contract documents (YTG, 1999, and City of Whitehorse, 1997).

Many of the general construction and operational & maintenance mitigation measures listed below have already been undertaken by Yukon Government, Community & Transportation Services and the contractor as part of their standard reconstruction practices. These standard practices are now generally contained as regulatory conditions for reconstruction works.

The general guidelines and standard operating procedures listed below are considered to provide acceptable mitigation measures for many of the potential impacts identified as a result of reconstruction works. Site-specific mitigation strategies for particular areas of concern are presented in the prominent features mitigation section.

Construction Mitigation Measures

Environmental Management

Yukon Government, Community & Transportation Services, has an Environmental Coordinator position for the Shakwak Highway Reconstruction Project. This initiative is consistent with the recommendation of the Shakwak Panel Report. Many of the environmental management activities are undertaken by this position, and as such, engineering staff and contractors are made aware of environmental issues and concerns. The work and programs carried out by Yukon Government, Community & Transportation Services, in this regard should continue as an integral component of strategic environmental management for highway reconstruction.

Instream or Watercourse Works

- Material placement to ensure fish habitat, wildlife, and general ecosystem values are preserved near watercourses;
- Maintain natural drainage course near wetlands, floodplains, and watercourse crossings;
- Minimize off highway traffic in sensitive areas near wetlands, floodplains, and stream crossings;
- Instream construction activities to occur during least critical fisheries periods;
- Instream fill materials, including culverts or other water bypass structures should be specified and placement requirements outlined;
- Sedimentation release into any watercourse due to reconstruction activities should be controlled. Sediment control methods should be specified and undertaken in accordance with permit and license conditions;
- Implement appropriate erosion control to minimize sediment runoff to watercourses;
- Maintenance and storage of equipment or hazardous wastes to be located 30 meters away from the water’s edge;
- Refueling locations and activities are located outside the wetted perimeter of watercourses and preferably 30 m distance;
- Ensure that hazardous or toxic material spill response plan, procedures and equipment are in place;
- Fish salvage by electro-fishing or netting and removal of fish should be conducted where fisheries resources are present within an instream construction zone;

- The Department of Fisheries and Oceans (DFO) should review watercourse crossing designs where fisheries resources are identified, and YTG should ensure coordination and liaison with DFO and other regulatory agencies.

Stream Crossing Designs

- Design watercourse conveyance structures conservatively for 100-year flow event, plus allowance for standard error;
- Ensure proper foundation preparation in stream beds to minimize settlements.

Areas of Construction, Operation and/or Maintenance

- Work areas should be maintained in a tidy condition and free from the accumulation of waste material and debris;
- pedestrian and other traffic on any public or private road or waterway should not be unduly impeded, interrupted or endangered by the performance or existence of the work or plant;
- the location of any services, both above and below the ground, should be confirmed prior to commencement of the work;
- fire hazards in the work area are eliminated; any fire is promptly extinguished.

Land Use Regulations

- A plan should be developed which details disposal of used oils, and containment and treatment plan for contaminated soils;
- Routine servicing of equipment should occur in identified service area. Service area should be lined with impermeable liner and covered with soil to prevent damage to liner. Service area to be developed so as to prevent runoff from carrying contaminants off the lined area. All soil contained within liner to be removed and treated as contaminated soil at completion of work;
- Contaminated soils to be removed in manner to minimize soil to be treated while removing all contaminated soil.

Construction Camp

- Use existing disturbed areas for construction camps to minimize additional site disturbances;
- Locate camps away from environmental sensitive areas;
- Maintain camps in neat and tidy condition;
- A Plan should be developed which details handling of solid wastes and septage;
- Camp and service areas should be cleaned up and reclaimed.

Clearing

- Use existing disturbed areas for waste spoil piles;
- Protect trees, shrubs, plants and other features that will remain after construction;
- Take necessary precautions to prevent fires from spreading;
- Hand clear areas within 10 m of ordinary high water mark of streams;
- Ensure that any rare plants are identified and mitigation employed.

Borrow Sources

- *Maintain minimum (>30m) tree screens between the highway right-of-way and the borrow source or quarry;
- Incorporation of only one access/haul road into each borrow source and quarry site;
- *Employ curvilinear characteristics in haul road design to provide further screen between the traveling public and the borrow sources or quarry, and to dissuade curious tourists from using area;
- Develop, where possible, excavations of no greater than 5m in height, with slopes not steeper than 2H:1V;
- *Stockpile stripped organic soils and waste for later distribution, contouring and (if required) seeding operations, as part of a reclamation program;
- Development of borrow sources or quarries in a progressive, as-found basis. Where limits cannot be absolutely determined prior to initial development, clear and strip in stages, so as to avoid over-clearing and over-stripping;

- *Developing borrow sources or quarry plan(s) that avoid water table, where possible and where desirable;
- *Where the water table cannot or should not be avoided (such as where wetlands are to be created), consult with other beneficiaries/parties and interest groups for optimum end use;
- Employ adequate soils testing to properly delineate stripping/quarry horizons and quantities, and to properly design an efficient and aesthetically pleasing finished quarry;
- Avoid, where reasonable, borrow sources or quarry locations on hillsides that can be seen from the new highway alignment. Where unavoidable, exercise additional and accelerated reclamation measures as aesthetic compensation;
- Avoid, where reasonable, borrow sources or quarry locations that conflict with other identified significant occurrences such as wildlife utilization areas or archaeological or traditional use sites.

**Guidelines may not apply directly to instream borrow pits*

Archaeological and Traditional Use

- Ensure contractors are aware of sensitive sites, use hand clearing in sensitive areas;
- Ensure contractors are informed of legislation protecting heritage sites and resources.
- No disturbance of sites or removal of artifacts/bones from sites permitted. Heritage Branch should be informed immediately in the event of an accidental discovery of a heritage site;
- Avoid sensitive sites or undertake additional mitigation as necessary including site excavation or removal.

Wildlife

- Continue use of Yukon Government (YTG) Conservation Officer during contractor education briefing on bear management and solid waste control;
- Continue YTG Fish and Wildlife management of wildlife hunting restrictions and possible “No hunting” Corridors;
- Identify sensitive habitats near road corridor and redirect development away from area;
- Identify raptor and waterbird critical sites and ensure construction timing to avoid impacts;
- Maintain raptor nesting sites confidentiality;

- Avoid cutting down nesting trees;
- Ensure timing restrictions are known and adhered to in sensitive wildlife habitats;
- Erect attractive and reflective wildlife warning sign near identified wildlife crossing or use areas;
- Consider speed reductions at wildlife crossing areas during key migration periods.

Socio-economic

- Local hire policies wherever possible, especially with First Nations;
- Continue to use Environmental Coordinator as community liaison person;
- Ensure that local manpower requirements are posted with local employment offices;
- Ensure continued access to local businesses along the highway.

Operations and Maintenance Mitigation Measures

Water Course Crossings

- Drainage courses should be routinely inspected for obstructions, especially for fish bearing streams;
- Watercourses with significant sediment loads should be routinely inspected for material buildup and/or blockage, especially following peak flood flow events. Channel excavations may be required upstream and downstream of highway crossings;
- Watercourse crossings with the potential for channel avulsions should be routinely inspected to ensure diversion and watercourse training structures are functioning and emergency overflows are not obstructed.

Road Access

- Road accesses are identified and maintained and not obstructed during road maintenance activity;
- Proper signage indicating major intersections.

Wildlife

- Important wildlife crossing areas should be signed to indicate wildlife crossing zone along the highway, particularly for Kluane caribou crossing areas;
- Continue to minimize the use of road salts or use alternative salts (calcium chloride) in areas of wildlife movement;
- Clear highway right-of-way of excess vegetation to distract animal forage and use.

9.3 PROMINENT FEATURES MITIGATION STRATEGIES

During the study, a number of important ecological areas were identified as being sensitive or vulnerable to highway reconstruction activities and operations and maintenance. The approach taken to addressing these areas was to identify them as prominent features and develop an overall mitigation strategy that would accommodate the various study issues, while still enabling highway reconstruction works.

Prominent feature locations include Silver Creek (km 1694), Slims River Delta (km 1702 – 1706), Sheep Mountain area (km 1706 – 1716), Duke Meadows (km 1767), Destruction Bay (km 1743 – 1745) and the Sakiw Creek area (km 1780 – 1790).

Table 9-2 summarizes the prominent feature locations, the identified discipline specific studies issues and mitigation measures or options that would address potential impacts. Several mitigation measures options are presented to address particular environmental concerns, depending on the highway alignment option or reconstruction method selected. This is particularly important for the Slims River Delta/Sheep Mountain area where highway alignment options are significant.

Because of the uniqueness and ecological importance of this area, Yukon Government, Community & Transportation Services should consider including an Environmental Monitor as part of the on-site inspection staff, in addition to the Engineer’s Resident Inspector for this area. The Environmental Monitor may form part of the Engineer’s staff and work in conjunction with, and under the direction of, the Engineer’s Resident Inspector but should also act independently with regard to monitoring and inspecting all in-stream and wildlife related work undertaken during reconstruction. Liaison with Kluane National Park staff, First Nations, and compliance with regulatory agreements, permits and licenses would be ensured for this important , ecologically sensitive area.

The reader is referenced to the individual study sections for a complete discussion of the potential environmental impacts and the mitigation measures or options.

Table 9-1 Mitigation Guidelines Various Highway Segments

Highway Segment	Potential Resource Concerns	Mitigation
Jarvis River to Silver Creek (km 1664.5 – km 1693.2)		
Km 1664.5 Jarvis River	• Grizzly bear movement area. • Waterbird habitat. • Traditional trail crossing. • Aesthetic viewpoint. • Moose movement.	• No camps or staging areas & manage solid waste. • Minimize riparian disturbance and revegetate. • Note trail crossing. • Consider limited expanding of existing pullout area • No camps or staging areas & manage solid waste.
Km 1666 + 600	HR 7 – Historic site – Isaac Moose cabin.	Near ROW, avoid impact to site
Km 1670 Sulphur Lake	• Raptor nesting within buffer zone. • Waterbird habitat in Sulphur Lake. • Aesthetically vulnerable during construction.	• Avoid construction May 1 – May 31. • Summer construction. Avoid construction camps or staging in area. • Avoid construction camps or staging in area. Create viewpoint after construction.
Km 1684 + 200	Site HR12 Archaeological site within ROW.	Hand clear area, if impacted, excavate & salvage site.
Km 1686 + 300 Christmas Creek	Christmas Creek • Fish habitat. • Tradition use access. • Culvert capacity, erosion protection, foundation conditions. • Riparian habitat. • Viewpoint/pullout.	• Provide fisheries passage, adequate culvert and erosion control. • Stream sediment controls and bank revegetation. • Provide TAC #1 access to traditional fishing area. To limit use to local access • Stream foundation treatments and provision for stilling pool. • Consider aesthetic viewpoint pullout before creek, to limit tourist access near creek.
Km 1688 + 000	Aesthetic point.	Interpretative signage
Km 1691 + 000	Kluane Lake viewpoint (existing) aesthetics.	Ensure access and pullout development. Upgrade roadside facilities.
Silver Creek (km 1692 + 500)	Prominent Feature. Historic/archaeological/traditional use, current land use, wildlife, hydrology, vegetation, and aesthetics.	Prominent Feature Mitigation. See Table 9-2.
Silver Creek to Williscroft Creek (km 1694 – km 1715.9)		
Km 1697 + 200	Aesthetic viewpoint/lake access.	Consider aesthetic tourist viewpoint pullout to Sheep Mountain; provide public lake access
Slims River Delta (km 1701 to 1704)	Prominent Feature. Land use, wildlife/waterbird, hydrology, fisheries, vegetation, aesthetics, and socio-economic concerns.	Prominent Feature Mitigation, See Table 9-2.
Sheep Mountain (km 1704 – 1713)	Prominent Feature. Historic, current land use, wildlife, hydrology, vegetation and aesthetic concerns.	Prominent Feature Mitigation, See Table 9-2
Km 1708 + 300	Bayshore Motel, current land use, aesthetic – lake view.	Provide business access, scenic route options, maintain lake view
Km 1712 + 500 Williscroft Creek	Williscroft Creek – channel avulsions, culvert blockage, and erosion/abrasion.	Monitor channel avulsions, culvert blockage, and erosion/abrasion. Reinforce training dykes and inlet alignment. Monitoring and on-going maintenance.
Willscroft Creek to Duke River (km 1715.9 – 1768.5)		
Km 1713 + 100	Cottonwood Campground, aesthetic lake view.	Provide business access, ensure scenic view of lake.
Km 1716 + 100	HR 26 – Survey marker.	Relocate survey marker
Km 1720 + 400 Congdon Creek	• Channel avulsions, bank and highway failure, sediment release and deposition. • Raptor nesting within corridor buffer, YTG campground areas. • Hiking trail access.	• Training works upstream, install additional culverts. Highway bank riprap protection, sediment control, and routine channel maintenance. • Avoid construction May 1 to May 31 or begin activities before May 1 for raptors. Maintain Campground access. • Maintain hiking trail access.
Km 1723 + 400 Goose Bay	HR27 Archaeological site within ROW; aesthetic viewpoint.	Site clearing acceptable, if not avoided, excavate and salvage. Consider scenic route option.
Km 1727	Grizzly bear forage area	Minimize camp area and avoid granular extraction.
Km 1730 + 200 Nines Creek	Nines Creek • Diversion failure, channel avulsions, sediment release, and approach angle. • Grizzly bear forage area. • Raptor nesting area.	• Diversion reinforcement and channel maintenance, upstream guidebank protection. • Minimize camp area and avoid granular extraction. • Avoid construction May 1 to May 31 or begin activities before May 1 for raptors. Avoid as borrow source due to resource conflicts.
Km 1732 + 000 Mines Creek	Mines Creek • Culvert blockage, channel avulsions, diversion failure and sediment release. • Aesthetics of push-up piles.	• Maintenance of channel diversions. Upstream guidebank protection. On-going channel maintenance. Control sediment release during low flows. • Grading of borrow piles. Maximize use of borrow material within stream channel area.
Km 1734 + 600 Bock's Brook	Bock's Brook – channel avulsions and highway impact, culvert blockage, sediment deposition, sediment release.	Channel training works, additional emergency overflow culverts, highway overflow areas, embankment amour, routine channel maintenance. Maximize borrow use, schedule borrow excavation during low flow and provide sediment control.

Highway Segment	Potential Resource Concerns	Mitigation
Km 1749 + 500 Lewis Creek	Lewis Creek – channel avulsions impacting highway, sediment deposition, culvert blockage, sediment release.	Reinforce training dyke and diversion. Install additional culverts or highway emergency overflow areas. Maximize use of borrow upstream, downstream KFN concerns. Confine borrow area to stream channel. Carry out regular channel maintenance and excavation. Schedule borrow development for low flow and sediment control.
Km 1754 + 000Copper Joe Creek	Copper Joe Creek • Channel avulsions impacting highway, culvert and debris blockage, sediment release • Sharp tail grouse lekking.	• Reinforce diversion and banks, install larger culverts, emergency overflows at highway, borrow material upstream of highway, install log deflectors, carry out regular channel maintenance, schedule borrow development low flow, and sediment control. • Avoid lekking site if found. Consider constructing lekking mound in old right of way.
Km 1754 + 800	HR39 – Grave Marker – plane crash.	Consider interpretive story.
Km 1759 + 500 – Burwash Landing	Burwash Landing – aesthetics value.	Maintain access to aesthetic features.
Km 1768 + 000 Duke River	Duke River – east bank erosion and potential channel avulsions impacting highway, local bridge pier erosion.	Erosion protection east guide bank, extend guide bank upstream with protection, monitor on-going erosion upstream, inspect central bridge pier, survey bridge for settlement.
Duke River to Quill Creek (km 1768.5 to 1788.5)		
Duke River Meadows (km 1768-1770)	Prominent Feature. Traditional use, current land use, wildlife, hydrology, vegetation, and aesthetics.	Prominent Feature Mitigation. See Table 9-2.
Km 1771 + 600	HR43 Historic Alaska Highway bridge remain, near borrow & field camp.	Ensure feature not impacted by borrow or camp activities. Consider interpretative potential.
Km 1774	Possible sharp tail grouse lekking area.	Advise of possible lekking area. If lekks found, avoid area. Consider constructing lekking mound in old right of way.
Km 1775 + 600 Burwash Creek	Burwash Creek • Channel avulsions, sediment deposition, debris blockage, sediment release. • HR44 – Traditional site, downstream of proposed stream borrow source. • Raptor nesting area. • Traditional trail crossing.	• Reinforce confining dykes upstream, extend guidebank upstream, reinforce highway embankment, carry out regular channel inspections, borrow source upstream within channel confines. • Design borrow source and water control measures to not impact site. • Avoid construction May 1 to May 31 or begin activities before May 1. • Consider traditional trail crossing signage.
Km 1784 + 500	Kluane River overlook (existing aesthetic).	Maintain and upgrade access to aesthetic feature. Improve public facilities.
Km 1778 + 200	HR46 – Traditional site – Jacquot camp.	Avoid impact to camp.
Km 1780 + 100	HR48 - Archaeological site near borrow area, traditional use.	Site clearing acceptable, if not avoided excavate and salvage. Discuss development with KFN.
Km 1780 + 400	HR49 – Traditional use area – concern with impact to traditional area.	Prior to development, discuss with KFN to address impacts.
Km 1783 + 500	HR51 - Archaeological site near borrow area.	Do not disturb site.
Km 1783 + 800	HR56 – Archaeological site.	Avoid or mitigate.
Kluane Caribou Crossing Areas (Km 1780 – 1790)	Prominent Feature – see Table 9-2.	Prominent Feature Mitigation.
Km 1783 + 500 Sakiw Creek	Sakiw Creek • Wetlands impact, channel foundations. • Fisheries resources, sediment release.	• Minimize construction disturbance. • Provide fish passage, provide erosion control on streambanks, sediment control and revegetation.
Km 1786.5 Quill Creek	Traditional trail crossing.	Note crossing area; discuss with KFN.

Table 9-2 Prominent Features - Potential Impacts and Mitigation Measures/Options

Prominent Feature	Archaeology	Traditional Land Use	Current Land Use	Wildlife & Waterfowl	Hydrology	Vegetation & Revegetation	Aesthetics	Socio- Economic
Silver Creek Issues (km 1694)	downstream Silver City historic site (Northwest Mounted Police site); possible old fish camp; graves on hillside	traplines; fishing; creek movement	potential loss of residential areas (Arctic Institute); road; airstrips; traplines, Local access.	raptors nesting; grizzly habitat	ongoing creek movement, diversion failure; loss of culvert capacity; guide bank failure; erosion & sediment deposition; channel & culvert maintenance	*Dryas drummondii* plant community on alluvium is valued by local residents; possible borrow impact	aesthetic vulnerable area; flowers - visual aspect; gravel push piles	channel movement affects airstrip; Arctic Institute; historical site
Silver Creek Mitigation	keep channel in place; long term maintenance; sediment traps and stream borrow development not to impact site	minimize disturbance	confine creek channel; annual maintenance of channel. Provide local access.	no camps; avoid garbage areas; avoid construction Feb. 15 - April 30 for raptors	on-going channel maintenance; erosion protection; schedule borrow at low flow; sediment control; use borrow up & downstream for road fill, spread out over wide area; split/shift channel periodically	minimize use or disturbance of roadside	provide pull-out(s), interpretive signage explaining berms; improve berm appearance	annual channel maintenance
Slims River Delta Issues (km 1702 - 1706)		traditional fishing	bottleneck at bridge; trails access; Parks Canada Interpretive Center; Kluane First Nation new facility	deer; peregrine site within delta; waterfowl; falcon nests south of delta; spring & fall tern colony	delta build-up downstream; fisheries/waterfowl issues in isolated areas of lake; major geotechnical issues; channel treatments; erosion control	several delta plant species are rare Yukon endemics	aesthetic vulnerable area; public facility; north bound drivers' eyes drawn upwards	safety issues at bridge; access to interpretive center; recreational shoreline access loss
Slims River Delta Mitigation		provide access to fisheries resources	retain local access to trails facilities	retain existing alignment or use causeway to avoid wildlife; avoid spring construction; culverts to keep water in areas isolated by causeway	use causeway (subject to geotechnical study); build divided highway & twin bridge, or directional traffic control	retain current highway alignment; possible salvage of rare plants; develop revegetation mix from delta plant species	visual disturbance of delta; ensure viewpoint /interpretive /widening opportunity	provide access to Kluane National Park Centre and trails; bridge warning/ causeway signs
Sheep Mountain Issues (km 1706 - km 1716)		Fisher cabin	Soldier Summit; Kluane Park use; Boat Launch; historic road segment	raptor nest sites; two sheep licks (one on south side is man-made); traffic concern; natural lick needs protection; wildlife/traffic conflicts; moose calving area	Kluane Lake infill; road stability (geotechnical and erosion); siltation during construction; fisheries resources	rare plant species habitat on lower slopes of Sheep Mountain	aesthetic vulnerable area; Soldier Summit access; Kluane Lake viewpoint; poor mix of road users; interpretive opportunity	lack of facility/trail signage
Sheep Mountain Mitigation		avoid historic site	provide proper safe access to trails/facility; heritage route highway options; slight upgrade to road	avoid natural licks; excavate & reclaim site where man-made lick is; put rocks or fences on side of road to deter wildlife from standing on highway; minimize construction impact; reconstruction limitation between Sept. 15 - June 15; no camps or storage areas; consider causeway option	minimize lake encroachments; stable roadbed with rockfill and riprap; sediment control during construction; erosion control; competent clean materials; no camp or staging areas	avoid rerouting highway northwest of current alignment; possible salvage of rare plants	profile access to viewpoint; separate user types; ensure safe access; tourist/traffic areas; minimize road disturbance 1. Heritage highway 2. Scenery routes	provide signage
Duke Meadows Issues (km 1767 - 1769)		KFN Hunting/ gathering areas; traditional trail crossing; KFN concerned with borrow in area	KFN, minimize tourist use	excessive hunting concerns; raptor nesting, sharp tailed grouse, lekking area	bridge stability; channel stability	potential rare plant species habitat on meadows	aesthetic vulnerable area; viewpoint for wildlife; limited access; unsafe stopping	
Duke Meadows Mitigation		restrict tourist access; avoid borrow sources in area	use private residential access TAC; limit tourist use to foot access	Hunting regulations; avoid reconstruction May 1-31 or begin before May 1 (raptors); do not establish camps in area.	maintain bridge erosion protection (pier, abutments); channel maintenance for upsteam guide banks	stick to current highway alignment; avoid off-highway traffic during construction	no camps/staging; possible viewpoint/interpretive area, or possible widening; conflicts with CFN Usage	
Destruction Bay Issues (km 1743 - 1745)	historic interpretative signage		proper business access both during construction and after; speed traffic	no specific issue	Bocks Brook channel stability; impact to village	no specific issue	Historic milepost signage;lack of Service Roads; Unsafe access points; Low profile desirable	business access; customer loss; pilot car business aviation; community impacts
Destruction Bay Mitigation	maintain access to interpretive signage		speed riffles entrance into town; trail access; maintain access during construction		maintain channel guide banks and training works		maintain signage; maintain status quo (service roads, access intersections, low profile) due to local pressures and economic factors	maintain access during and post construction; community meeting
Kluane Caribou Crossing Area Issue (Sakiw Creek area) (km 1780 - km 1790)		traditional hunting, gathering area	vehicle wildlife conflicts; access; hunting	avoidance by caribou herd; attraction to road by vegetation or road salt; traffic related mortality	stream crossing; erosion protection; fisheries resources	potential for revegetation to attract caribou (see wildlife)	possible wildlife viewing	
Kluane Caribou Crossing Area Mitigation (Sakiw Creek area)		avoid borrow field camp and staging in area; no new access locations	proper signage; limited access; hunting regulations	minimize disturbance during construction; avoid borrow and camps development at crossings near km 1780 - 1790; proper animal visual barriers; address salt use; road signage; YTG wildlife management; implement monitoring programs; minimize right-of-way width; consider speed warning signs and wildlife signs during winter; no new access development; use revegetation seed mix that does not attract caribou	fish passage; adequate culvert signing; erosion protection; minimize riparian disturbances	develop revegetation mix (native grasses) that would be unpalatable to caribou (Burwash to Quill Creek) (see wildlife/waterfowl)	wildlife viewing conflicts with Kluane Caribou herd protection	

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Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

VOLUME I – TECHNICAL APPENDICES

February 2000

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Appendix I List of Contacts

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Bruce Bennett	YTG - Fish and Wildlife Branch
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Al Close	YTG – Community & Transportation Services
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Gerald Dickson – Lands	Kluane First Nation
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Dale Eftoda	Ducks Unlimited Canada
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Rick Farnell – Caribou Biologist	YTG - Fish and Wildlife Branch
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Marsha Flumerfelt, Heritage Communicator	Kluane National Park
Marjorie Fraser	DIAND Lands Branch
G. Friese	Kluane National Park
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Beth Hawkings	YTG - Fish and Wildlife Branch
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Appendix II-1 Yukon Archaeological Site Inventory Forms

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Yukon Archaeological Site Inventory Form

Borden Number

Site Name

Reporter Number Stop 51; HR-12

Permit Number 99-3ASR

Contract Number

Project Name Shakwak Highway Archaeological Impact

Jurisdiction Crown

Protection None

Location Located just west of the Alaska Highway on a terrace that skirts small pond that drains into Christmas Creek.

Access Alaska Highway

Vegetation Aspen, small white spruce, kinnikinick, grasses.

Soil Matrix Silt.

Cultural Strata B Horizon 15-25cm thick.

Latitude 61 00 17.4

Longitude 138 12 01.8

UTM

Map Ref. 115 G & F

Air Photo Ref.

Minor Drainage Christmas Creek

Major Drainage Kluane Lake/River

Elevation

Condition slightly disturbed

Environment

Size|Orientation 25x25m

Owner Name

Site Type Class prehistoric

Site Subclass subsurface

Site Type Lithic scatter, core reduction and tool manufacturing. Possible camp.

Features

Dates

Culture

Researcher T.J. Hammer & Ty Heffner

Research Date May 1999

Research Activity Impact Assessment

Informant Name

Collections In situ biface, core frgaments, flakes and endscraper found on surface.

Collection Repository Yukon Heritage Branch

Yukon Archaeological Site Inventory Form

Published References

Unpublished References

Remarks The site has had its top layer removed (humus/ash), however, there are intact cultural deposits in a red B soil horizon. Flakes are evident on the surface of this B. Site appears to be fairly rich, further investigations are warranted.

Ethnographic Area Champagne and Aishihik First Nations

Yukon Archaeological Site Inventory Form

Borden Number		**Site Name**	
Reporter Number	Stop 49; HR-14a	**Permit Number**	99-3ASR
Contract Number		**Project Name**	Shakwak Highway Archaeological Impact
Jurisdiction	Crown		
Protection	None		
Location	Site located on ridge, part of an esker complex, northeast of an active borrow pit on Silver City Access Road.		
Access	Silver City access road.		
Vegetation	Sage, grases, kinnikinick, white spruce and aspen.		
Soil Matrix	silt		
Cultural Strata	Indeterminate, likely an isolated find.		
Latitude	61 01 31.2	**Longitude**	138 19 49.8
UTM		**Map Ref.**	115 F
Air Photo Ref.			
Minor Drainage	Silver Creek	**Major Drainage**	Kluane Lake/River
Elevation			
Condition			
Environment			
Size|Orientation	Isolated find.		
Owner Name			
Site Type Class	prehistoric		
Site Subclass	subsurface		
Site Type	Isolated find.		
Features			
Dates			
Culture			
Researcher	T.J. Hammer & Ty Heffner		
Research Date	May 1999		
Research Activity	Impact assessment.		
Informant Name			
Collections	1 black chert flake.		
Collection Repository	Yukon Heritage Branch		

Yukon Archaeological Site Inventory Form

Published References

Unpublished References

Remarks Isolated find, no further work needed.

Ethnographic Area Champagne and Aishihik First Nations

Yukon Archaeological Site Inventory Form

Borden Number

Site Name

Reporter Number Stop 28; HR-31

Permit Number 99-3ASR

Contract Number

Project Name Shakwak Highway Archaeological Impact

Jurisdiction Crown

Protection None

Location Site located on the north side of highwy on a east-west running terrace skirting Mines Creek, adjacent to an active YTG borrow pit.

Access Dirt road or creek bed.

Vegetation Grasses, kinnikinick, wild rose, white spruce and aspen.

Soil Matrix silt

Cultural Strata B horizon 10-20cm below surface.

Latitude 61 12 51

Longitude 138 42 20.4

UTM

Map Ref. 115 G/2

Air Photo Ref.

Minor Drainage Mines Creek

Major Drainage Kluane Lake/River

Elevation

Condition intact

Environment

Size|Orientation

Owner Name

Site Type Class prehistoric

Site Subclass subsurface

Site Type Lithic scatter.

Features

Dates

Culture

Researcher T.J. Hammer and Ty Heffner

Research Date

Research Activity Impact Assessment

Informant Name

Collections Two jasper flakes

Collection Repository Yukon Heritage Branch

Published References

Unpublished References

Remarks Site is small and may be isolated find. No further work needed at the site.

Ethnographic Area Kluane First Nation

Yukon Archaeological Site Inventory Form

Borden Number

Site Name

Reporter Number Stop 13; HR-48

Permit Number 99-3ASR

Contract Number

Project Name Shakwak Highway Archaeological Impact

Jurisdiction Crown

Protection None

Location Site located on an east -west running terrace, on the east (north) side of the present day Alaska Hwy 4.5km north of the Burwash Creek crossing.

Access Short dirt road ends 100m south of terrace.

Vegetation Open aspen with grasses, kinnikinick, grading into open white spruce.

Soil Matrix Silt.

Cultural Strata 25-50cm below surface in red B horizon.

Latitude 61 28 34.8

Longitude 139 14 25.2

UTM

Map Ref. 115 G/6

Air Photo Ref.

Minor Drainage Old creek bed

Major Drainage Kluane River

Elevation

Condition intact

Environment

Size|Orientation Site appears to run along the terrace (30m x 10).

Owner Name

Site Type Class prehistoric

Site Subclass stratified

Site Type Lithic scatter

Features

Dates

Culture

Researcher T.J. Hammer and Ty Heffner

Research Date May 1999

Research Activity Impact Assessment

Informant Name

Collections ~51 chert flakes from two test pits.

Collection Repository Yukon Heritage Branch

Yukon Archaeological Site Inventory Form

Published References

Unpublished References

Remarks Site warrants further investigation. Also on same ridge are the remains of a recent brush camp, wire drawn nails used as fasteners as well as a Labatts beer bottle.

Ethnographic Area Kluane First Nation

Yukon Archaeological Site Inventory Form

Borden Number		**Site Name**	
Reporter Number	Stop 12; HR-49	**Permit Number**	99-3ASR
Contract Number		**Project Name**	Shakwak Highway Archaeological Impact
Jurisdiction	Crown		
Protection	None		
Location	Located on a prominent southwest facing knoll over looking a small lake, which is part of a larger terrace complex on the east (north) side of the present Alaska Highway approximately 5km (Hwy Kms) north of Burwash Creek crossing.		
Access	150m walk from the present day Alaska Highway.		
Vegetation	Grases, Kinnikinick, wild rose on exposure, white spruce and aspen.		
Soil Matrix	Silt.		
Cultural Strata	15-25cm below surface in red B horizon.		
Latitude	61 28 19.8	**Longitude**	139 14 28.2
UTM		**Map Ref.**	115 G/6
Air Photo Ref.			
Minor Drainage		**Major Drainage**	Kluane River
Elevation			
Condition	intact		
Environment			
Size|Orientation	10x10m estimated.		
Owner Name			
Site Type Class	prehistoric		
Site Subclass	subsurface		
Site Type	Lithic scatter		
Features			
Dates			
Culture			
Researcher	T.J. Hammer, Ty Heffner		
Research Date	May 1999		
Research Activity	Impact Assessment		
Informant Name			
Collections	two flakes		
Collection Repository	Yukon Heritage Branch		

Yukon Archaeological Site Inventory Form

Published References	
Unpublished References	
Remarks	Good view of Kluane range and Valley bottom. Knoll is flat and site is suitable as a hunting lookout. Stratigraph consist of humus layer, ash, 10cm of red B horizon and a yellow C horizon. Only two shovel tests were excavated.
Ethnographic Area	Kluane First Nation

Yukon Archaeological Site Inventory Form

Borden Number

Site Name

Reporter Number Stop 3; HR-51

Permit Number 99-3ASR

Contract Number

Project Name Shakwak Highway Archaeological Impact

Jurisdiction Crown

Protection None

Location Site located 2.5km south of Quill Creek on the east side of the Alaska Highway on the Northwestern border of an old gravel pit, over looking an old creek bed to the north.

Access Dirt road.

Vegetation White spruce grading into black spruce, grasses and moss.

Soil Matrix Mottled loess.

Cultural Strata Recent First Nation camp on surface to top of ash; flakes recovered 10-15cm below ash.

Latitude 61 29 34.8

Longitude 139 16 41.4

UTM

Map Ref. 115G/6

Air Photo Ref.

Minor Drainage

Major Drainage Kluane River

Elevation

Condition slightly disturbed

Environment

Size|Orientation 20x20m, estimated.

Owner Name

Site Type Class First Nation traditional/prehistoric

Site Subclass surface/subsurface

Site Type indeterminate

Features Possible pre-ash hearth.

Dates

Culture

Researcher T.J. Hammer

Research Date May 1999

Research Activity Highway Archaeological Assessment

Informant Name

Collections Obsidian Flake, Obsidian retouched flake.

Collection Repository Yukon Heritage Branch

Yukon Archaeological Site Inventory Form

Published References

Unpublished References

Remarks Traditional occupation is relatively recent. Ash likely represents north lobe of the White River Ash. Further testing is warrented.

Ethnographic Area Kluane First Nation

Yukon Archaeological Site Inventory Form

Borden Number **Site Name**

Reporter Number Stop 6; HR-56 **Permit Number** 99-3ASR

Contract Number **Project Name** Shakwak Highway Archaeological Impact

Jurisdiction Crown

Protection None

Location Located on a southwest facing knoll on the west side of the Alaska Highway over looking an unnamed creek north of Sakiw Creek. Site is approximately 400m west of Alaska Highway. (New km 1783+800).

Access Foot

Vegetation Sage, Kinnikinick, grasses, open white spruce and aspen.

Soil Matrix 0-5cm humus and ash, 8-50cm BS B horizon (silt).

Cultural Strata 0-10cm Late prehistoric hearth (FCR and burnt soil and bone); prehistoric component at 0-10cm below ash.

Latitude 61 29 31.8 **Longitude** 139 17 06.6

UTM **Map Ref.** 115 G/6

Air Photo Ref.

Minor Drainage Old Creek Bed flows into Sakiw **Major Drainage** Kluane River

Elevation

Condition intact

Environment

Size|Orientation Initial testing identified 10x15m area, could be larger.

Owner Name

Site Type Class prehistoric

Site Subclass surface/subsurface

Site Type Late prehistoric and undetermined pre-ash prehistoric.

Features Late prehistoric hearth.

Dates

Culture

Researcher T.J. Hammer

Research Date May 1999

Research Activity Highway realignment assessment

Informant Name

Collections Two subsurface flakes.

Collection Repository Yukon Heritage Branch

Published References

Unpublished References

Remarks Late prehistoric component consists of one hearth with FCR and burnt bone, no flakes identified on surface in association with the hearth. The pre-ash component appears to be small (five test pits excavated). Knoll provides a good view to the south. Further testing is warranted.

Ethnographic Area Kluane First Nation

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Appendix II-2 Selected Archaeological/Traditional Land Use Plates

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Plate 1. HR-1: Old Alaska Highway Jarvis River Bridge pilings.

Plate 2. HR-7: Mr. Isaac Moose's cabin and outbuilding.

Plate 3. HR-12: View of archaeological site No. 12; Stop 5, site located on knoll in background.

Plate 4. HR-12: *In situ* biface recovered from test pit in dark red B horizon; Stop 51.

Plate 5. HR-21: East (Front) and side (north) elevation of post-1940 shed near Horseshoe Bay.

Plate 6. HR-23: Crew excavated test pits at destroyed archaeological site JgVp-2.

Plate 7. HR: 26: tentatively identified survey platform between Williscroft and Congdon Creek, ca. 1940s.

Plate 8. HR-25: Prospector’s (Soup-mix) shed between Congdon Creek and Goose Bay.

Plate 9. HR-25: Side (north) elevation of prospector’s shed.

Plate 10. HR-29: Crew excavating test pits at JgVp-3, Goose Bay.

Plate 11. HR-37: Recent disturbance at Copper Joe Creek where JhVr-3 once existed.

Plate 12. HR-43: Old Alaska Highway Bridge bordering proposed borrow pit and field camp.

Plate 13. HR: 44: Sam Johnson's cabin by Burwash Creek, likely moved from up Quill Creek ca. 1940s.

Plate 14. HR-46: Jaquot Camp cabin front (west) elevation, ca. 1940s.

Plate 15. HR-46: Jaquot Camp horse stall, ca. 1940s.

Plate 16. HR-48: View of Alaska Highway from terrace of new archaeological site No. 48, Stop 13, view to the southwest.

Plate 17. HR-48: Remains of a brush camp on terrace, wire-drawn nail associated with camp, Stop 13.

Plate 18. HR-49: West view from archaeological site, HR-49-Stop 12, in forefront is small pond at foot of knoll.

Plate 19. HR-51: View of recent camp and testing new archaeological site, Stop 3.

Plate 20. HR-56: Steven Reid testing HR-56, Stop 6.

Plate 21. HR-56: Photograph of Late Prehistoric hearth 0-5cm BS at new archaeological site HR-56, Stop 6.

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Appendix II-3 Site Maps

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Prepared by:

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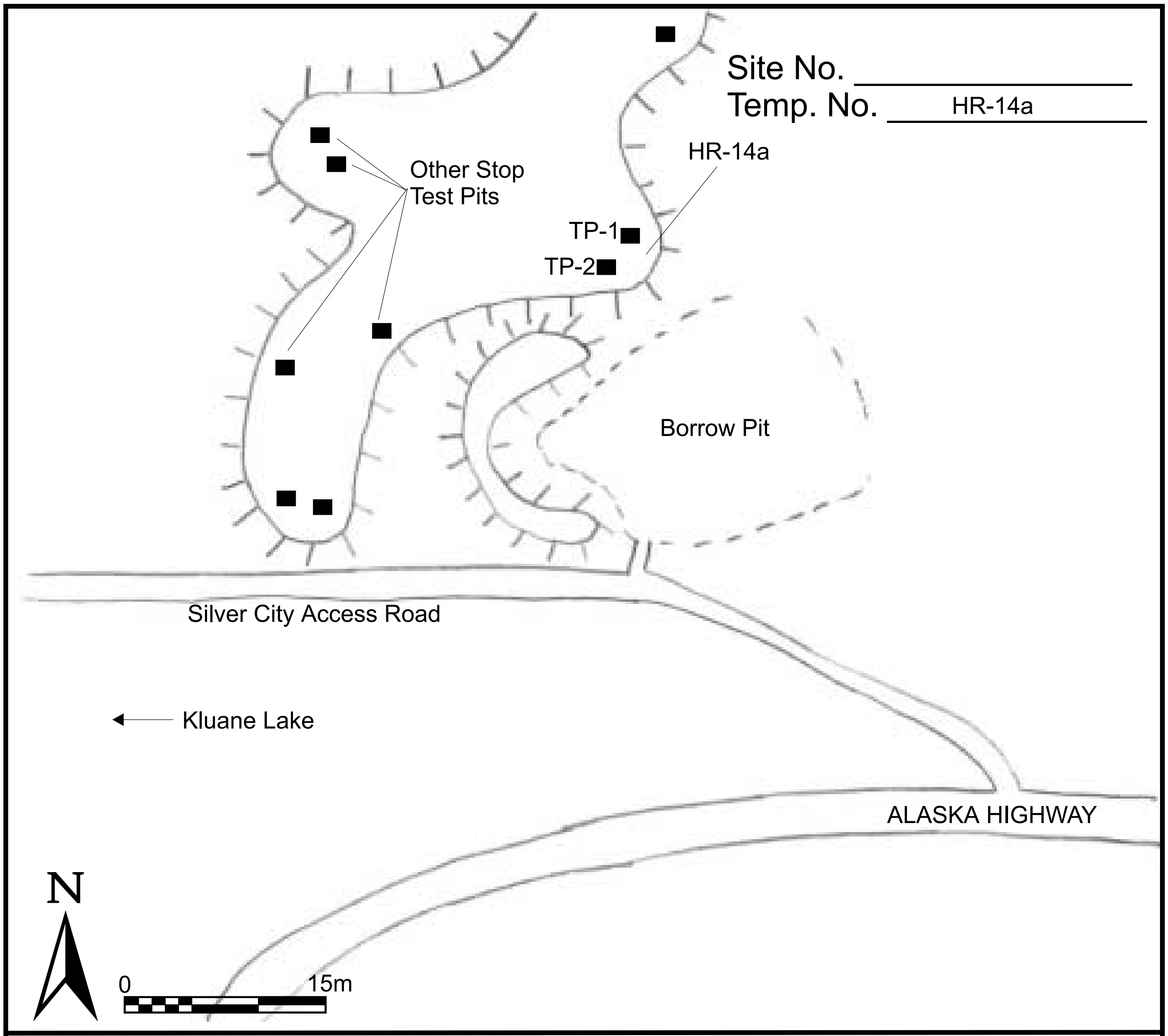
Site No. ________________

Temp. No. HR-14a



EXTENT OF SITE	
BUILDING	■
FOUNDATION	□
ROAD	═════ = =
TRAIL	━ · ━ · ━
FENCE	--X--X--X--X--X--X--X--X--X--X--X
RAILWAY	┼┼┼┼┼┼┼┼
RIVER/CREEK	
STEEP RISE	)))))))

1:250,000 MAP NO. NTS 115 G & F

LATITUDE 61°01'31.2"

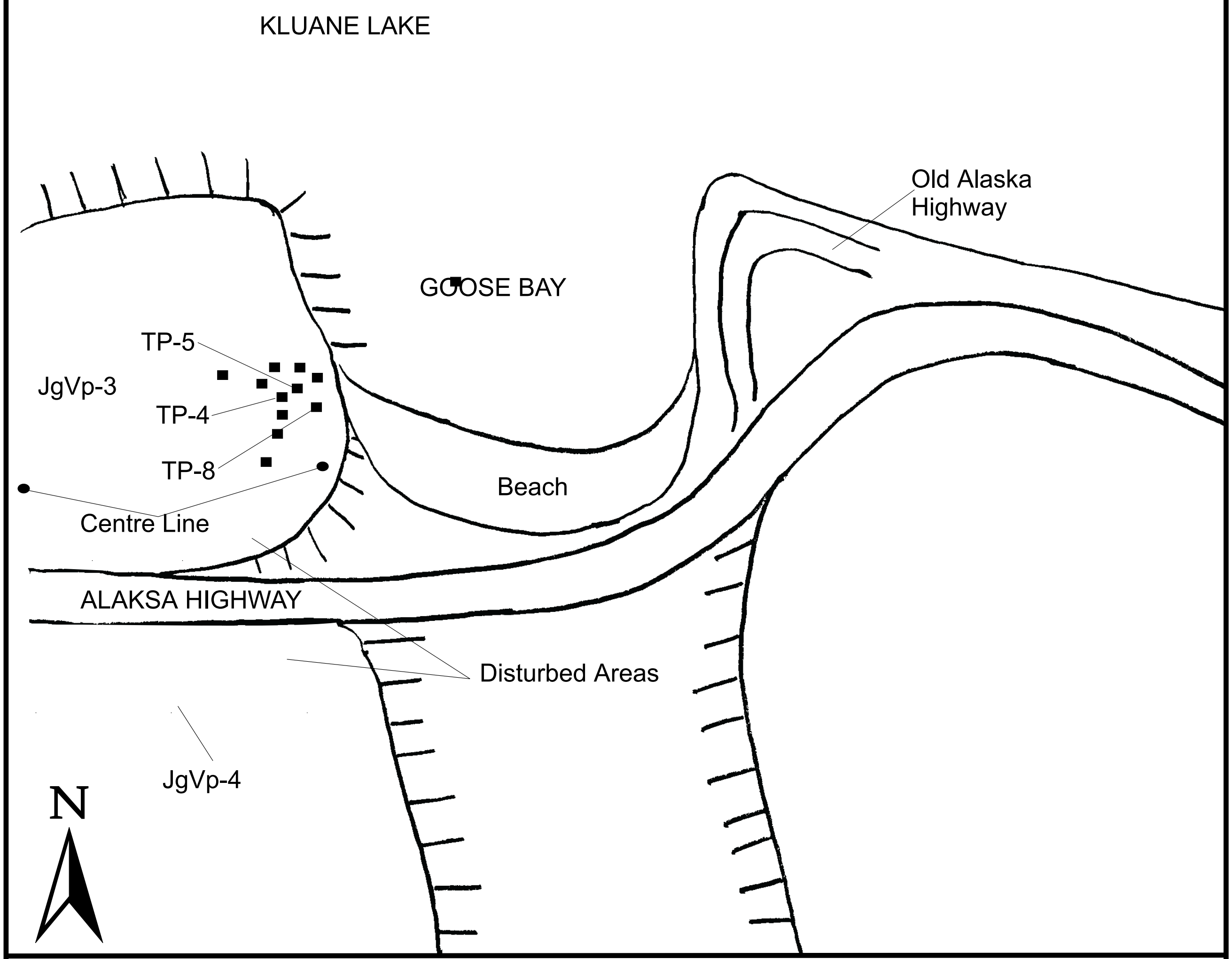
LONGITUDE 138°19'49.8"

NORTH
TRUE [✓ **MAGNETIC**]

DATE 05/30/99

SCALE: 1 CM = 5m

Site No. JgVp-3
Temp. No. HR-27

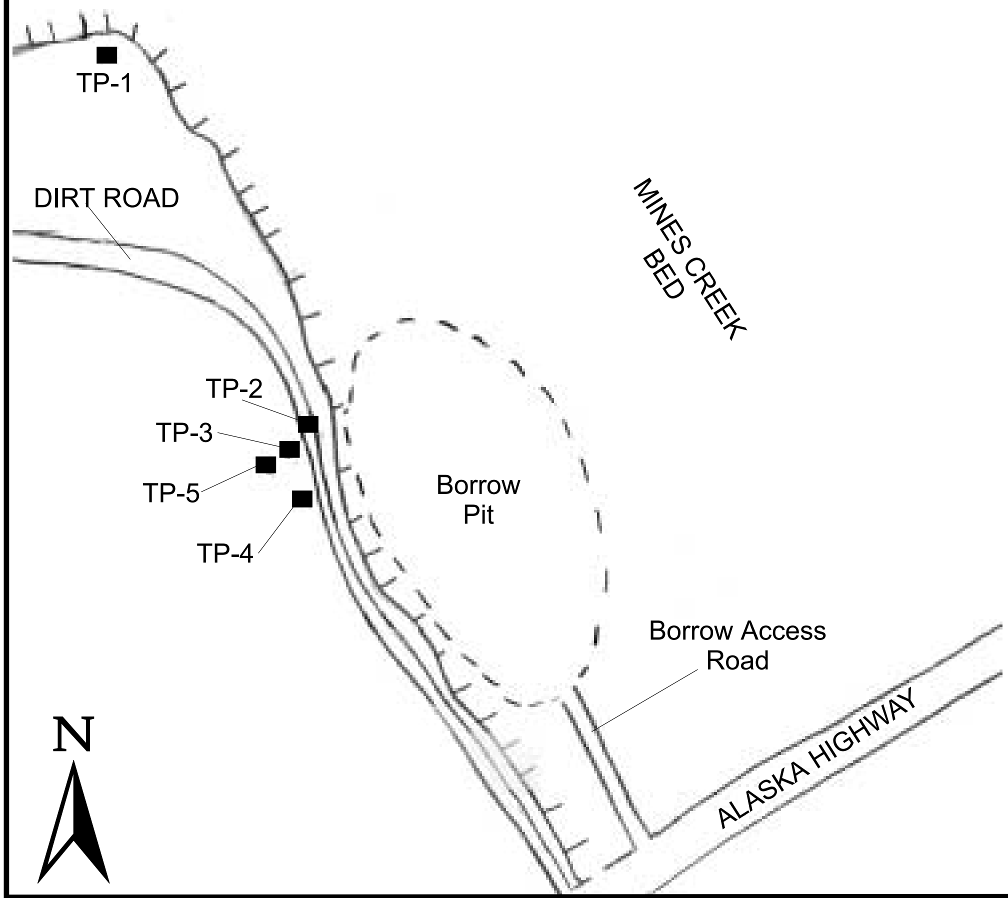


EXTENT OF SITE
BUILDING ■
FOUNDATION □
ROAD ═══════ = =
TRAIL ▬ · ▬ · ▬
FENCE --X--X--X--X--X--X--X--X--X--X--X
RAILWAY ┼┼┼┼┼┼┼┼
RIVER/CREEK
STEEP RISE)))))))

1:250,000 MAP NO. NTS 115 G & F
LATITUDE 61°10'00"
LONGITUDE 138°35'00"
NORTH
TRUE [✓ **MAGNETIC**]
DATE 05/27/99
SCALE: 1 CM = Not to scale

Site No. ________________

Temp. No. HR-31



EXTENT OF SITE	
BUILDING	■
FOUNDATION	☐
ROAD	═══════ ═ ═
TRAIL	▬ · ▬ · ▬
FENCE	--X--X--X--X--X--X--X--X--X--X--X
RAILWAY	┼┼┼┼┼┼┼┼
RIVER/CREEK	
STEEP RISE	)))))))

1:250,000 MAP NO. NTS 115 G & 115F

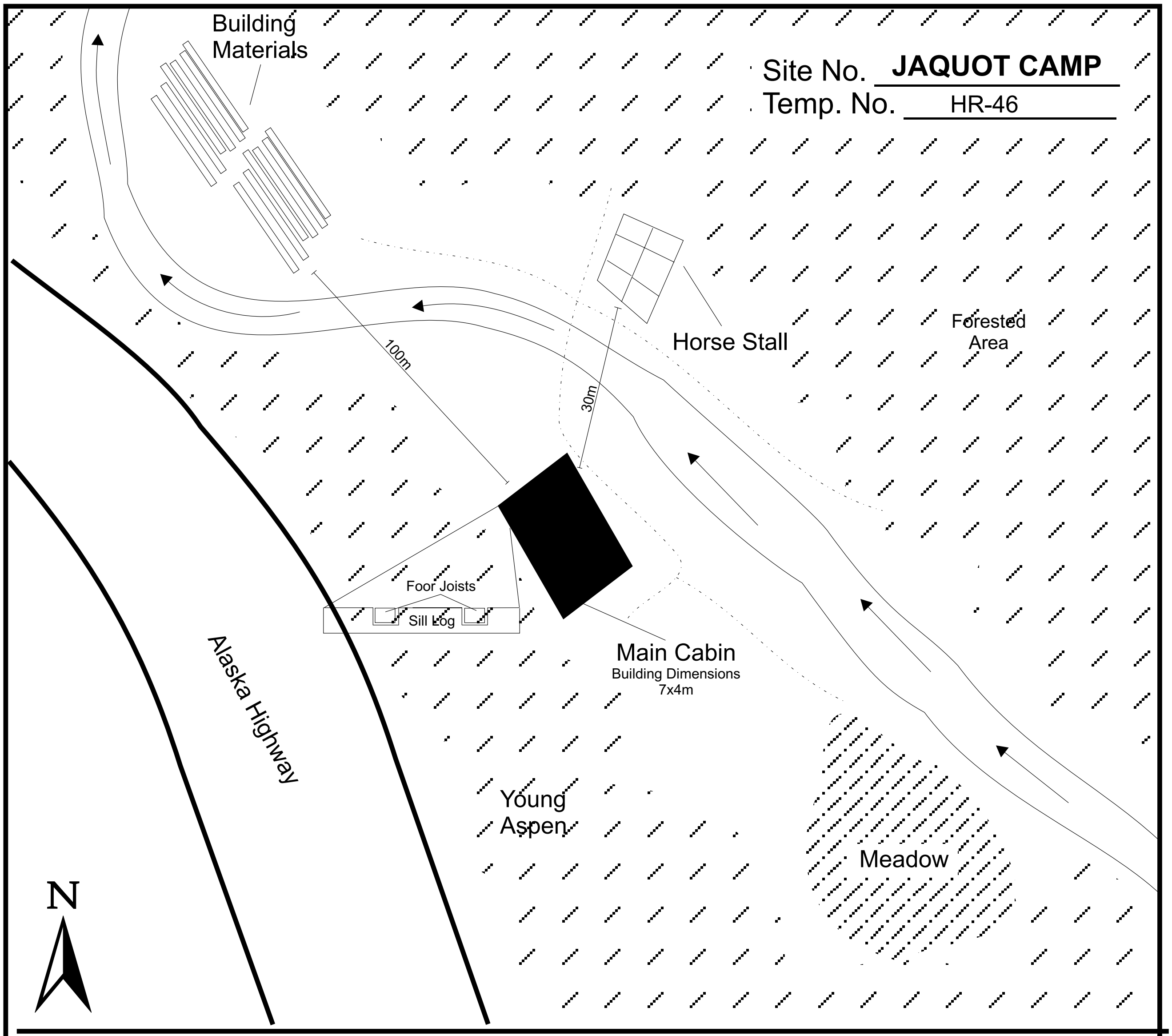
LATITUDE 61°12'51"

LONGITUDE 138°42'20.4"

NORTH TRUE [✓ **MAGNETIC**]

DATE 05/21/99

SCALE: 1 CM = Not to Scale



Site No. **JAQUOT CAMP**

Temp. No. HR-46

EXTENT OF SITE — — — — —

BUILDING ■

FOUNDATION ☐

ROAD

TRAIL — · — · —

FENCE **--X--X--X--X--X--X--X--X--X--X--X**

RAILWAY

RIVER/CREEK

STEEP RISE

1:50,000 MAP NO. NTS 115 G/6

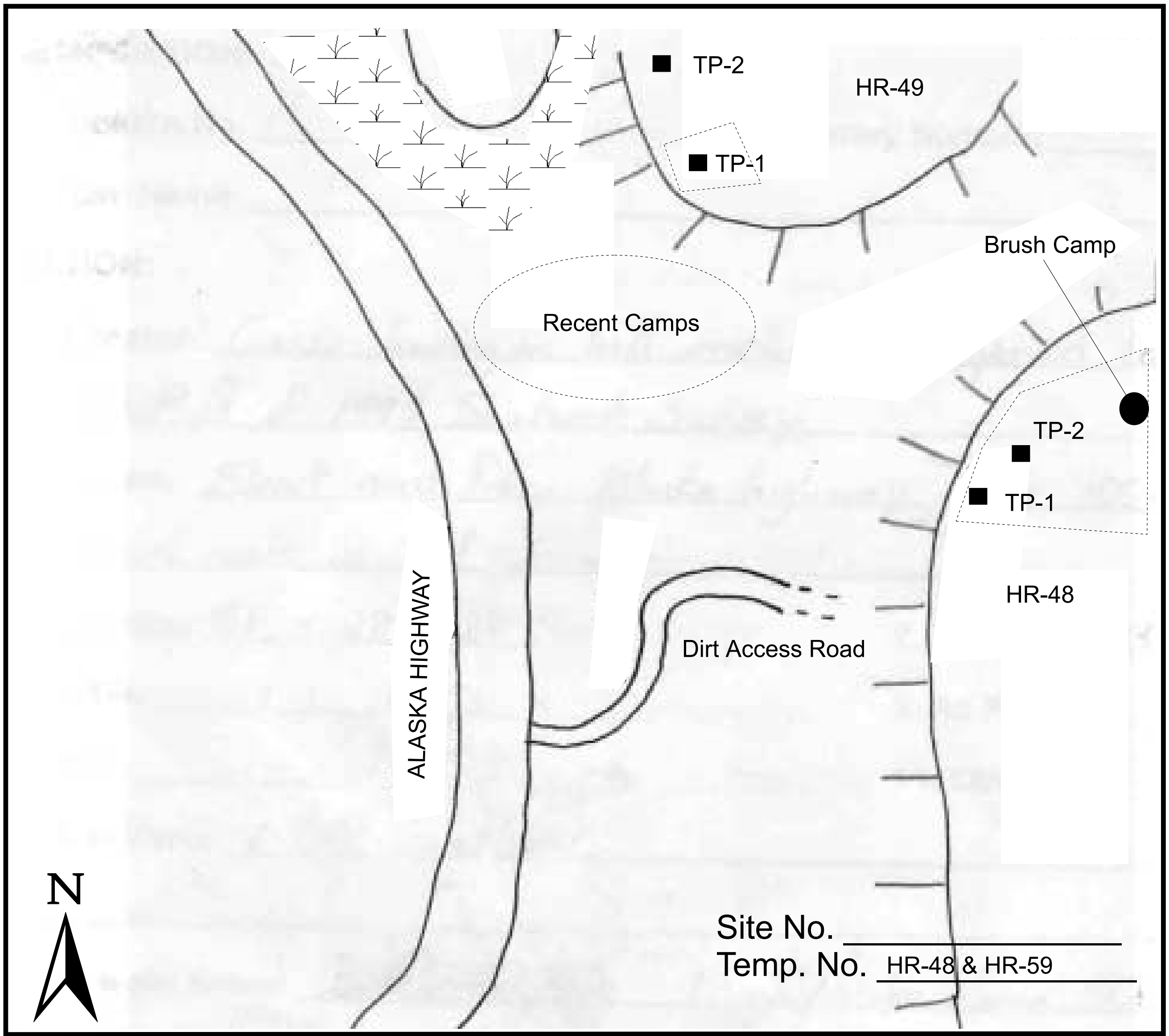
LATITUDE 61°27'8.4"

LONGITUDE 139°13'51.6"

NORTH
TRUE [✓ **MAGNETIC**]

DATE 05/22/99

SCALE: 1 CM = Not to scale



Site No. ____________________

Temp. No. HR-48 & HR-59

EXTENT OF SITE

BUILDING ■

FOUNDATION □

ROAD ═══════════ ═ ═

TRAIL — · — · —

FENCE --X--X--X--X--X--X--X--X--X--X--X

RAILWAY ┼┼┼┼┼┼┼┼

RIVER/CREEK ≈

STEEP RISE 〉〉〉〉〉〉〉

1:50,000 MAP NO. NTS 115 G/6

LATITUDE HR-48 61°28'34.8" HR-49 61°28'19.8"

LONGITUDE HR-48 139°14'25.2" HR-49 139°14'28.2"

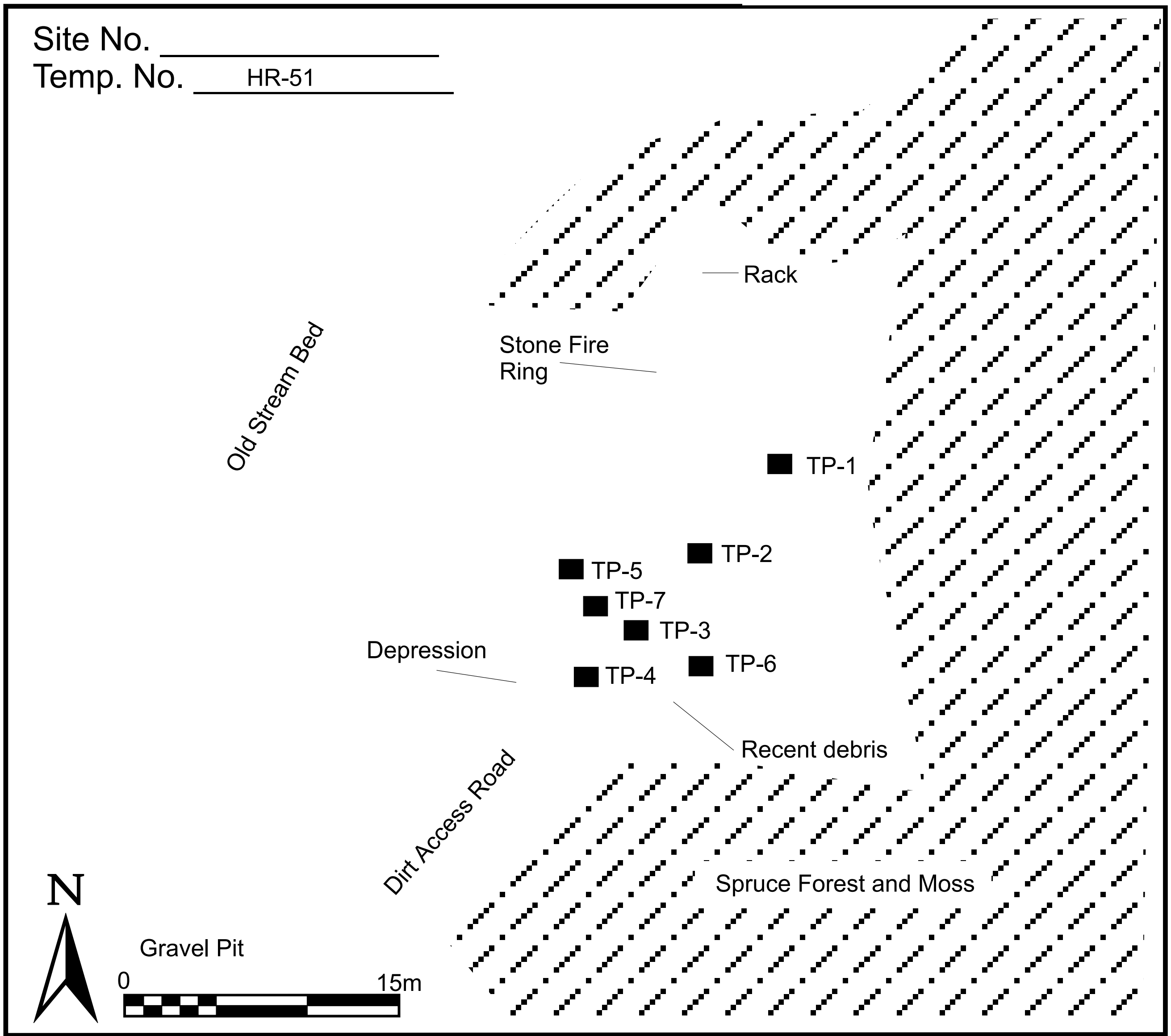
NORTH
TRUE [✓ **MAGNETIC**]

DATE 05/21/99

SCALE: 1 CM = Not to scale

Site No. ________________

Temp. No. HR-51



EXTENT OF SITE

BUILDING ■

FOUNDATION □

ROAD ═══════ ═ ═

TRAIL ▬ · ▬ · ▬

FENCE --X--X--X--X--X--X--X--X--X--X--X

RAILWAY ┼┼┼┼┼┼┼┼

RIVER/CREEK

STEEP RISE)))))))

1:50,000 MAP NO. NTS 115 G/6

LATITUDE 61°29'34.8"

LONGITUDE 139°16'41.4"

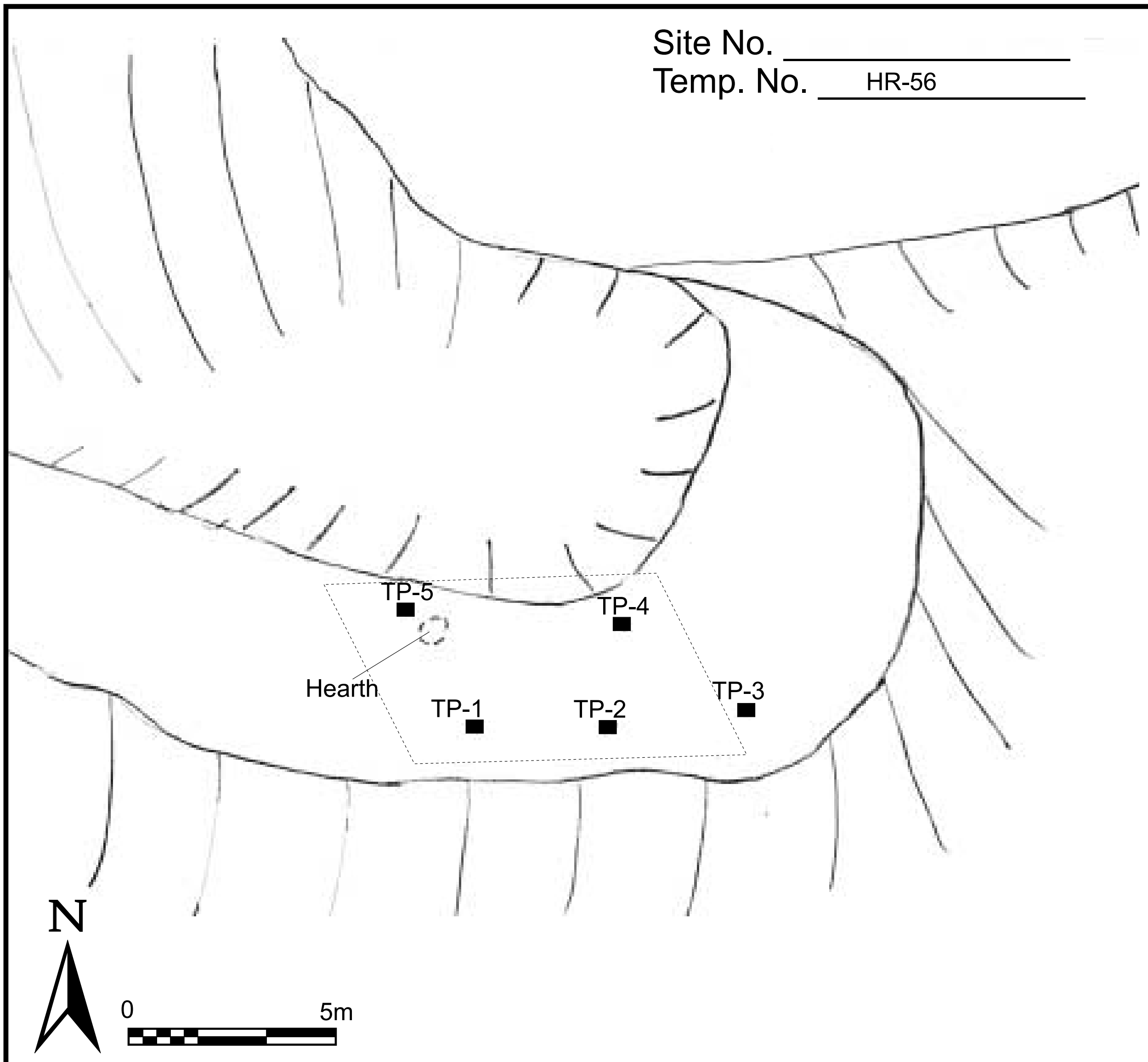
NORTH TRUE [✓ MAGNETIC]

DATE 05/21/99

SCALE: 1 CM = 5m

Site No. ________________

Temp. No. HR-56



EXTENT OF SITE

BUILDING ■

FOUNDATION □

ROAD ═══════ = =

TRAIL ▬ · ▬ · ▬

FENCE --X--X--X--X--X--X--X--X--X--X--X

RAILWAY ┼┼┼┼┼┼┼┼

RIVER/CREEK

STEEP RISE)))))))

1:50,000 MAP NO. NTS 115 G/6

LATITUDE 61°29'31.8"

LONGITUDE 139°17'06.6"

NORTH
TRUE [✓ MAGNETIC]

DATE 05/21/99

SCALE: 1 CM = 0.6m

Yukon
Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix III Contaminants/Waste Sites

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

SITE NUMBER: HJ026 **DISTRICT:** Haines Junction **SITE NAME:** KM 1687.4 ALASKA HWY

TRADITIONAL AREA: Champagne & Aishihik
TRADITIONAL AREA: Champagne & Aishihik

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	UTM Zone: 7V
Latitude:	61	0	30	**Easting:**648666.817928
Longitude:	138	15	0	**Northing:**6766837.11190
Longitude:	138	15	0	067 406

NTS SHEET: 115 G/01

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Unknown **Date from:** **Date to:** **Activities:** VEHICLE DUMP
Inactive Dump

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: KM 1687.4 ALASKA HWY. L.H.S. 100M INTO GRAVEL PIT.; VEHICLE

SITE DESCRIPTION:

HOLIDAY TRAILER + SCRAP METAL PRESENT OCCUPANT: UNKNOWN PREVIOUS OCCUPANT: UNKNOWN. ABANDONED. AFFECTED IS THE AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal Vehicle

Inspector: J. TROTTER **Inspection date:**

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: No

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: HJ036 **DISTRICT:** Haines Junction **SITE NAME:** Kluane Maint. Station

TRADITIONAL AREA: Champagne & Aishihik
TRADITIONAL AREA: Champagne & Aishihik
Kluane/White River

COORDINATES:

	deg	min	sec		
Latitude:	61	1	15	**Easting:**	639605.130186
Longitude:	138	25	0	**Northing:**	6767861.74079
Longitude:	138	25	0		479
					216

UTM Zone: 7V

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/01

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	**Date to:**	**Activities:**

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS Alaska Hwy near Kluane Lake (East side)

SITE DESCRIPTION:

Old maintenance camp on Kluane Lake which is now a service station/ residence

Distance to Residence: 501 m - 1 km **Distance to Water:** high water mark - 50 m **Visual Impact:** Low

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse

Inspector: Rick Seaman **Inspection date:** 10/1/97

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

Leave buried debris as is.

PREVIOUS SITE REPORTS:

Author EBA **Date** 1997

Title Phase 2 Env. Ass.

Report Location DIAND WASTE MGT **Reference No.** EBA-023-1998

AVAILABLE AIRPHOTOS: Yes

Title: Sketch of sample locations

Year: 1985 **File Name:** HJ036c01

AVAILABLE MAPS: No

AVAILABLE PHOTOS: No

Was an environmental risk assessment completed for this site? No

Author EBA **Date** 1997

Title Phase 1 ENV.Assess. AES-AOW

Report Location **Reference No.**

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:** No environmental concerns present.

SITE NUMBER: HJ045 **DISTRICT:** Haines Junction **SITE NAME:** Kluane Maintenance Camp

TRADITIONAL AREA: Champagne & Aishihik
TRADITIONAL AREA: Champagne & Aishihik

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	0	45	**Easting:**639416.596772
Longitude:	138	25	15	**Northing:**6766925.15592
Longitude:	138	25	15	986
				088

NTS SHEET: 115 G/01

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Commercial	**Date from:**	**Date to:**	**Activities:**
Military	**Date from:**	**Date to:**	**Activities:**

SITE ACCESS: Road **Name of access route:** Alaska Hwy

SITE DESCRIPTION:

Old landfill from highway construction. Located at Kluane lake near service station.

Distance to Residence: 0 - 500 m **Distance to Water:** high water mark - 50 m **Visual Impact:** Low

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL

Inspector: Rick **Inspection date:**

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

Leave buried

PREVIOUS SITE REPORTS:

Author EBA **Date** 1997

Title Phase 1 Env. Ass.

Report Location DIAND WASTE MGT **Reference No.** EBA -022-1997

Author EBA **Date** 1998

Title Phase 2 Env. Ass. Site HJ 045 ,Kluane Lk. Main. Camp

Report Location DIAND WASTE MGT **Reference No.** EBA -024-1998

AVAILABLE AIRPHOTOS: Yes

Title: Site location map
Year: 1956 **File Name:** HJ045c02

Title: Site location map
Year: 1985 **File Name:** HJ045c03

Title: GPR profile areas and TP locations
Year: 1988 **File Name:** HJ045c01

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: site overview
Year: 1998 **File Name:** HJ045a01

Was an environmental risk assessment completed for this site? No

NERAS score: 25 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/14/99 **Action:** This site does not represent an environmental hazard or health risk, no further action is required.

SITE NUMBER: HJ032 **DISTRICT:** Haines Junction **SITE NAME:** H/F PIPELINE- 207.6

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	12	25
Longitude:	138	43	15
Longitude:	138	43	15

UTM Zone: 7V
Easting:622450.554560191
Northing:6787972.89858252

NTS SHEET: 115 G/02

LAND TENURE: Federal **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	**Date to:**	**Activities:** H/F PIPELINE

SITE ACCESS: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: HAINES-FAIRBANKS PIPELINE MILE 207.6- SOUTH OF DESTRUCTION BAY PUMP STATION; TRAIL BETWEEN NINES AND MINES CREEK ; 500M SOUTH WEST OF ALASKA HIGHWAY ACCESS MILE 1082.5 ON OVERGROWN ROAD, BOTH ARMS OF ROAD CROSS SPILL AREA.

SITE DESCRIPTION:

PRESENT OCCUPANT: NONE. PREVIOUS OCCUPANT: US MILITARY. MILE 207.6 IS 7 KM SOUTH OF THE DESTRUCTION BAY PUMPSTATION, THIS SITE WAS AN OLD PIPELINE SPILL THAT WAS ASSESSED. THE 60M X 500M SPILL WAS CAUSED BY THE CUTTING OF THE HAINES-FAIRBANKS PIPELINE FOR MAINTENANCE PURPOSES IN FEBRUARY 1956. UMA AUGUST 1995 FIELD INVESTIGATION INDICATES HYDROCARBON CONTAMINATION IS EXTENSIVE AND HAS IMPACTED VEGETATION BUT RECOVERY IS EVIDENT. PCB AND PAH PRESENT AT LEVELS BELOW CCME CRITERIA . ORGANOCHLORINE PESTICIDE AND PHENOXYACID HERBICIDE LEVELS WERE BELOW DETECTION LIMITS. BTEX ANALYTES XYLENE EXCEEDED CCME CRITERIA AND ETHYLBENZENE WAS PRESENT IN LOW LEVELS. VEGETATION SURROUNDING AFFECTED AREA IS MATURE WHITE SPRUCE, BEAR BERRY, CROWBERRY, LABRADOR TEA, LICORICE ROOT, HORSETAIL, SEDGE, LICHEN AND MOSS.THE VEGETATION IN AFFECTED AREA SPRUCE SEEDLING AND GRASSES, OTHER VEGETATION ABSENT.

Distance to Residence: >10 km **Distance to Water:** >100 m **Visual Impact:** Low

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons	Hydrocarbon/Fuel	Pipeline	Contaminants
PAH'S	BTEX		
PCB's			
BTEX			

Inspector: UMA ENGINEERING LTD,
AMBIO RESEARCH INC

Inspection date: 8/1/95

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

UMA/AMBIO 1995 RECOMMEND MILE 207.6 SPILL SITE AS LOWEST PRIORITY OF THE HAINES-FAIRBANKS PIPELINE SITES SINCE CLAY SOILS LIMIT MIGRATION OF HYDROCARBON.

PREVIOUS SITE REPORTS:

Author UMA -AMBIO Research Associates Inc **Date** 1995

Title Preliminary Environmental Assessment Haines-Fairbanks Pipeline

Report Location AES, DIAND **Reference No.**

Author US Army Corps of Engineers **Date** 1972

Title PEI of Petroleum Spillage H-F Pipeline

Report Location Copy-Waste mgt **Reference No.** RIC-073-1972

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: site overview

Year: 1995 **File Name:** HJ032a01

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/11/99 **Action:** The Environmental Assessment report from 1995 recommends that no further action be taken since the spill is not spreading due to clay soils. Human health risks and ecosystem risks are minor and a remediation program might do more harm than good.

SITE NUMBER: HJ031 **DISTRICT:** Haines Junction **SITE NAME:** DESTRUCTION BAY PUMP STATION

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	13	35
Longitude:	138	45	28
Longitude:	138	45	28

UTM Zone: 7V
Easting: 620391.929271659
Northing: 6790069.23906983

NTS SHEET: 115 G/02

LAND TENURE: Federal **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	1950	**Date to:**	1972	**Activities:**	Camp Pump Station Active Dump

SITE ACCESS: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: DESTRUCTION BAY PUMP STATION IS 4.5 KM EAST OF DESTRUCTION BAY ON WEST SIDE OF ALASKA HWY, 200M ON GRAVEL ROAD.

SITE DESCRIPTION:

THE DESTRUCTION BAY PUMP STATION IS LOCATED AT MILE 209 OF THE HAINES-FAIRBANKS PIPELINE, 4.5 KM SOUTH EAST OF DESTRUCTION BAY ALONG THE ALASKA HIGHWAY. PRESENT OCCUPANT: NONE LORIMER 1996 FIELD INVESTIGATION INDICATES HOUSING IS REMOVED, 2 ABOVE GROUND STORAGE TANKS IN SOUTH EAST CORNER OF COMPLEX. ASSOCIATED DUMP IS LOCATED ACROSS THE HIGHWAY. ON SITE WATER WELLS DEPTH OF WATER >30M BELOW GROUND. SOIL SAMPLING INDICATES LOW HYUDROCARBON CONTAMINATION AROUND FUEL STORAGE TANKS; TRACE PESTICIDELEVELS, NO BTEX IN 1 SOIL SAMPLE, TRACE PAH IN SOIL AND WATER, TRACE PCB; GROUND WATER SAMPLE EXCEEDED CCME DRINKING WATER CRITERIA FOR CADMIUM AND MANGANESE. CURSORY SAMPLING OF SURFACE, EVIDENCE OF HYDROCARBON SPILLS, SUBSURFACE CONDITIONS NOT DEFINED.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons	Metals	Above ground storage tank	Contaminants
Pesticides	Cadmium	Building	
PCB's	Manganese		
PAH'S			
Nickel			

Inspector: LORIMER AND ASSOCIATES **Inspection date:** 10/1/96

Date of last modification to database: 10/18/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

LORIMER AND ASSOCIATES 19 95 RECOMMEND FURTHER EXPLORATORY WORK REQUIRED. GROUND WATER MONITORING WELLS AROUND DUMP AND ABOVE GROUND STORAGE TANK. TESTPIT TO TO CONFIRM DUMP LOCATION. DATA REVIEWED BY DIAND WASTE MANAGEMENT AND NO FURTHER WORK REQUIRED.

PREVIOUS SITE REPORTS:

Author Lorimer and Associates, Hemmera Resource Consultan **Date** 1995

Title Haines-Fairbanks Pipeline- Environmental Assessments of Beaver Creek, Donjek and Destruction Bay Pu

Report Location Waste Mgt, DIAND **Reference No.**

Author Ground Trax E.S. **Date** 1997

Title Evn. Invs.D-BAY Pump Sta.

Report Location Waste Mgt - DIAND **Reference No.** GRO-017-1997

Author Arctic Environmental Services Ltd. **Date** 1998

Title Inventory of Equipment, Machinery, Major Fixtures and Hazardous Materials at Destruction Bay PS

Report Location AES, DIAND **Reference No.**

AVAILABLE AIRPHOTOS: Yes

Title: Site Overview

Year: 1995 **File Name:** HJ031C01

AVAILABLE MAPS: Yes

Title: site location map

Year: 1997 **File Name:** HJ031b01

Title: detailed site map

Year: 1998 **File Name:** HJ031b02

AVAILABLE PHOTOS: Yes

Title: front of main building

Year: 1998 **File Name:** HJ031a01

Title: main product tank

Year: 1998 **File Name:** HJ031a02

Title: boiler room

Year: 1998 **File Name:** HJ031a03

Title: foundation

Year: 1998 **File Name:** HJ031a04

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:** No environmental concerns present

SITE NUMBER: HJ038 **DISTRICT:** Haines Junction **SITE NAME:** Cluett Creek

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	15	18	**Easting:**	616826.410853
Longitude:	138	49	20	**Northing:**	6793137.93762
Longitude:	138	49	20		525

UTM Zone: 7V

NTS SHEET: 115 G/07

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	1943	**Date to:**	1953	**Activities:**	Active Dump
Military	**Date from:**	1953	**Date to:**		**Activities:**	Inactive Dump

SITE ACCESS: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: see assess # A-25 -96; THIS SITE IS LOCATED 500M WEST OF THE ALASKA HIGHWAY ON THE SOUTH SIDE OF CLUETT CREEK.

SITE DESCRIPTION:

THIS INACTIVE DUMP IS LOCATED IN A DRY CHANNEL IMMEDIATELY SOUTH OF CLUETT CREEK 400M UPSTREAM, JUST NORTH OF DESTRUCTION BAY. THIS DUMP WAS ACTIVELY USED 1943 TO EARLY 1950'S. TRANSNORTHERN FALL 1996 INNVESTIGATION SAMPLE ANALYSIS INDICATES PCB, PAH AND ORGANOCHLORINE PESTICIDE LEVELS WERE BELOW DETECTION LIMITS. PRESENCE OF BTEX IN BACKGROUND EXPECTED TO BE A FALSE SOURCE FROM EQUIPMENT USED NOT FROM SOIL. SEE ASSESS #A-25-96

Distance to Residence: 501 m - 1 km **Distance to Water:** 0 m - below high water **Visual Impact:** High

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons			Debris/Refuse Contaminants

Inspector: TRANSNORTHERN CONSULTING **Inspection date:** 9/1/96

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

TRANSNORTHERN 1997 RECOMMENDS TTHAT THE SITE IS NOT LIKELY TO BE CONSIDERED CONTAMINATED BY CCME STANDARDS AND NO FURTHER INVESTIGATION IS REQUIRED. FUTURE CLEANUP FOR AESTHETIC REASONS OR TO PROTECT THE UNWARRY FROM INJURY DUE TO DEBRIS.

PREVIOUS SITE REPORTS:

Author TransNorthern Consulting, David Loeks,Don Wilson,J **Date** 1997

Title PEI Destruction Bay Sites 24, 25, & 26

Report Location WASTE MGT, DIAND **Reference No.** TRA-032-1997

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Topographic map

Year: 1997 **File Name:** HJ038b01

Title: Site map and sample location

Year: 1997 **File Name:** HJ038b02

AVAILABLE PHOTOS: Yes

Title: drainage course towards Kluane lake

Year: 1997 **File Name:** HJ038a01

Title: wood debris, drums and refuse

Year: 1997 **File Name:** HJ038a02

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/14/99 **Action:** In accordance with CCME Assessment Criteria, this site does not represent an environmental hazard or health risk. Only aesthetics are affected and no action is required.

SITE NUMBER: HJ040 **DISTRICT:** Haines Junction **SITE NAME:** Old Dump Site, Burwash, AES#27

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	21	30	**Easting:** 606493.779083 187
Longitude:	139	0	30	
Longitude:	139	0	30	**Northing:** 6804325.88219 851

NTS SHEET: 115 G/06

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):
Military **Date from:** 1940 **Date to:** **Activities:** Active Dump

SITE ACCESS: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: SEE ASSESSMENT# A-27-96; ON BOTH SIDES OF OLD ACCESS ROAD TO BURWASH LANDING JUST NORTH OF ALASKA HIGHWAY.

SITE DESCRIPTION:

WWII LOCATION OF A PAN AMERIACAN CONSTRUCTION BUILDING WITH A BORROW PIT ACROSS THE ROAD. ACCESS ROAD NOW A RESIDENTIAL STREET IN BURWASH LANDING. LABERGE FALL 1996 NOTE A SOUTHERN CLEARING WITH NEW CONSTRUCTION WASTE, OLD DUMP WITH SOME METAL WASTE VISIBLE. SOIL SAMPLES INDICATED PCB AND ORGANOCHLORINE PESTICIDE BELOW DETECTION LIMITS, HYDROCARBONS PRESENT BUT BELOW CCME CRITERIA. VEGETATION: WILLOW, GRASS AND WHITE SPRUCE. SEE ASSESSMENT #A-27-96

Distance to Residence: 0 - 500 m **Distance to Water:** high water mark - 50 m **Visual Impact:** Low

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons		Excavations - Basement	Buildings Scrap Metal Contaminants

Inspector: LABERGE ENVIRONMENTAL SERVICES **Inspection date:** 9/1/97

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

LABERGE 1997 RECOMMENDS THAT THE HYDROCARBON LEVELS ARE LOW, BELOW CCME CRITERIA. MINOR LANDSCAPING COULD BE ACCOMPLISHED.

PREVIOUS SITE REPORTS:

Author Laberge Evironmental Services **Date** 1997

Title P E I at Sites 1(WL066), 2(WL067),27(HJ040) AND 2(HJ042)

Report Location AES, DIAND **Reference No.**

AVAILABLE AIRPHOTOS: Yes

Title: Old dumps near Burwash Landing II

Year: 1947 **File Name:** HJ040c02

Title: Old dumps near Burwash Landing I

Year: 1987 **File Name:** HJ040c01

AVAILABLE MAPS: Yes

Title: Site plan

Year: 1997 **File Name:** HJ040b01

AVAILABLE PHOTOS: Yes

Title: metal waste

Year: 1997 **File Name:** HJ040a01

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/14/99 **Action:** In accordance with CCME Assessment Criteria, this site does not represent an environmental hazard or health risk. Only aesthetics are affected and no action is required.

SITE NUMBER: HJ042 **DISTRICT:** Haines Junction **SITE NAME:** SWEDE JOHNSON CREEK , AES#29

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

COORDINATES:

	deg	min	sec	UTM Zone: 7V
Latitude:	61	20	0	**Easting:**602566.130466
Longitude:	139	5	0	**Northing:**6801421.90604
Longitude:	139	5	0	057 96

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/06

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	1942	**Date to:**	1946	**Activities:**	Active Dump Highway Maintenance
Government	**Date from:**	1975	**Date to:**		**Activities:**	Inactive Dump Active Dump

SITE ACCESS: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: SEE ASSESSMENT # A-29-96; 1.7KM WEST OF SWEDE JOHNSON CREEK AT MP 1120 ON SOUTH SIDE OF ALASKA HIGHWAY, GRAVEL ACCESS ROAD.

SITE DESCRIPTION:

SWEDE JOHNSON CREEK CROSSING AT MP1120 DUMPSITE ORGINATED WITH HIGHWAY CONSTRUCTION AND WAS USED BY DONJEK PUMPING STATION ON HAINES-FAIRBANKS PIPELINE FOR UNBURNABLE WASTE. MAIN DUMPSITE WAS BACKFILLEDIN1970'S AND A PIT DUG FOR HOUSEHOLD WASTE FOR LOCAL RESIDENTS. LAGERGE FALL 1996 INVESTIGATION INDICATED METAL WASTE AND CANS BARELY VISIBLE IN GRAVEL QUARRY. NO PCB OR ORGANOCHLORINE PESTICIDES WERE DETECTED. NO HYDROCARBONS IN GROUND WATER OR SURFACE WATER. LOW SOIL HYDROCARBON PRESENT BUT BELOW CCME CRITERIA. VEGETATION: WILLOWS AND GRASSES. SEE ASSESS #A-29-96

Distance to Residence: >10 km **Distance to Water:** high water mark - 50 m **Visual Impact:** Low

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons		Excavations - Basement	Scrap Metal Contaminants

Inspector: LABERGE ENVIRONMENTAL SERVICES **Inspection date:** 8/1/96

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

LABERGE 1997 RECOMMENDS THAT CONCENTRATIONS OF HYDROCARBON ARE LOW, BELOW CLEAN UP CRITERIA. THE OLD DUMP IS POORLY LOCATED ON TOP OF SATURATED SANDS VERY NEAR A YEAR ROUND CREEK, BUT NO DETECTABLE CONTAMINATION.

PREVIOUS SITE REPORTS:

Author Laberge Environmental Services **Date** 1997

Title P E I at Sites 1(WL066),2(WL067,27(HJ040), AND 29(HJ042)

Report Location AES, DIAND **Reference No.**

AVAILABLE AIRPHOTOS: Yes

Title: Old dumps near Swede Johnson Creek, old Mile Post 1120 II

Year: 1989 **File Name:** HJ042c02

Title: Old dumps near Swede Johnson Creek, old Mile Post 1120 I

Year: 1947 **File Name:** HJ042c01

AVAILABLE MAPS: Yes

Title: Site map

Year: 1997 **File Name:** HJ042b01

AVAILABLE PHOTOS: Yes

Title: looking down on casual garbage

Year: 1997 **File Name:** HJ042a01

Title: old buried dump site

Year: 1997 **File Name:** HJ042a02

Title: current garbage dump

Year: 1997 **File Name:** HJ042a03

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/14/99 **Action:** In accordance with CCME Assessment Criteria, this site does not represent an environmental hazard or health risk. Only aesthetics are affected and no action is required.

SITE NUMBER: HJ039 **DISTRICT:** Haines Junction **SITE NAME:** MP1086, N. of Dbay

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	22	0
Longitude:	139	2	0
Longitude:	139	2	0

UTM Zone: 7V
Easting: 605129.356086679
Northing: 6805213.30890089

NTS SHEET: 115 G/06

LAND TENURE: Federal DIAND **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	1955	**Date to:**	1975	**Activities:**	Active Dump
Military	**Date from:**	1975	**Date to:**		**Activities:**	Inactive Dump

SITE ACCESS: Road **Name of access route:** Army Pioneer Road

GENERAL ACCESS: SEE ASSESSMENT # A-26-96; NEAR MILE POST 1086 NORTH OF DESTRUCTION BAY ON ALASKA HIGHWAY, ACCESS IS AN ARMY PIONEER ROAD FROM THE SHORE OF KLUANE LAKE NEAR TOWER MARKED AM186W, ADJACENT SITE NEAR JUNCTION OF ARMY PIONEER ROAD AND TELEPHONE RIGHT OF WAY.

SITE DESCRIPTION:

ACTIVE DUMP FOR DOMESTIC AND CONSTRUCTION WASTE FROM MID 1950'S TO MID 1970'S. WASTE WAS DISCARDED OVER TOP EDGE OF 70M BENCH. TRANSNORTHERN FALL 1996 INVESTIGATION INDICATES THE DUMP WAS PARTIALLY COVERED WITH SAND BUT WASTE STILL VISIBLE. A BED FRAME AND DRUM FOUND NEARBY. SAMPLES ANALYSED FOR PCB, PAH AND ORGANOCHLORINE PESTICIDE WERE BELOW DETECTION LIMITS. BENZENE WAS FOUND IN TRACE AMOUNTS. METAL CONTENT IN WATER SAMPLE EXCEEDED CCME CRITERIA FOR FRESHWATER AQUATIC LIFE. ALUMINUM, CHROMIUM, COPPER AND IRON THOUGHT TO BE OF NATURAL SOURCE THAT EXCEEDS CCME CRITERIA (EXCEPT POSSIBLY

CHROMIUM). SEE ASSESSMENT #A-26-96.

Distance to Residence: 1 - 10 km **Distance to Water:** high water mark - 50 m **Visual Impact:** Medium

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
Hydrocarbons	Aluminum		Contaminants
Aluminum	Chromium		Drums
Chromium	Copper		
Iron	Iron		
Copper			

Inspector: TRANSNORTHERN **Inspection date:** 9/1/96

Date of last modification to database: 7/28/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

TRANSNORTHERN 1997 RECOMMENDS THAT THE SITE IS NOT LIKELY TO BE CONSIDERED CONTAMINATED BY CCME STANDARDS AND NO FURTHER INVESTIGATION IS REQUIRED. FUTURE CLEANUP MAY BE CONDUCTED FOR AESTHETIC REASONS OR TO PROTECT THE UNWARRY FROM INJURY DUE TO DEBRIS.

PREVIOUS SITE REPORTS:

Author TransNorthern Consulting, D.Loeks,D.Wilson,J.Gibso **Date** 1997

Title P E I Destruction Bay Sites 24,25,&26

Report Location waste Mgt, DIAND **Reference No.** TRA-032-1997

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Topographic map

Year: 1997 **File Name:** HJ039b01

Title: Site map and sample location

Year: 1997 **File Name:** HJ039b02

AVAILABLE PHOTOS: Yes

Title: scrap metal buried in slope

Year: 1997 **File Name:** HJ039a01

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: 6/14/99 **Action:** In accordance with CCME Assessment Criteria, this site does not represent an environmental hazard or health risk. Only aesthetics are affected and no action is required.

SITE NUMBER: BC035 **DISTRICT:** Beaver Creek **SITE NAME:** MILE 1100, ALASKA HWY

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	24	0
Longitude:	139	10	0
Longitude:	139	10	0

UTM Zone: 7V
Easting:597899.003184
Northing:6808717.82469
266
519

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Government **Date from:** **Date to:** **Activities:** ABANDONED GRAVEL PIT

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: MILE 1100, ALASKA HWY (NORTH OF DUKE RIVER); VEHICLE

SITE DESCRIPTION:

MILE 1100 ALASKA HWY (NORTH OF DUKE RIVER). ABANDONED GRAVEL PIT AND STAGING AREA. WASTE CONSISTS OF DRUMS, REFUSE AND SCRAP METAL. MINIMAL IMPACT. AESTHETICS AFFECTED.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
	Hydrocarbon/Fuel		Drums Debris/Refuse Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 2/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

CLEANUP AND REMOVE TO APPROVED DUMP SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC035B01

AVAILABLE PHOTOS: Yes

Title: Site overview

Year: **File Name:** BC035A01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC034 **DISTRICT:** Beaver Creek **SITE NAME:** DUKE RIVER OLD ALASKA HWY

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

UTM Zone: 7V

	deg	min	sec	
Latitude:	61	24	0	**Easting:**597899.003184266
Longitude:	139	10	0	
Longitude:	139	10	0	**Northing:**6808717.82469519

NTS SHEET: 115 G/06

LAND TENURE: Federal Heritage **SITE STATUS:** No Action **Date:**

SITE OCCUPANT(S):

Unknown	**Date from:**	**Date to:**	**Activities:**

SITE ACCESS: Trail (foot) **Name of access route:**

GENERAL ACCESS: OLD ALASKA HWY (DUKE RIVER); VEHICLE

SITE DESCRIPTION:

OLD ALASKA HWY (DUKE RIVER). OLD BRIDGE TIMBERS AND DECKING. MINIMAL IMPACT. AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
			Debris/Refuse

Inspector: NEALE WORTLEY **Inspection date:** 2/10/92

Date of last modification to database: 10/18/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes
Title: Site location
Year: **File Name:** BC034B01

AVAILABLE PHOTOS: Yes
Title: Site overview
Year: **File Name:** BC034A01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC036 **DISTRICT:** Beaver Creek **SITE NAME:** MILE 1101 ALASKA HWY

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	24	0	**Easting:**597899.003184
Longitude:	139	10	0	**Northing:**6808717.82469
Longitude:	139	10	0	266
				519

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Unknown	**Date from:**	**Date to:**	**Activities:**

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: MILE 1101, ALASKA HWY (NORTH OF DUKE RIVER); VEHICLE

SITE DESCRIPTION:

MILE 1101 ALASKA HWY NORTH OF DUKE RIVER. SITE INVENTORY CONSISTS OF AN OLD WASHING MACHINE, METAL DOZER BLADE AND SCRAP METAL PLATE. VEGETATION: MOSS, SHRUBS, SMALL BLACK SPRUCE. IMPACT MINIMAL. AFFECT: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 2/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

CLEANUP AND REMOVE TO APPROVED DUMP SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

Title:

Year: **File Name:**

AVAILABLE PHOTOS: Yes

Title: scattered debris

Year: 1992 **File Name:** BC036a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC042 **DISTRICT:** Beaver Creek **SITE NAME:** DUKE RIVER

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	22	0	**Easting:**	595330.960931
Longitude:	139	13	0	**Northing:**	6804931.77075
Longitude:	139	13	0		828 924

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Helicopter **Name of access route:**

GENERAL ACCESS: DUKE RIVER (BURWASH UPLANDS); VEHICLE

SITE DESCRIPTION:

DUKE RIVER (BURWASH UPLANDS). MINING CAMP WITH TANKER ON SITE. ON SITE WASTE INCLUDES REFUSE, SCRAP METAL. VEGETATION: BRUSH. ASPECT AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 4/12/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

REMOVE BY ROAD ACCESS

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: tanker

Year: 1992 **File Name:** BC042a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC052 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	22	0	**Easting:**	594440.170745
Longitude:	139	14	0	**Northing:**	6804907.54159
Longitude:	139	14	0		076
					08

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM WITH PIPE AND SLUICE BOX NO VEGETATION AND IMPACT IS MINIMAL TO AESTHETICS

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes
Title: Site Location
Year: **File Name:** BC052b01

AVAILABLE PHOTOS: Yes
Title: pipe and sluice box
Year: 1993 **File Name:** BC052a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC053 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	22	0	**Easting:**594440.170745
Longitude:	139	14	0	**Northing:**6804907.54159 076 08
Longitude:	139	14	0	

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM, OLD STEAM SHOVEL AND SLUICE BOX. MINIMAL IMPACT. VEGETATION: BRUSH. ASPECT AFFECTE: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel		Drums Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/13/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC053b01

AVAILABLE PHOTOS: Yes

Title: steam shovel and sluice box

Year: 1993 **File Name:** BC053a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC054 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	22	0
Longitude:	139	15	0
Longitude:	139	15	0

UTM Zone: 7V
Easting:593549.376236
Northing:6804883.53995
776
358

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM. SITE INVENTORY CONSISTS OF AN OLD TRUCK BODY, CAT BLADE AND TRACKS. MINIMAL IMPACT. VEGETATION: BRUSH. ASPECT AFFECTED: AESTHETICS

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
	Hydrocarbon/Fuel		Drums Debris/Refuse Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC054b01

AVAILABLE PHOTOS: Yes

Title: equipment - cat

Year: 1993 **File Name:** BC054a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC055 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	22	0	**Easting:**	593549.376236776
Longitude:	139	15	0		
Longitude:	139	15	0	**Northing:**	6804883.53995358

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM. SITE INVENTORY CONSISTS OF OLD SLUICE BOX. IMPACT POTENTIAL IS MINIMAL. VEGETATION: BRUSH. ASPECT AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC055b01

AVAILABLE PHOTOS: Yes

Title: sluice box

Year: 1993 **File Name:** BC055a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC056 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	22	0	**Easting:**592658.577447 756
Longitude:	139	16	0	
Longitude:	139	16	0	**Northing:**6804859.76584 681

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM, SITE INVENTORY CONSISTS OF AN OLD PIPE. POTENTIAL IMPACT IS MINIMAL.
VEGETATION: NONE, ASPECT AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC056b01

AVAILABLE PHOTOS: Yes

Title: steel pipe

Year: 1993 **File Name:** BC056a01

Title: steel pipes

Year: 1993 **File Name:** BC056a02

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC057 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	**min**	**sec**	
Latitude:	61	22	0	**Easting:**592658.577447756
Longitude:	139	16	0	
Longitude:	139	16	0	**Northing:**6804859.76584681

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

ACTIVE PLACER MINING CLAIM. SITE INVENTORY CONSISTS OF AN OLD SLUICE BOX. IMPACT POTENTIAL IS MINIMAL. NO VEGETATION. ASPECTED AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Beaver Creek Regional Site Inventory

Year: **File Name:** BC057b01

AVAILABLE PHOTOS: Yes

Title: sluice box

Year: 1993 **File Name:** BC057a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC075 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	22	0
Longitude:	139	14	0
Longitude:	139	14	0

UTM Zone: 7V
Easting: 594440.170745
076
Northing: 6804907.54159
08

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK;

SITE DESCRIPTION:

OLD TRUCK CAMPER SHELL ON SITE. IMPACT IS MINIMAL. VEGETATION IS BRUSH. ASPECT AFFECTED AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Equipment Scrap Metal

Inspector: N. WORTLEY **Inspection date:** 6/14/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

REMOVE TO DESIGNATED WASTE METAL DUMP

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: Old truck camper shell

Year: 1992 **File Name:** BC075a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC078 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
Latitude:	61	22	0	**Easting:**592658.577447
Longitude:	139	16	0	**Northing:**6804859.76584
Longitude:	139	16	0	756 681

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

	Date from:	Date to:	Activities:
Mining			Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

ABANDONED PLACER CLAIM. 4 DRUMS AND FUEL TANKS ON SITE. VEGETATION:BRUSH. IMPACT IS MODERATE. ASPECT AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel		Drums FUEL TANKS

Inspector: N. WORTLEY **Inspection date:** 6/14/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: Building, above ground storage tanks and drums

Year: 1992 **File Name:** BC078a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC080 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	22	0	**Easting:**	592658.577447
Longitude:	139	16	0	**Northing:**	6804859.76584
Longitude:	139	16	0		756
					681

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining	**Date from:**	**Date to:**	**Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

ABANDONED PLACER CLAIM. WASTE ON SITE CONSISTS OF SCRAP METAL, TRUCK AND EQUIPMENT BODIES AND 5 FULL DRUMS. THERE ARE PERMANENT IMPROVEMENTS. VEGETATION: BRUSH. THE IMPACT IS MODERATE AND AFFECTS THE AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel		Drums Equipment Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 6/14/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

ASK PLACER CLAIM HOLDER TO CLEAN UP

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: Truck, equipment and scrap metal

Year: 1992 **File Name:** BC080a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC076 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	23	0	**Easting:**	593499.600042878
Longitude:	139	15	0		
Longitude:	139	15	0	**Northing:**	6806739.58419294

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining	**Date from:**	**Date to:**	**Activities:** Mine Site

SITE ACCESS: **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

ABANDONED PLACER CAMP. WASTE CONSISTS OF WASTE METAL, WOOD, PIPE AND OTHER DEBRIS. 2 TENT FRAMES AND 1 FRAME STRUCTURE. 4 DRUMS ON SITE. NO VEGETATION. IMPACT IS MODERATE. ASPECT AFFECTED: AESTHETICS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel		Debris/Refuse Drums Equipment WOOD SCRAPS TENT FRAMES

Inspector: **Inspection date:**

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

CONTACT PLACER CLAIM HOLDER TO CLEAN UP.

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: Old structures and equipment

Year: 1992 **File Name:** BC076a01

Title: Old structures, equipment and srap metal

Year: 1992 **File Name:** BC076a02

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC048 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	25	0	**Easting:**	594289.395556187
Longitude:	139	14	0		
Longitude:	139	14	0	**Northing:**	6810475.65986045

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining	**Date from:**	**Date to:**	**Activities:** Mine Site

SITE ACCESS: **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

SITE IS A PLACER CLAIM. OLD FUEL TANK VEGETATION: BRUSH, MINIMAL IMPACT, ASPECT AFFECTED; AESTHETIC.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 6/7/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC048b01

AVAILABLE PHOTOS: Yes

Title: drum

Year: 1993 **File Name:** BC048a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC049 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	25	0	**Easting:**	594289.395556187
Longitude:	139	14	0		
Longitude:	139	14	0	**Northing:**	6810475.65986045

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining	**Date from:**	**Date to:**	**Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

PLACER CLAIM, OLD PIPE IMPACT POTENTIAL MINIMAL, ASPECT AFFECTED AESTHETICS. WASTE ON SITE INCLUDES DRUMS, AND METAL SCRAP. THE VEGETATION OF THE AREA IS BRUSH.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location
Year: **File Name:** BC049b01

AVAILABLE PHOTOS: Yes

Title: steel pipe
Year: 1993 **File Name:** BC049a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC050 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

COORDINATES:

	deg	min	sec		
Latitude:	61	24	0	**Easting:**	594339.662037
Longitude:	139	14	0	**Northing:**	6808619.61628
Longitude:	139	14	0		706
					808

UTM Zone: 7V

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/06

LAND TENURE: Federal Mineral Claims **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining **Date from:** **Date to:** **Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

MINING CAMP, PIPE, OLD SLUICE BOX, OLD CAT. MINIMAL IMPACT POTENTIAL. VEGETATION: BRUSH, ASPECT AFFECTED: AESTHETICS

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel	Sluice Box	Scrap Metal Drums Equipment

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location
Year: **File Name:** BC050b01

AVAILABLE PHOTOS: Yes

Title: equipment - cat
Year: 1993 **File Name:** BC050a01

Title: sluice box
Year: 1993 **File Name:** BC050a02

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC051 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec
Latitude:	61	24	0
Longitude:	139	14	0
Longitude:	139	14	0

UTM Zone: 7V
Easting:594339.662037
Northing:6808619.61628
706
808

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Mining	**Date from:**	**Date to:**	**Activities:** Mine Site

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH CREEK; VEHICLE

SITE DESCRIPTION:

ABANDONED MINING CAMP. VEGETATION: BRUSH MINIMAL IMPACT, AFFECTED IS AESTHETICS. WASTE ON SITE INCLUDES DRUMS REFUSE AND METAL SCRAPS.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
	Hydrocarbon/Fuel		Scrap Metal Drums

Inspector: NEALE WORTLEY **Inspection date:** 7/26/93

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site Location

Year: **File Name:** BC051b01

AVAILABLE PHOTOS: Yes

Title: drumms and metal scraps

Year: 1993 **File Name:** BC051a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: HJ041 **DISTRICT:** Haines Junction **SITE NAME:** Duke River

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
Latitude:	61	25	0	**Easting:** 597846.839614986
Longitude:	139	10	0	
Longitude:	139	10	0	**Northing:** 6810573.83148667

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal DIAND **SITE STATUS:** Active Low Environmental Risk **Date:**

SITE OCCUPANT(S):

	Date from:	**Date to:**	**Activities:**
Military			

SITE ACCESS: **Name of access route:**

GENERAL ACCESS: Road

SITE DESCRIPTION:

SEE ASSESS #A-28-96 EBA Report Phase 2 env. Assess HJ 35,36,41...

Distance to Residence: 1 - 10 km **Distance to Water:** high water mark - 50 m **Visual Impact:** Medium

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
Asbestos			Debris/Refuse
Hydrocarbons			

Inspector: **Inspection date:**

Date of last modification to database: 11/30/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

Pick up Asbestos and sample wells

PREVIOUS SITE REPORTS:

Author EBA **Date** 1997

Title Phase 1 Env. Ass.

Report Location DIAND WASTE MGT **Reference No.** EBA 022 1997

Author EBA **Date** 1997

Title Phase 2 Env. Ass.

Report Location DIAND WASTE MGT **Reference No.** EBA -023-1998

AVAILABLE AIRPHOTOS: Yes

Title: Site location

Year: 1975 **File Name:** HJ041c01

Title: Locations investigated

Year: 1964 **File Name:** HJ041c02

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: site overview

Year: 1997 **File Name:** HJ041a01

Title: drums and refuse

Year: 1997 **File Name:** HJ041a02

Title: scrap metal

Year: 1997 **File Name:** HJ041a03

Title: metal ana wood debris

Year: **File Name:** HJ041a04

Was an environmental risk assessment completed for this site? No

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC037 **DISTRICT:** Beaver Creek **SITE NAME:** MILE 1102 ALASKA HWY

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	25	0	**Easting:**	596957.485232
Longitude:	139	11	0	**Northing:**	6810548.94766
Longitude:	139	11	0		887
					387

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

	Date from:	Date to:	Activities:
Unknown			

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: MILE 1102 ALASKA HWY (NORTH OF DUKE RIVER); VEHICLE

SITE DESCRIPTION:

MILE 1102 ALASKA HWY NORTH OF THE DUKE RIVER. OVERTURNED TRUCK BODY/FRAME. VEGETATION: MOSS, SHRUBS, SMALL BLACK SPRUCE. MINIMAL IMPACT. THE AFFECT IS AESTHETIC.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 2/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

CLEANUP AND REMOVE TO APPROVED DUMP SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: equipment

Year: 1992 **File Name:** BC037a01

Title: equipment

Year: 1992 **File Name:** BC037a02

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC038 **DISTRICT:** Beaver Creek **SITE NAME:** MILE 1102 ALASKA HWY

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

COORDINATES:

	deg	min	sec		
Latitude:	61	25	0	**Easting:**	597846.839614986
Longitude:	139	10	0		
Longitude:	139	10	0	**Northing:**	6810573.83148667

UTM Zone: 7V

SETTLEMENT AREA:
SETTLEMENT AREA:

NTS SHEET: 115 G/06

LAND TENURE: Federal **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Date from: **Date to:** **Activities:** GRAVEL PIT

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: MILE 1102 ALASKA HWY (NORTH OF DUKE RIVER); VEHICLE

SITE DESCRIPTION:

MILE 1102 ALASKA HWY NORTH OF DUKE RIVER. ABANDONED TRUCK. SITE IS AN ABANDONED GRAVEL PIT WITH METAL SCRAP. THE AFFECT IS AESTHETIC. MINIMAL IMPACT.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	**HAZARDS**	**STRUCTURES**	**WASTE MATERIAL**
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 2/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

CLEANUP AND REMOVE TO APPROVED DUMP SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: No

AVAILABLE PHOTOS: Yes

Title: abandoned vehicle

Year: 1992 **File Name:** BC038a01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC026 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH PIPELINE TEST SITE

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	26	0	**Easting:**	593350.223406
Longitude:	139	15	0	**Northing:**	6812307.74185
Longitude:	139	15	0		247
					472

UTM Zone: 7V

NTS SHEET: 115 G/06

LAND TENURE: Federal Land Lease/Land Use **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):
Commercial **Date from:** **Date to:** **Activities:** Pipeline

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH PIPELINE TEST SITE; VEHICLE

SITE DESCRIPTION:

ACTIVE CLAIM - LEASE. (INACTIVE) NORTHERN PIPELINE AGENCY (LEASE#). CONCRETE PLATFORM, BURIED INSULATED PIPE, UNDERGROUND TANKS. AN ABANDONED STAGING AREA. NO VEGETATION, ASPECT AFFECTS AESTHETICS, IMPACT MINIMAL.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
	Hydrocarbon/Fuel	Underground storage tanks	Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 1/10/92

Date of last modification to database: 10/25/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

REMOVAL AND RECONTOUR SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site location

Year: **File Name:** BC026b01

AVAILABLE PHOTOS: Yes

Title: Site overview and close-up on pipeline

Year: **File Name:** BC026A01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC027 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH PIPELINE TEST SITE

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	26	0	**Easting:**593350.223406 247
Longitude:	139	15	0	
Longitude:	139	15	0	**Northing:**6812307.74185 472

NTS SHEET: 115 G/06

LAND TENURE: Federal Other **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	**Date to:**	**Activities:** STAGING AREA Fuel Cache

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH PIPELINE TEST SITE; VEHICLE

SITE DESCRIPTION:

PRESENT OCCUPANT: NORTHERN PIPELINE AGENCY (LEASE #). THE SITE IS AN ACTIVE CLAIM NOT ACTIVE. THE VEGETATION OF THE AREA CONSISTS OF GRASSES AND MOSS. THE SITE IS AN ABANDONED STAGING SITE. WASTE LEFT ON SITE CONSISTS OF SCRAP METAL AND REFUSE. ASPECT AFFECT: AESTHETICS AND WILDLIFE HAZARD.

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse
			Scrap Metal

Inspector: NEALE WORTLEY **Inspection date:** 1/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes
Title: Site location
Year: **File Name:** BC027b01

AVAILABLE PHOTOS: Yes
Title: Site overview
Year: **File Name:** BC027A01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC008 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH CREEK

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec		
Latitude:	61	26	0	**UTM Zone:**	7V
Longitude:	139	13	0	**Easting:**	595128.014256 042
Longitude:	139	13	0	**Northing:**	6812355.90049 546

NTS SHEET: 115 G/06

LAND TENURE: Federal Other **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	1942	**Date to:**		**Activities:**	Active Dump
Government	**Date from:**		**Date to:**		**Activities:**	Inactive Dump

SITE ACCESS: Road **Name of access route:** ALASKA HIGHWAY

GENERAL ACCESS: BURWASH CREEK; VEHICLE; SITE POSSIBLY ON RESIDENCE MILE 1103.

SITE DESCRIPTION:

LARGE OLD ENGINE BLOCK, CULVERTS, PIPE MACHINERY PARTS. STAGING AREA, ABANDONED DUMP SITE. REFUSE, SCRAP METAL. PRESENT OCCUPANT: LAND CLAIMS R-1 BLOCK. PREVIOUS OCCUPANT: SITE POSSIBLY ON RESIDENCE MILE 1103.9 OR FEDERAL. VEGETATION: GRASS. ESTHETICS: AFFECTED. IMPACT POTENTIAL: MINIMAL.

Distance to Residence: >10 km **Distance to Water:** N/A **Visual Impact:** Medium

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
		Culverts	Scrap Metal Equipment Debris/Refuse

Inspector: NEALE WORTLEY **Inspection date:** 9/29/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

REMOVE TO APPROVED DUMP SITE

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site location

Year: **File Name:** BC008b01

AVAILABLE PHOTOS: Yes

Title: Site overview

Year: **File Name:** BC008A01

Was an environmental risk assessment completed for this site? No

NERAS score: 18 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

SITE NUMBER: BC028 **DISTRICT:** Beaver Creek **SITE NAME:** BURWASH PIPELINE TEST SITE

TRADITIONAL AREA: Kluane/White River
TRADITIONAL AREA: Kluane/White River

SETTLEMENT AREA:
SETTLEMENT AREA:

COORDINATES:

	deg	min	sec	
				UTM Zone: 7V
Latitude:	61	27	0	**Easting:**593300.415189
Longitude:	139	15	0	**Northing:**6814163.80271
Longitude:	139	15	0	788
				807

NTS SHEET: 115 G/06

LAND TENURE: Federal Other **SITE STATUS:** Active **Date:**

SITE OCCUPANT(S):

Military	**Date from:**	**Date to:**	**Activities:** STAGING AREA Fuel Cache

SITE ACCESS: Road **Name of access route:**

GENERAL ACCESS: BURWASH PIPELINE TEST SITE; VEHICLE

SITE DESCRIPTION:

ACTIVE CLAIM - LEASE(INACTIVE). NORTHERN PIPELINE AGENCY (LEASE#). LARGE SYROFOAM ON SITE. ABANDONED STAGING AREA. VEGETATION: SHRUBS. ASPECT AFFECTS: WATER QUALITY. POTENTIAL IMPACT: MODERATE

Distance to Residence: **Distance to Water:** **Visual Impact:**

CONTAMINANTS	HAZARDS	STRUCTURES	WASTE MATERIAL
			Debris/Refuse

Inspector: NEALE WORTLEY **Inspection date:** 1/10/92

Date of last modification to database: 7/27/99

SITE MONITORING INFORMATION:

SITE RECOMMENDATIONS:

REMOVE TO APPROVED DUMP SITE.

PREVIOUS SITE REPORTS:

AVAILABLE AIRPHOTOS: No

AVAILABLE MAPS: Yes

Title: Site location

Year: **File Name:** BC028b01

AVAILABLE PHOTOS: Yes

Title: Site overview

Year: **File Name:** BC028A01

Was an environmental risk assessment completed for this site?

NERAS score: 0 **CEAA screening?** No **CEAA screening date:**

National Contaminated Site Rating: 0

SITE FOLLOW-UP:

Date: **Action:**

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Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix IV Waterbird Survey Results

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

Table 1 Waterbird Survey Results - May 30-31, 1999

Pond Location (see Volume II, Figures 4-8 to 4-13)	Species	Number of Birds Observed	Comments
WB2	MALL	2	PAIR
WB2	NOSH	2	PAIR
WB2	AGWT	2	MALES
WB3	AGWT	1	MALE
WB4	SCAU	8	PAIRS
WB4	AGWT	2	PAIR
WB4	AGWT	1	MALE
WB5	SWAN	8	
WB5	AMWI	2	PAIR
WB5	CANV	2	PAIR
WB5	MALL	1	MALE
WB5	CANV	2	PAIR
WB5	MALL	2	MALES
WB5	AMWI	8	4 PAIRS
WB5	MALL	2	PAIR
WB5	AMWI	3	MALES
WB5	BOGU	3	
WB5	BAGO	2	PAIR
WB5	SCAU	1	male
WB5	BAGO	1	male
WB5	BUFF	400	mixed group
WB5	SWAL	300	
WB5	BAGO	10	
WB6	NOPI	1	MALE
WB6	RTLO		
WB8	LEYE	6	
WB8	NOSH	3	MALES
WB8	NOPI	3	
WB8	RNPH	3	
WB8	BUFF	2	PAIR
WB9	BUFF	2	
WB9	MALL	5	2 males 3 female
WB10	MERL	1	CHRISTMAS CREEK
WB10	NOHA	1	
WB10	SCAU	4	3 MALES, 1 FEMALE
WB11	RBME	2	pair
WB11	SPSA	6	
WB11	MEGU	2	
WB11	ARTE	1	
WB11	HEGU	1	
WB11	AGWT	1	
WB11	CLSW	2	

Pond Location (see Volume II, Figures 4-8 to 4-13)	Species	Number of Birds Observed	Comments
WB11	VGSW	4	
WB11	AGWT	8	
WB11	VGSW	3	
WB11	SEPL	2	
WB11	SOSA	1	
WB11	SEPL	2	
WB12	NOSH	2	pair
WB12	MALL	2	males
WB12	SCAU	2	pair
WB12	SCAU	16	8 pairs
WB12	BAGO	2	pair
WB12	AGWT	6	pairs
WB12	NOPI	1	male
WB12	ARTE	1	
WB13	MEGU	2	
WB13	ARTE	1	
WB14	SCAU	32	18 male / 14 female
WB14	MEGU	6	
WB14	MEGU	12	
WB14	MEGU	4	
WB15	MERG	1	
WB15	MEGU	1	
WB16	AGWT	6	3 pair
WB16	LEYE	12	
WB16	MEGU	4	
WB16	BUFF	4	2 pair
WB16	MALL	3	1 male

Note: See Table 5 for Species Codes

Table 2 Waterbird Survey Results - August 3-4, 1999

Pond Location (see Volume II, Figures 4-8 to 4-13)	Species	Number of Birds Observed	Comments
WB1	MALL	2	
WB1	MALL	12	
WB1	GULL	2	
WB2	BUFF	3	2 YOUNG
WB2	AGWT	1	
WB2	LEYE	2	
WB5	SCAU	8	1 FEMALE / 7 YOUNG
WB5	SUSC	5	1 FEMALE / 4 YOUNG
WB5	SCAU	28	YOUNG
WB5	SCAU	325	MOLTING
WB5	HOGR	5	
WB5	AGWT	21	
WB5	LEYE	5	
WB6	LEYE	1	
WB6	MALL	5	
WB6	GOLD	4	3 YOUNG
WB6	LEYE	4	
WB8	LEYE	3	
WB9	MALL	5	
WB9	NOSH	2	
WB9	MALL	4	
WB9	AGWT	2	
WB9	MALL	7	
WB10	SWAL	8	
WB11	MALL	6	YOY
WB11	AGWT	5	YOY
WB11	SCAU	25	IN OPEN WATER AREA
WB11	SPSA	5	
WB11	GULL	1	
WB13	AGWT	3	YOUNG OF YEAR
WB14	HEGU	1	

Notes: See Table 5 for Species Codes

Table 3 Waterbird Survey Results - September 20-21, 1999

Pond Location (see Volume II, Figures 4-8 to 4-13)	Species	Number of Birds Observed	Comments
WB1	GOLD	3	
WB5	GOLD	5	
WB5	HOGR	3	
WB5	SCAU	2	
WB5	SCAU	12	
WB5	HOGR	2	
WB5	SWAN	7	
WB5	RNGR	1	
WB5	HOGR	9	
WB5	BUFF	1	
WB5	SUSC	5	
WB5	MALL	14	
WB7	BUFF	3	
WB9	AMWI	14	
WB9	BUFF	3	
WB11	MALL	15	
WB11	AGWT	2	
WB11	WWSC	28	APPROX. 400M FROM SHORE
WB12	AGWT	1	FEMALE
WB16	MALL	7	
WB16	NOHA	1	MALE

Notes: See Table 5 for Species Codes

Table 4 Waterbird Survey Results - September 30, 1999

Pond Location (see Volume II, Figures 4-8 to 4-13)	Species	Number of Birds Observed	Comments
WB5	SWAN	75	
WB5	TRSW	4	3 CYGNETS
WB5	MALL	12	
WB5	AMWI	3	
WB5	AMWI	12	
WB5	BUFF	4	
WB5	MALL	2	
WB5	HOGR	6	
WB5	SCAU	35	
WB5	SCOT	18	
WB5	BUFF	8	
WB5	GOLD	9	
WB11	SCOT	17	
WB11	MALL	18	
WB11	MALL	60	
WB11	MERG	2	
WB11	AGWT	24	
WB11	AGWT	12	
WB11	MALL	6	
WB11	SCAU	8	OPEN WATER

Notes: See Table 5 for Species Codes

Table 5 Species Codes

SPECIES CODE	**COMMON NAME**	***SCIENTIFIC NAME***
RTLO	Red-Throated Loon	*Gavia stellata*
HOGR	Horned Grebe	*Podicep auritus*
RNGR	Red-necked Grebe	*Podiceps grisegena*
SWAN	Swan	*Cygnus sp.*
TRSW	Trumpeter Swan	*Cygnus buccinator*
AGWT	American Green-winged Teal	*Anas crecca*
MALL	Mallard	*Anas platyrhynchos*
NOPI	Northern Pintail	*Anas acuta*
NOSH	Northern Shoveler	*Anas clypeata*
AMWI	American Wigeon	*Anas americana*
CANV	Canvasback	*Aythya valisineria*
SCAU	Scaup	*Aythya sp.*
SCOT	Scoter	*Melanitta sp.*
WWSC	White-winged Scoter	*Melanitta fusca*
SUSC	Surf Scoter	*Melanitta perspicillata*
GOLD	Goldeneye	*Bucephala sp.*
BAGO	Barrow’s Goldeneye	*Bucephala islandica*
BUFF	Bufflehead	*Bucephala albeola*
MERG	Merganser	*Mergus sp.*
RBME	Red-breasted Merganser	*Mergus serrator*
NOHA	Northern Harrier	*Circus cyaneus*
LEYE	Lesser Yellowlegs	*Tringa flavipes*
RNPH	Red-Necked Phalarope	*Phalaropus lobatus*
SPSA	Spotted Sandpiper	*Actitus macularia*
SOSA	Solitary Sandpiper	*Tringa solitaria*
SEPL	Semipalmated Plover	*Charadrius semipalmatus*
BOGU	Bonapartes Gull	*Larus philadelphia*
MEGU	Mew Gull	*Larus canus*
HEGU	Herring Gull	*Larus argentatus*
ARTE	Arctic Tern	*Sterna paradisaea*
MERL	Merlin	*Falco columbarius*
VGSW	Violet Green Swallow	*Tachycineta thalassina*
CLSW	Cliff Swallow	*Hirundo pyrrhonota*
GRJA	Gray Jay	*Perisoreus canadensis*
BBMA	Black-billed Magpie	*Pica pica*
CORA	Common Raven	*Corvus corax*
BOCH	Boreal Chickadee	*Parus hudsonicus*
BLCH	Black-Capped Chickadee	*Parus atricapillus*
SWTH	Swainson’s Thrush	*Catharus ustulatus*
AMRO	American Robin	*Turdus migratorius*
BOWA	Bohemian Waxwing	*Bombycilla garrulus*
YRWA	Yellow-rumped Warbler	*Dendroica coronata*
YEWA	Yellow Warbler	*Dendroica petechia*
WIWA	Wilson’s Warbler	*Wilsonia pusilla*
COYE	Common Yellowthroat	*Geothlypis trichas*
ATSP	American Tree Sparrow	*Spizella arborea*
CHSP	Chipping Sparrow	*Spizella passerina*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
DEJU	Dark-eyed Junco	*Junco hyemalis*

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SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

APPENDIX V – HISTORICAL STREAMFLOW DATA

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

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SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix V-1 Mean Monthly Discharges

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

KLUANE RIVER AT OUTLET OF KLUANE LAKE

Station Number 09CA002

Drainage Area = 4950 km2
Natural Flow
LAT 61:25:37N
LONG 139:02:56W

Monthly Mean Discharge in Cubic Metres per Second

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1952	--	---	---	--	--	-	-	-	-	-	-	10.9	---
1953	8.1	5.68	10.7	15.8	24.9	74.1	146	112	80.4	46.0	24.3	7.84	46.7
1954	6.03	5.62	5.35	5.35	12.7	74.8	172	248	214	107	41.8	11.8	75.8
1955	9.79	8.79	8.34	10.8	10.3	33.9	162	228	165	70.7	29.1	11.3	62.8
1956	4.09	1.77	1.04	1.23	12.9	80.9	216	274	191	109	50.8	20.0	80.7
1957	16.7	16.3	15.1	13.4	27.7	135	244	310	234	120	56.6	33.4	102
1958	19.4	13.4	12.8	14.8	22.3	104	214	132	69	32.7	17.7	10.8	55.6
1959	8.34	6.88	6.03	10.9	23.2	96.9	211	220	167	81.0	38.3	14.0	74.2
1960	15.4	17.1	12.0	11.7	26.5	68.7	157	238	178	85.0	35.4	22.7	72.6
1961	19.2	17.6	17.6	15.8	22.4	55.4	137	220	149	63.9	31.1	20.4	64.5
1962	11.6	5.95	5.95	5.95	18.7	102	228	306	223	96.2	-	17.6	---
1963	17.0	15.9	15.3	15.7	27.7	69.7	-	-	-	-	39.5	18.4	---
1964	17.3	17.8	17.8	18.7	21.1	120	206	269	188	82.4	35.6	7.96	83.7
1965	6.48	6.55	6.09	5.25	12.5	54.9	131	202	150	68.2	34.1	17.4	58.2
1966	10.2	8.51	7.67	8.44	12.9	80.8	240	291	130	49.9	21.6	13.0	73.6
1967	9.34	8.95	8.69	8.86	23.2	143	192	147	76.0	42.9	25.7	12.4	58.5
1968	5.79	7.07	11.4	13.6	29.4	78.5	191	165	95.7	49.2	19.8	7.22	56.4
1969	6.13	6.68	8.97	19.7	30.8	106	258	257	150	77.4	35.7	6.98	80.9
1970	9.49	18.0	18.2	16.4	20.2	55.9	122	114	62.2	33.5	12.5	5.21	40.9
1971	2.39	0.649	0.637	1.18	6.97	65.9	197	348	214	89.9	33.3	15.6	81.9
1972	10.2	10.1	10.4	12.9	35.7	108	244	302	207	94.6	49.2	26.8	93.1
1973	16.1	12.0	13.4	14.9	23.0	48.5	171	232	160	77.5	34.2	14.5	68.6
1974	6.49	4.32	4.1	5.33	26.2	83.3	186	265	216	109	46.8	24.5	82.1
1975	14.4	13.4	20.4	18.2	20.6	48.1	207	260	184	102	56.1	21.8	81.1
1976	15.4	13.2	14.5	19.9	28.8	78.6	216	244	156	78.7	38.9	14.8	76.9
1977	17.5	23.8	19.0	15.2	17.6	66.6	157	225	179	87.3	46.3	25.1	73.7
1978	18.9	18.8	19.9	19.7	22.0	65.6	170	288	213	92.6	33.0	11.5	81.5
1979	9.44	10.8	16.1	21.5	33.4	82.5	210	308	231	99.8	46.2	18.4	91.2
1980	15.9	15.6	17.8	23.0	25.3	71.6	179	242	170	103	44.4	27.4	78.3
1981	22.0	18.2	15.5	14.9	25.7	68.2	173	272	202	93.4	38.9	21.8	81.0
1982	13.5	12.7	12.3	11.2	17.8	95.6	203	276	187	91.5	42.3	18.9	82.3
1983	13.0	12.2	13.5	18.4	23.4	76.2	206	276	171	76.4	41.7	25.2	80.0
1984	14.7	13.4	17.2	15.7	18.9	49.8	150	218	150	71.2	35.9	22.0	64.9
1985	17.5	16.0	15.1	14.7	18.0	44.3	150	240	190	91.8	36.8	34.0	72.9
1986	29.7	26.2	22.0	17.0	22.5	57.7	209	276	177	84.5	22.2	20.8	81.0
1987	20.8	19.5	16.4	14.0	19.0	57.1	167	272	218	102	45.2	18.0	81.2
1988	9.46	13.4	22.9	21.1	27.5	75	260	252	145	74.8	37.6	20.7	80.4
1989	12.0	10.9	11.8	20.1	35.8	61.9	92.9	78.8	58.6	35.2	11.7	8.62	36.7
1990	7.52	6.83	11.3	14.3	30.7	127	253	274	187	88.6	36.0	16.2	88.4
1991	13.8	11.1	14.0	22.8	36.6	94.1	267	282	200	104	48.8	26.7	94.1
1992	18.2	13.5	16.2	24.5	28.9	81	234	269	159	81.4	40.4	21.9	82.8
1993	16.1	14.8	14.9	19.5	34.5	112	231	354	232	120	44.1	16.8	102
	(Station Discontinued in 1995)												
MEAN	13.1	12.2	12.9	14.4	23.4	79.3	194.0	244.7	168.2	81.6	36.5	17.7	75.0
MAX	29.7	26.2	22.9	24.5	36.6	143.0	267.0	354.0	234.0	120.0	56.6	34.0	102.0
MIN	2.39	0.649	0.637	1.18	6.97	33.9	92.9	78.8	58.6	32.7	11.7	5.21	36.7

DONJEK RIVER BELOW KLUANE RIVER

Station Number 09CA003

Drainage Area = 12400 km2
Natural Flow
LAT 62:04:56N
LONG 139:51:35W

Monthly Mean Discharge in Cubic Metres per Second

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1979	-	-	-	-	-	-	-	-	-	187	57.4	26.5	---
1980	20.6	19.8	26.6	44.7	77.2	277	515	438	232	149	69.1	30.3	159
1981	24.4	20.2	18.7	22.2	119	210	460	478	271	142	41.1	17.3	153
1982	14.5	14.6	16.7	19.9	50.0	296	480	470	217	56.7	30.3	21.3	142
1983	19.1	19.8	20.5	28.7	69.7	274	554	519	254	135	63.2	26.7	167
1984	-	-	-	-	-	-	458	-	-	-	-	-	---
1986	-	-	-	-	-	-	-	-	-	118	36.6	28.5	---
1987	22.3	18.8	17.2	20.8	78.4	-	-	-	-	-	-	-	---
1988	23.5	19.0	16.5	20.4	97.5	231	689	502	221	97.4	54.3	41.9	169
1989	31.5	24.7	18.9	18.3	94.9	236	504	421	188	72.3	27.5	16.9	139
1990	13.4	11.9	11.2	12.8	72.9	348	481	400	145	56.4	36.8	24.0	135
1991	15.6	11.7	15.4	34.2	112	364	619	518	407	183	56.6	30.0	199
1992	24.5	21.9	32.8	46.6	102	251	673	517	245	114	66.1	40.4	179
1993	24.4	20.2	19.7	45.2	180	362	627	657	401	190	73.7	34.7	221
		(Station Discontinued in 1995)											
MEAN	21.3	18.4	19.5	28.5	95.8	285	551	492	258	125	51.1	28.2	166.3
MAX	31.5	24.7	32.8	46.6	180.0	364.0	689.0	657.0	407.0	190.0	73.7	41.9	221.0
MIN	13.4	11.7	11.2	12.8	50	210	458	400	145	56.4	27.5	16.9	135

DUKE RIVER NEAR THE MOUTH

Station Number 09CA004

Drainage Area = 631 km2
Natural Flow
LAT 61:21:37N
LONG 139:09:23W

Monthly Mean Discharge in Cubic Metres per Second

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1981	0.969	0.882	0.891	1.43	13.8	8.94	18.8	14.4	5.15	3.39	2.13	1.42	6.07
1982	1.13	1.11	1.09	1.20	4.44	16.8	17.3	15.0	6.06	3.68	2.72	2.15	6.09
1983	1.55	1.41	1.26	1.21	3.22	16.1	41.1	21.0	6.45	4.03	2.60	1.95	8.56
1984	1.09	0.692	0.481	0.801	4.19	20.5	-	-	7.96	3.98	2.17	1.31	---
1985	1.19	1.06	1.15	1.23	3.91	7.21	30	13.6	9.45	5.23	1.65	1.40	6.48
1986	1.25	0.897	0.38	0.822	--	--	23.8	-	--	--	1.93	1.62	---
1987	1.57	1.53	1.42	1.38	4.77	13.5	24.4	33.1	10.9	3.52	2.35	1.98	8.44
1988	1.41	1.45	1.28	1.20	4.28	14.1	87.7	21.2	6.09	3.61	2.70	2.60	12.4
1989	1.93	1.59	1.40	1.84	6.89	11.6	23.8	20.0	8.44	3.51	1.98	1.92	7.14
1990	1.64	1.19	0.996	1.28	5.90	19.7	19.1	18.4	8.64	3.23	2.16	2.04	7.06
1991	1.33	0.875	0.66	1.27	4.40	19.8	29.7	33.9	45.2	4.64	2.15	1.57	12.2
1992	1.14	1.02	1.06	1.32	7.98	40.7	109	20.7	5.78	3.98	2.57	1.42	16.5
1993	0.643	0.439	0.403	0.756	6.69	11.5	32.2	26.5	9.96	4.15	2.63	0.765	8.14
MEAN	1.30	1.09	0.96	1.21	5.87	16.7	38.1	21.6	10.8	3.91	2.29	1.70	9.01
MAX	1.93	1.59	1.42	1.84	13.8	40.7	109	33.9	45.2	5.23	2.72	2.60	16.5
MIN	0.643	0.439	0.38	0.756	3.22	7.21	17.3	13.6	5.15	3.23	1.65	0.765	6.07

DEZADEASH RIVER AT HAINES JUNCTION

Station Number 08AA003

Drainage Area = 8500 km2
Regulated since 1974
LAT 60:44:54N
LONG 137:30:19W

Monthly Mean Discharge in Cubic Metres per Second

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1953	13.2	9.70	8.89	12.6	49.6	87.6	100	71.0	66.7	50.6	35.3	21.1	44.1
1954	14.9	13.6	12.9	12.0	61.2	106	94.4	72.4	53.4	41.9	25.2	18.9	44.1
1955	17.2	15.6	15.0	15.2	40.2	102	142	87.6	59.2	41.6	21.9	14.1	47.8
1956	12.7	11.9	10.9	14.9	48.0	67.9	80.4	55.1	45.7	42.9	32.4	22.9	37.3
1957	18.2	15.4	14.3	16.2	71.1	173	124	78.0	63.5	52.0	30.2	19.7	56.4
1958	16.7	15.7	14.8	19.5	46.0	58.0	37.5	26.8	29.6	24.8	18.1	15.5	27.0
1959	13.3	11.4	10.5	10.7	53.6	125	72.1	70.3	55.5	43.4	27.4	21.3	43.0
1960	17.8	15.2	13.5	12.5	71.4	96.7	92.8	70.8	49.5	33.9	21.0	19.3	43.0
1961	17.0	14.4	12.7	13.0	54.1	117	117	67.0	51.2	38.7	24.4	22.1	45.9
1962	17.0	12.2	9.91	9.91	36.1	171	152	95.1	64.8	51.3	38.7	26.6	57.2
1963	21.5	17.6	16.4	15.9	65.4	101	156	95.5	74.1	58.9	35.5	27.8	57.5
1964	23.6	19.9	17.5	18.5	40.3	189	109	88.1	68.9	42.5	21.9	14.6	54.5
1965	13.8	13.3	12.6	12.6	34.2	71.4	88.8	45.5	32.7	27.8	17.8	15.4	32.3
1966	11.1	9.06	10.3	15.3	26.7	111	79.4	54.5	45.7	33.2	19.5	14.9	36.0
1967	12.1	9.04	7.09	11.9	54.8	130	105	75.9	67.5	45.0	21.1	15.6	46.5
1968	14.6	14.9	14.7	19.0	72.5	77.6	101	74.4	71.5	54.2	27.7	21.3	47.1
1969	16.4	15.8	14.4	22.7	52.5	86.0	60.3	63.5	68.4	69.4	42.1	29.4	45.2
1970	19.3	17.0	16.3	22.7	44.7	70.5	68.2	50.7	42.3	34.7	25.5	17.2	35.9
1971	12.2	11.0	9.93	10.2	31.8	92.8	83.5	62.7	43.6	30.6	18.3	12.5	35.0
1972	10.5	11.3	12.3	12.8	53.9	109	84.2	76.5	50.0	35.9	20.8	15.1	41.1
1973	13.6	12.7	11.3	13.7	33.2	66.3	77.9	66.2	52.6	36.9	17.7	14.8	34.9
1974	11.8	9.16	8.49	9.55	42.5	65.4	61.1	59.1	53.6	32.9	18.6	17.8	32.6
1975	15.1	11.6	8.40	10.3	50.3	-	-	99.9	117	77.6	23.8	22.4	---
1976	19.4	19.7	20.4	18.1	41.4	115	132	67.7	41.0	38.5	29.9	26.2	47.6
1977	22.4	21.6	22.3	28.0	31.2	102	97.6	65.7	44.4	38.2	31.5	28.2	44.5
1978	22.6	19.4	17.9	18.4	42.2	70.6	50.7	47.8	40.3	35.1	28.6	21.1	34.6
1979	18.7	16.1	18.4	22.3	51.1	98.4	97.4	57.6	54.9	42.3	23.3	15.3	43.1
1980	16.7	19.9	17.8	20.9	44.8	85.2	55.2	42.4	37.4	35.6	27.5	16.5	35.0
1981	15.6	15.5	15.3	17.6	55.1	61.5	54.3	44.3	46.6	45.8	30.8	22.3	35.5
1982	20.2	16.6	14.9	17.9	62.1	271	62.5	57.9	40.0	34.1	21.7	17.9	52.9
1983	17.2	17.8	14.2	32.3	44.0	75.9	69.0	45.6	36.9	30.0	21.8	16.1	35.1
1984	13.1	13.4	17.6	31.8	35.0	64	62.6	46.2	43.9	27.3	13.6	16.3	32.1
1985	17.8	21.0	20.1	26.4	61.4	84.9	106	55.6	41.5	30.4	21.0	13.3	41.8
1986	11.7	17.3	15.6	13.8	28.5	107	134	85.4	63.7	43.3	21.8	23.7	47.3
1987	23.2	22.4	22.6	26.2	43.9	74.0	64.1	51.2	51.7	45.5	32.0	27.0	40.4
1988	24.2	21.6	20.6	25.3	71.1	130	179	127	71.6	54.8	41.6	34.8	67.0
1989	29.2	26.3	23.0	29.7	84.5	104	85.8	56.1	46.2	41.5	32.6	31.7	49.3
1990	29.8	24.9	23.2	33.0	64.7	119	85.5	51.8	45.4	35.3	24.8	19.8	46.5
1991	21.1	24.4	22.0	23.8	38.0	77.0	98.0	87.4	102	65.8	31.0	29.9	51.8
1992	26.2	23.2	24.2	30.6	48.8	124	157	94.2	66.7	40.7	34.0	27.3	58.1
1993	27.1	21.4	25.1	32.3	66.4	93.2	71.2	53.2	43.8	46.7	37.6	28.3	45.7
All Data to 1993													
MEAN	17.8	16.3	15.6	19.0	50.0	103	93.7	66.9	54.8	42.2	26.6	20.9	43.8
MAX	29.8	26.3	25.1	33.0	84.5	271	179	127	117	77.6	42.1	34.8	67.0
MIN	10.5	9.04	7.09	9.55	26.7	58.0	37.5	26.8	29.6	24.8	13.6	12.5	27.0
1953 to 1973 only (pre-regulation natural flow)													
MEAN	15.6	13.7	12.7	14.8	49.6	105	96.5	68.9	55.1	42.4	25.8	19.1	43.4
MAX	23.6	19.9	17.5	22.7	72.5	189	156	95.5	74.1	69.4	42.1	29.4	57.5
MIN	10.5	9.04	7.09	9.91	26.7	58.0	37.5	26.8	29.6	24.8	17.7	12.5	27.0

GILTANA CREEK NEAR THE MOUTH

Station Number 08AA009

Drainage Area 194 km2
Natural Flow
LAT 61:11:50N
LONG 136:58:42W

Monthly Mean Discharge in Cubic Metres per Second

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1980	---	---	---	---	---	---	---	---	---	0.437	0.263	0.106	---
1981	0.057	0.046	0.045	0.050	1.65	0.561	0.269	0.041	0.257	0.757	0.344	0.091	0.350
1982	0.008	0.0	0.0	0.001	2.26	4.17	0.533	1.34	0.642	0.582	0.377	0.161	0.842
1983	0.094	0.103	0.111	0.130	1.72	1.39	0.535	1.10	0.596	0.376	0.140	0.071	0.533
1984	0.030	0.001	0.0	0.018	0.82	1.05	0.616	0.304	0.766	0.472	0.268	0.171	0.377
1985	0.032	0.001	0.0	0.001	2.43	2.40	0.651	0.439	0.612	0.526	0.235	0.119	0.624
1986	0.113	0.075	0.031	0.053	---	---	---	---	---	---	0.252	0.125	---
1987	0.080	0.078	0.083	0.116	1.60	1.98	0.253	0.194	0.472	0.386	0.245	0.164	0.472
1988	0.099	0.124	0.133	0.14	2.75	1.51	3.15	1.29	0.764	0.708	0.402	0.304	0.956
1989	0.202	0.134	0.134	1.15	3.12	0.931	0.37	0.168	0.202	0.299	0.221	0.145	0.593
1990	0.073	0.003	0.005	0.386	1.85	1.72	0.872	0.206	0.520	0.536	0.282	0.146	0.553
1991	0.093	0.082	0.075	0.168	2.75	1.48	1.64	1.51	2.06	0.924	0.462	0.369	0.975
1992	0.261	0.188	0.210	0.250	3.26	4.73	1.22	0.847	0.865	0.658	0.439	0.287	1.10
1993	0.125	0.132	0.144	0.530	2.07	0.798	0.685	0.665	0.711	0.671	0.387	0.203	0.597
MEAN	0.097	0.074	0.075	0.230	2.19	1.89	0.900	0.675	0.706	0.564	0.308	0.176	0.664
MAX	0.261	0.188	0.210	1.15	3.26	4.73	3.15	1.51	2.06	0.924	0.462	0.369	1.10
MIN	0.008	0.0	0.0	0.001	0.82	0.561	0.253	0.041	0.202	0.299	0.14	0.071	0.35

CHRISTMAS CREEK at Km 1687.8 Alaska Highway

Station Number 29CA005

Drainage Area 112.5 km2

Monthly Mean Discharge in Cubic Metres per Second
(Seasonal Data Only)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1983						*0.16*	0.26	0.24	0.23	*0.24*			
1984					*0.61*	1.00	0.36	0.32	*0.43*				
1985					1.65	0.71	0.42	0.33	0.36	*0.31*			
1986						1.60	0.79	0.41	0.34	0.30			
1987					*1.16*	*0.94*	0.15	*0.09*					
1988						1.35	2.46	0.69		*0.57*			
1989					1.92	0.59	*0.20*		*0.46*				
1990							*0.42*	*0.22*	*0.31*	*0.28*			
1991						*0.69*	0.44	0.27	0.33				
1992				*0.169*	1.20	1.83	0.603	0.393	0.412	*0.365*			
1993				*0.329*	1.65	0.511	0.432	0.296	0.307	*0.290*			
1994				*0.372*	0.318	0.311	0.249	0.237	0.276	*0.270*			
1995				*0.529*	0.663	0.259	0.237	0.243	0.227	*0.218*			
1996		No data for 1996											
1997						*0.261*	0.197	0.186	*0.186*				
1998		No data for 1998											
MEAN				0.350	1.15	0.786	0.516	0.302	0.322	0.316			
MAX				0.529	1.92	1.83	2.46	0.69	0.46	0.57			
MIN				0.169	0.318	0.16	0.15	0.09	0.186	0.218			

0.329 Monthly Mean Discharge Estimated from partial or incomplete month of data

Station operated by Indian & Northern Affairs Canada Water Resources

SLIMS RIVER at Alaska Highway Bridge

Drainage Area 2456 km2

Monthly Mean Discharge in Cubic Metres per Second
(Seasonal Data Only)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1993				*20*	23	58							
1994					34	73	162	*265*					

20 Monthly Mean Discharge Estimated from partial or incomplete month of data

Station operated seasonally by University of Ottawa (Sawada & Johnson 1999)

Yukon
Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix V-2 Mean Monthly Water Levels

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

KLUANE LAKE NEAR BURWASH LANDING

Station Number 09CA001

Natural Flow
LAT 61:03:18N
LONG 138:30:12W

Monthly Mean Water Levels in metres

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1953	---	---	---	---	---	---	3.356	3.139	2.932	---	---	---	---
1954	---	---	---	---	---	---	---	---	3.777	---	---	---	---
1961	---	---	---	---	---	2.703	3.275	3.706	3.300	2.777	---	---	---
1962	---	---	---	---	---	---	3.733	---	---	---	---	---	---
1963	---	---	---	---	---	---	---	---	---	---	---	---	---
1964	---	---	---	---	---	3.065	3.589	---	3.488	2.891	---	2.464	---
1965	---	2.436	2.413	---	---	---	3.206	3.633	3.333	2.810	2.616	2.547	---
1966	---	2.472	2.441	2.395	2.395	2.880	3.807	4.062	3.211	2.670	2.451	2.393	---
1967	2.384	2.357	2.348	2.332	2.471	3.275	3.558	3.285	2.799	2.521	2.351	2.295	2.667
1968	2.307	2.324	2.326	---	2.375	2.849	3.559	3.419	2.981	2.603	2.438	2.394	---
1969	2.394	---	2.392	2.371	---	2.989	3.895	3.889	3.308	2.810	2.539	2.443	---
1970	2.410	2.363	2.276	2.213	2.264	2.633	3.127	3.075	2.689	---	---	---	---
1971	---	2.314	2.335	2.366	2.442	2.713	---	4.334	3.662	2.931	2.587	2.465	---
1972	2.417	2.395	2.376	2.345	2.458	3.031	3.859	4.176	3.656	2.936	2.582	2.433	2.891
1973	---	---	---	---	---	2.512	3.411	3.773	3.351	2.783	---	2.438	---
1974	2.370	2.341	2.359	2.382	2.422	2.829	3.501	3.970	3.683	3.008	2.590	2.467	2.830
1975	2.403	2.343	2.258	2.172	2.228	2.560	3.620	3.907	3.505	2.985	2.641	2.515	2.765
1976	2.452	2.408	2.363	2.286	2.322	2.772	---	---	3.322	2.790	2.518	2.452	---
1977	2.397	2.278	2.202	---	---	2.676	3.337	3.731	3.464	2.855	2.571	2.485	---
1978	2.386	2.327	2.260	2.187	2.236	2.699	3.419	4.041	3.659	2.920	2.571	2.487	2.769
1979	2.448	2.393	2.345	2.280	2.419	2.838	3.643	4.142	3.752	2.972	2.572	2.465	2.859
1980	2.421	2.376	2.312	2.204	---	---	---	---	---	2.838	2.485	---	---
1981	2.317	2.241	2.153	2.097	2.209	2.680	3.359	3.822	3.478	2.851	2.532	2.361	2.678
1982	2.298	---	---	2.196	2.205	2.851	3.521	3.881	3.407	2.852	2.505	2.347	---
1983	2.258	2.193	2.140	2.070	2.159	2.673	3.596	---	---	2.774	2.481	2.388	---
1984	2.293	2.233	2.170	2.080	2.104	2.456	3.221	3.636	3.263	2.691	2.389	2.208	2.564
1985	2.170	2.128	2.101	2.044	2.063	2.388	3.065	3.727	3.471	2.861	2.534	2.388	2.582
1986	2.287	2.220	2.203	2.154	2.153	2.504	3.549	3.901	3.386	2.773	2.468	2.343	2.666
1993	2.228	2.210	2.142	2.062	2.228	2.931	---	---	---	2.901	---	---	---
MEAN	2.349	2.318	2.282	2.223	2.286	2.761	3.487	3.774	3.370	2.825	2.521	2.418	2.727
MAX	2.452	2.472	2.441	2.395	2.471	3.275	3.895	4.334	3.777	3.008	2.641	2.547	2.891
MIN	2.170	2.128	2.101	2.044	2.063	2.388	3.065	3.075	2.689	2.521	2.351	2.208	2.564

Water levels referred to assumed datum
APPLY 777.304 m adjustment to convert to Geodetic Survey of Canada Datum (Local 1943 adj.)

KLUANE LAKE NEAR BURWASH LANDING

Station Number 09CA001
Monthly Mean Water Elevations in metres
(777.304 m added to measured levels)

Natural Flow
LAT 61:03:18N
LONG 138:30:12W

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1953							780.660	780.443	780.236				
1954									781.081				
1961						780.007	780.579	781.010	780.604	780.081			
1962							781.037						
1963													
1964						780.369	780.893		780.792	780.195		779.768	
1965		779.740	779.717				780.510	780.937	780.637	780.114	779.920	779.851	
1966		779.776	779.745	779.699	779.699	780.184	781.111	781.366	780.515	779.974	779.755	779.697	
1967	779.688	779.661	779.652	779.636	779.775	780.579	780.862	780.589	780.103	779.825	779.655	779.599	779.971
1968	779.611	779.628	779.630		779.679	780.153	780.863	780.723	780.285	779.907	779.742	779.698	
1969	779.698		779.696	779.675		780.293	781.199	781.193	780.612	780.114	779.843	779.747	
1970	779.714	779.667	779.580	779.517	779.568	779.937	780.431	780.379	779.993				
1971		779.618	779.639	779.670	779.746	780.017		781.638	780.966	780.235	779.891	779.769	
1972	779.721	779.699	779.680	779.649	779.762	780.335	781.163	781.480	780.960	780.240	779.886	779.737	780.195
1973						779.816	780.715	781.077	780.655	780.087		779.742	
1974	779.674	779.645	779.663	779.686	779.726	780.133	780.805	781.274	780.987	780.312	779.894	779.771	780.134
1975	779.707	779.647	779.562	779.476	779.532	779.864	780.924	781.211	780.809	780.289	779.945	779.819	780.069
1976	779.756	779.712	779.667	779.590	779.626	780.076			780.626	780.094	779.822	779.756	
1977	779.701	779.582	779.506			779.980	780.641	781.035	780.768	780.159	779.875	779.789	
1978	779.690	779.631	779.564	779.491	779.540	780.003	780.723	781.345	780.963	780.224	779.875	779.791	780.073
1979	779.752	779.697	779.649	779.584	779.723	780.142	780.947	781.446	781.056	780.276	779.876	779.769	780.163
1980	779.725	779.680	779.616	779.508						780.142	779.789		
1981	779.621	779.545	779.457	779.401	779.513	779.984	780.663	781.126	780.782	780.155	779.836	779.665	779.982
1982	779.602			779.500	779.509	780.155	780.825	781.185	780.711	780.156	779.809	779.651	
1983	779.562	779.497	779.444	779.374	779.463	779.977	780.900			780.078	779.785	779.692	
1984	779.597	779.537	779.474	779.384	779.408	779.760	780.525	780.940	780.567	779.995	779.693	779.512	779.868
1985	779.474	779.432	779.405	779.348	779.367	779.692	780.369	781.031	780.775	780.165	779.838	779.692	779.886
1986	779.591	779.524	779.507	779.458	779.457	779.808	780.853	781.205	780.690	780.077	779.772	779.647	779.970
1993	779.532	779.514	779.446	779.366	779.532	780.235				780.205			
MEAN	779.653	779.622	779.586	779.527	779.590	780.065	780.791	781.078	780.674	780.129	779.825	779.722	780.031
MAX	779.756	779.776	779.745	779.699	779.775	780.579	781.199	781.638	781.081	780.312	779.945	779.851	780.195
MIN	779.474	779.432	779.405	779.348	779.367	779.692	780.369	780.379	779.993	779.825	779.655	779.512	779.868

Monthly Elevations in feet

MEAN	2557.9	2557.8	2557.7	2557.5	2557.7	2559.3	2561.7	2562.6	2561.3	2559.5	2558.5	2558.1	2559.2
MAX	2558.3	2558.3	2558.2	2558.1	2558.3	2561.0	2563.0	2564.4	2562.6	2560.1	2558.9	2558.6	2559.7
MIN	2557.3	2557.2	2557.1	2556.9	2557.0	2558.0	2560.3	2560.3	2559.0	2558.5	2557.9	2557.5	2558.6

Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix V-3 Extremes of Discharges and Water Levels

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

KLUANE LAKE NEAR BURWASH LANDING

Station Number 09CA001

Extremes in Water Levels for the Period of Record

YEAR	Maximum Instantaneous Water Level					Max. Daily Water Level				Minimum Daily Water Level			
1953	---					3.456	JUL	7		---			
1957	---					4.398	AUG	18		---			
1961	3.801	21:00	AUG	5		3.770	AUG	7		---			
1962	4.197	16:00	AUG	18		4.188	AUG	17		---			
1964	4.081	19:00	AUG	7		4.075	AUG	8		---			
1965	3.731	12:00	AUG	24		3.722	AUG	25		---			
1966	4.279	18:15	AUG	10		4.246	AUG	10		2.365	MAY	5	
1967	3.688	17:15	JUN	26		3.652	JUN	26		2.271	DEC	12	
1968	3.725	19:00	JUL	19		3.719	JUL	15		---			
1969	4.145	20:15	AUG	7		4.121	AUG	8		2.344	MAY	7	
1970	3.322	15:54	JUL	30		3.316	JUL	30		2.188	APR	30	
1971	4.508	2:30	AUG	15	*	4.502	AUG	15	*	2.280	JAN	4	
1972	4.240	15:40	AUG	10		4.240	AUG	10		2.326	APR	18	
1973	3.880	2:10	AUG	14		3.850	AUG	14		2.176	APR	29	
1974	4.228	19:50	AUG	19		4.170	AUG	19		2.332	FEB	15	
1975	3.972	3:55	AUG	11		3.968	AUG	11		2.131	APR	30	
1976	3.944	12:00	AUG	10		3.941	AUG	10		2.249	APR	26	
1977	3.941	20:00	AUG	24		3.938	AUG	24		---			
1978	4.231	22:00	AUG	17		4.206	AUG	18		2.167	APR	26	
1979	4.217	4:50	AUG	28		4.195	AUG	21		2.252	APR	18	
1981	3.910	17:51	AUG	12		3.901	AUG	12		2.079	APR	24	
1982	3.963	2:40	AUG	12		3.939	AUG	11		2.140	MAY	5	
1983	---	---				---	---			2.039	APR	26	
1984	3.784	19:11	AUG	12		3.773	AUG	13		2.057	APR	29	
1985	3.844	14:24	AUG	17		3.829	AUG	18		2.009	MAY	7	*
1986	4.068	7:53	AUG	13		4.051	AUG	7		2.107	APR	30	
1993	---	---				---	---			2.041	APR	26	

APPLY 777.304 m adjustment to convert to Geodetic Survey of Canada Datum (Local 1943 adj.)

KLUANE LAKE NEAR BURWASH LANDING

Station Number 09CA001

Extremes in Water Elevations (m) for the Period of Record

YEAR	Maximum Instantaneous Water Level				Max. Daily Water Level				Minimum Daily Water Level			
1953	---				780.76	JUL	7		---			
1957	---				781.702	AUG	18		---			
1961	781.105	21:00	AUG	5	781.074	AUG	7		---			
1962	781.501	16:00	AUG	18	781.492	AUG	17		---			
1964	781.385	19:00	AUG	7	781.379	AUG	8		---			
1965	781.035	12:00	AUG	24	781.026	AUG	25		---			
1966	781.583	18:15	AUG	10	781.55	AUG	10		779.669	MAY	5	
1967	780.992	17:15	JUN	26	780.956	JUN	26		779.575	DEC	12	
1968	781.029	19:00	JUL	19	781.023	JUL	15		---			
1969	781.449	20:15	AUG	7	781.425	AUG	8		779.648	MAY	7	
1970	780.626	15:54	JUL	30	780.62	JUL	30		779.492	APR	30	
1971	781.812	2:30	AUG	15	781.806	AUG	15	*	779.584	JAN	4	
1972	781.544	15:40	AUG	10	781.544	AUG	10		779.63	APR	18	
1973	781.184	2:10	AUG	14	781.154	AUG	14		779.48	APR	29	
1974	781.532	19:50	AUG	19	781.474	AUG	19		779.636	FEB	15	
1975	781.276	3:55	AUG	11	781.272	AUG	11		779.435	APR	30	
1976	781.248	12:00	AUG	10	781.245	AUG	10		779.553	APR	26	
1977	781.245	20:00	AUG	24	781.242	AUG	24		---			
1978	781.535	22:00	AUG	17	781.51	AUG	18		779.471	APR	26	
1979	781.521	4:50	AUG	28	781.499	AUG	21		779.556	APR	18	
1981	781.214	17:51	AUG	12	781.205	AUG	12		779.383	APR	24	
1982	781.267	2:40	AUG	12	781.243	AUG	11		779.444	MAY	5	
1983	---	---			---	---			779.343	APR	26	
1984	781.088	19:11	AUG	12	781.077	AUG	13		779.361	APR	29	
1985	781.148	14:24	AUG	17	781.133	AUG	18		779.313	MAY	7	*
1986	781.372	7:53	AUG	13	781.355	AUG	7		779.411	APR	30	
1993	---	---			---	---			779.345	APR	26	

KLUANE RIVER AT OUTLET OF KLUANE LAKE

Extremes of Discharge for the Period of Record

Station Number 09CA002

Drainage Area = 4950 km2

YEAR	Maximum Instantaneous Discharge					Maximum Daily Discharge				Minimum Daily Discharge			
1953	---					162	JUL	6		4.96	FEB	10	B
1954	---					269	AUG	14		5.24	MAR	29	B
1955	---					242	AUG	13		6.65	DEC	31	B
1956	---					283	AUG	16		0.963	MAR	21	B
1957	---					331	AUG	18		12.2	APR	21	B
1958	---					244	JUL	15		9.4	DEC	31	B
1959	---					229	AUG	26		5.72	MAR	13	B
1960	---					275	AUG	21		10.9	MAR	20	B
1961	237	5:00	AUG	12		235	AUG	12		14.3	APR	29	B
1962	317	16:00	AUG	18		314	AUG	16		5.95	FEB	1	B
1963	---					311	AUG	23	E	14.4	APR	1	B
1964	294	19:00	AUG	7		294	AUG	8		6.51	DEC	31	B
1965	219	12:00	AUG	24		218	AUG	25		5.04	APR	21	B
1966	337	18:15	AUG	10		328	JUL	30		7.36	MAR	22	B
1967	216	17:15	JUN	26		209	JUN	26		7.79	DEC	31	B
1968	222	19:00	JUL	19		221	JUL	15		4.67	FEB	4	B
1969	309	20:15	AUG	7		303	AUG	8		5.35	JAN	20	B
1970	151	15:54	JUL	30		150	JUL	28		4.19	DEC	31	B
1971	385	2:30	AUG	15		382	AUG	14		0.538	FEB	27	B *
1972	314	15:40	AUG	10		314	AUG	10		9.63	MAR	5	B
1973	251	2:10	AUG	14		246	AUG	14		9.17	DEC	31	B
1974	311	19:50	AUG	19		300	AUG	19		3.99	MAR	11	B
1975	274	3:55	AUG	11		273	AUG	11		11.5	FEB	12	B
1976	277	12:00	AUG	11		262	AUG	9	E	12.6	FEB	14	B
1977	262	20:00	AUG	24		262	AUG	24		14.6	APR	17	E
1978	326	22:00	AUG	17		323	AUG	18		9.0	DEC	28	B
1979	323	4:50	AUG	28		319	AUG	18		8.86	JAN	10	B
1980	267	11:13	AUG	15		259	AUG	15		14.3	JAN	31	B
1981	325	14:34	AUG	15		308	AUG	15		14.4	APR	14	B
1982	323	15:47	AUG	7		310	AUG	7		11.0	APR	9	B
1983	298	12:06	AUG	13		294	AUG	14		11.5	FEB	10	B
1984	257	21:21	AUG	24		246	AUG	19		11.9	JAN	31	B
1985	263	5:41	AUG	21		263	AUG	21		12.8	APR	27	
1986	321	1:32	AUG	9		311	AUG	8		16.2	APR	23	B
1987	303	18:50	AUG	16		299	AUG	16		10.1	DEC	31	B
1988	340	17:54	JUL	20		329	JUL	20		8.8	JAN	11	B
1989	112	10:58	JUL	14		105	JUL	14		7.95	DEC	20	B
1990	312	10:06	JUL	28		298	JUL	28		6.36	FEB	11	B
1991	334	21:30	JUL	31		324	AUG	1		10.0	FEB	20	B
1992	315	13:46	AUG	15		306	AUG	12		12.5	FEB	21	B
1993	427	19:42	AUG	14	*	413	AUG	14	*	14.3	MAR	9	B
1994	378		AUG	23		373	AUG	24		13.1	DEC	31	B
1995						340	JUL	27	E	12.4	JAN	27	B
1996	**Station Discontinued**												
1997													
1998													
MEAN	**291**					**281**				**9.28**			
						Average (Inst / Daily) = **1.036**							
MAX	**427**					**413**				**16.2**			
MIN	**112**					**105**				**0.538**			

A - Manual Gauge B - Ice Conditions E - Estimated R - Revised * - Extreme of period of record

DONJEK RIVER BELOW KLUANE RIVER

Extremes of Discharge for the Period of Record

Station Number 09CA003
Drainage Area = 12400 km2

YEAR	Maximum Instantaneous Discharge					Maximum Daily Discharge				Minimum Daily Discharge			
1980	673	17:51	AUG	13		642	JUL	15		18.7	FEB	18	B
1981	758	16:18	JUL	21		709	JUL	21		15.0	DEC	31	B
1982	828	12:20	JUL	31		746	JUL	31		13.5	JAN	25	B
1983	953	12:17	JUL	6		862	JUL	6		17.9	JAN	22	B
1984	777	15:19	AUG	8		756	AUG	8		---			
1987	---	---								16.4	MAR	22	B
1988	1700	21:20	JUL	16	*	1430	JUL	16	*	15.6	MAR	26	B
1989	782	13:39	JUL	13		712	JUL	13		14.7	DEC	31	B
1990	---					701	JUL	22	A	10.9	MAR	25	B *
1991	833	19:00	JUL	2		788	JUL	2		11.1	FEB	21	B
1992	850	10:13	JUL	14		826	JUL	14		20.3	FEB	19	B
1993	937	16:06	AUG	3		887	JUL	31		19.0	MAR	12	B
1994	1040		AUG	13		976	AUG	13		15.0	DEC	28	B
1995	**Station Discontinued**												
1996													
1997													
1998													
MEAN	**921**					**836**				**15.7**			
						Average (Inst / Daily) = **1.101**							
MAX	**1700**					**1430**				**20.3**			
MIN	**673**					**642**				**10.9**			

DUKE RIVER NEAR THE MOUTH

Extremes of Discharge for the Period of Record

Station Number 09CA004
Drainage Area = 631 km2

YEAR	Maximum Instantaneous Discharge					Maximum Daily Discharge				Minimum Daily Discharge			
1981	56.9	5:00	AUG	9		34.6	JUL	17		0.845	FEB	18	B
1982	68.8	1:40	JUN	7		30.8	JUN	7		1.03	FEB	25	B
1983	96.9	13:38	JUL	20		85.2	JUL	19		1.12	APR	13	A
1984	---	---								0.460	MAR	15	B
1985	72.4	0:18	JUL	12		66.7	JUL	14		1.01	FEB	24	B
1986	---	---								0.188	MAR	31	B *
1987	77.5	20:03	AUG	17		54.8	AUG	18		1.34	APR	23	B
1988	573	20:41	JUL	15	E *	308	JUL	15	*	1.10	APR	10	B
1989	61.4	23:04	JUL	11		39.0	JUL	12		1.20	OCT	28	B
1990	55.2	1:52	JUN	2		46.7	JUN	1		0.900	MAR	31	B
1991	73.7	13:12	JUN	22	E	69.9	JUN	22	E	0.510	APR	13	B
1992	227	0:44	JUL	5	E	190	JUL	7	E	0.778	DEC	31	B
1993	63.4	18:26	JUL	10		51.2	JUL	10		0.397	MAR	26	B
1994	62.8		AUG	12		39.4	AUG	12		0.312	FEB	15	B
1995	65.8		JUL	23		57.1	JUL	2		0.805	APR	6	B
1996	74.2		JUL	16		64.1	JUL	3		0.458	MAR	18	B
1997	61.6		JUL	8		44.2	JUL	8		0.926	OCT	18	B
1998	36.5		JUL	14		28.7	JUL	14		1.08	MAR	16	B
MEAN	**107.9**					**75.7**				**0.803**			
						Average (Inst / Daily) = **1.427**							
MAX	**573**					**308**				**1.34**			
MIN	**36.5**					**28.7**				**0.188**			

A - Manual Gauge B - Ice Conditions E - Estimated R - Revised * - Extreme of period of record

DEZADEASH RIVER AT HAINES JUNCTION

Extremes of Discharge for the Period of Record

Station Number 08AA003
Drainage Area 8500 km2
Regulated since 1974

YEAR	Maximum Instantaneous Discharge					Maximum Daily Discharge				Minimum Daily Discharge			
1953	---					133	JUL	16		8.16	MAR	20	B
1954	---					164	JUN	7	E	11.3	APR	27	B
1955	---					184	JUN	26		12.7	DEC	31	B
1956	---					125	JUN	29		10.5	MAR	24	B
1957	---					210	JUN	13		13.9	MAR	14	B
1958	---					70.8	JUN	7		14.3	MAR	21	B
1959	---					157	JUN	24		10.2	MAR	30	B
1960	---					141	MAY	31		11.3	APR	16	B
1961	---					286	JUN	28		11.9	APR	1	B
1962	---					275	JUN	21		9.91	MAR	1	B
1963	---					180	JUL	7		15.9	APR	1	B
1964	---					236	JUN	8		14.1	DEC	26	B
1965	---					111	JUL	8		12.3	MAR	26	B
1966	---					199	JUN	21		8.92	FEB	21	B
1967	---					158	JUN	6		6.74	MAR	22	B *
1968	---					261	MAY	23		10.2	FEB	1	B
1969	---					123	MAY	25		12.7	MAR	17	B
1970	---					81.0	JUN	17		14.4	DEC	31	B
1971	151	5:56	JUN	29		148	JUN	29		9.23	MAR	31	B
1972	198	7:30	MAY	31		190	MAY	31		9.77	JAN	18	B
1973	124	8:15	JUN	21		119	JUN	21		10.5	APR	12	B
1974	98.8	20:26	JUN	24		91.7	JUN	24		7.93	MAR	9	B
1975	---					---				7.50	APR	6	B
1976	184	13:06	JUL	12		183	JUL	12		15.9	APR	6	B
1977	172	12:27	JUN	3		166	JUN	3		20.0	FEB	14	B
1978	96.6	7:00	JUN	6		90.3	JUN	6		16.4	APR	21	B
1979	150	16:25	JUN	23		147	JUN	24		13.2	DEC	22	B
1980	124	1:10	JUN	8		121	JUN	7		12.1	APR	5	B
1981	87.9	9:00	MAY	28		86.2	MAY	28	S	11.4	FEB	16	B
1982	---					700	JUN	8	E *	10.0	MAR	8	B
1983	131	6:20	JUN	1		121	JUN	1		11.6	MAR	29	B
1984	108	5:46	JUL	1		105	JUL	1		11.0	JAN	13	B
1985	152	11:08	JUN	5		148	JUN	5		11.2	DEC	31	B
1986	165	9:47	JUL	3		160	JUL	3		10.6	JAN	9	B
1987	180	7:33	JUN	1		168	JUN	1		21.0	FEB	27	B
1988	355	13:22	JUL	17	*	337	JUL	17		19.2	APR	7	B
1989	141	6:43	MAY	31		130	MAY	31		21.5	APR	7	B
1990	171	7:55	JUN	2		166	JUN	2		18.9	DEC	14	B
1991	137	5:00	JUL	29		136	JUL	29		20.1	JAN	7	B
1992	197	16:59	JUL	15		192	JUL	15		22.2	FEB	12	B
1993	116	0:34	MAY	19		111	JUN	6		21.1	FEB	14	B
MEAN													
All Data	**154**					**173**				**13.2**			
Concurrent	**154**	(1971 - 1993 only)				**148**				**14.7**			
						Average (Inst / Daily) = **1.040**							
Prior to 1974 Regulation													
Mean						**169**				**11.4**			
Max						**286**				**15.9**			
Min						**71**				**6.74**			
Maximums and Minimums for complete period of record													
MAX	**355**					**700**				**22.2**			
MIN	**87.9**					**70.8**				**6.74**			

GILTANA CREEK NEAR THE MOUTH

Extremes of Discharge for the Period of Record

Station Number 08AA009

Drainage Area 194 km2

YEAR	Maximum Instantaneous Discharge					Maximum Daily Discharge				Minimum Daily Discharge			
1981	---					4.93	MAY	12	A	0.006	AUG	23	
1982	9.14	4:27	JUN	2		9.04	JUN	2		0.0	JAN	16	B *
1983	3.05	5:51	JUN	5		3.01	JUN	5		0.06	DEC	30	B
1984	2.33	13:12	JUN	8		2.31	JUN	8		0.0	FEB	5	B *
1985	8.02	1:00	MAY	29		7.99	MAY	29		0.0	FEB	13	B *
1986	---					---				0.026	MAR	25	B
1987	5.1	14:28	JUN	2		5.02	JUN	2		0.074	MAR	2	B
1988	9.07	15:45	JUL	17		8.94	JUL	17		0.094	JAN	28	B
1989	7.31	14:20	MAY	2		7.26	MAY	2		0.105	DEC	31	B
1990	2.87	3:30	JUN	9		2.75	JUN	4		0.001	FEB	8	B
1991	4.80	11:33	MAY	8		4.76	MAY	8		0.074	MAR	12	B
1992	**15.0**	8:06	MAY	29	*	**14.8**	MAY	29	*	0.126	DEC	31	B
1993	4.25	17:01	MAY	3		3.10	MAY	19		0.122	JAN	24	B
1994	1.19		MAY	22		1.19	MAY	22		0.102	AUG	30	
1995						2.85	MAY	4		0.06	DEC	31	B
1996	3.18		MAY	27		1.98	MAY	27		0.001	FEB	19	B
1997	3.89		MAY	24		3.84	MAY	24		0.0	JAN	5	B *
1998	2.48		MAY	6		2.45	MAY	6		0.029	JUL	28	
MEAN	**5.45**					**5.08**				**0.049**			
						Average (Inst / Daily) = **1.072**							
MAX	**15.0**					**14.8**				**0.126**			
MIN	**1.19**					**1.19**				**0.0**			

CHRISTMAS CREEK at Km 1687.8 Alaska Highway

Extremes of Discharge for the Period of Record

Station Number 29CA005

Drainage Area 112.5 km2

YEAR	Maximum Instantaneous Discharge	Maximum Daily Discharge				Minimum Daily Discharge			
1983		***				0.05	JUN	29	
1984		3.59	June	6		0.02	MAY	7	* ++
1985		4.23	May	25		0.19	MAY	12	(++)
1986		3.12	May	27	(++)	0.25	OCT	20	(++)
1987		4.19	May	31		0.04	AUG	12	++
1988		5.09	July	16		0.43	OCT	17	++
1989		4.24	May	1	++	0.18	SEPT	13	
1990		3.21	June	1		0.18	AUG	17	
1991		***				0.21	AUG	24	
1992		4.25	May	26		0.144	APR	19	
1993		**5.16**	May	16	*	0.165	APR	16	
1994		0.531	June	19		0.191	JUL	28	
1995		1.76	May	8		0.175	APR	21	++
1996		---				---			
1997		***				0.15	JUL	21	
1998		---				---			
MEAN		**3.58**				**0.18**			
MAX		**5.16**				**0.43**			
MIN		**0.531**				**0.02**			

SLIMS RIVER at Alaska Highway Bridge

Drainage Area 2456 km2

YEAR	Maximum Instantaneous Discharge	Maximum Daily Discharge				Minimum Daily Discharge			
1993		68	JUN	25	++	10	MAY	11	
1994		**314**	AUG	5	++	7	MAY	9	++
MEAN									
MAX									
MIN									

Flows estimated from Sawada (1996) and do not correspond to annual extremes due to seasonal operation.

* Extreme of period of Record
*** Station operation began after annual snowmelt completed
--- No data available for year
++ Maximum or Minimum recorded on or near first or last day of data collection for year

Yukon
Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix V-4 Selected Hydrology Plates

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

Christmas Creek looking downstream at wooden culvert inlets.

Christmas Creek looking downstream.

Christmas Creek Looking Upstream.

Silver Creek culverts inlet with steel sheeting headwalls, semi-circular central pier. Note water drop at inlet on left.

Christmas Creek (km 1688) looking east. Flow right to left under Highway.

Slims River bridge upstream from right abutment. Note riprap around central pier and within left (far) bridge opening.

Sheep Mountain looking west from Slims River bridge. Upstream training groynes on left. Note debris chute and colluvial fan deposit right of causeway, unstable slope right-centre, and landslide deposit far right along existing highway on north shore.

Congdon Creek looking upstream from highway.

Congdon Creek culvert inlet. Note minor bedload deposition, sand with gravel.

Nines Creek culvert inlet. No evidence of significant flow in channel.

Mines Creek culvert inlet with severe sediment aggradation. Culvert could be 4300mm to 4600mm diameter circular <u>or</u> pipe arch with 4370 to 4570mm span and 2870 to 3070mm rise

Bock’s Brook looking downstream through culvert. Note extensive sediment deposition.

Bock’s Brook looking upstream from highway. Note push-up dykes both sides, log-catcher angle irons across channel.

Lewis Creek looking upstream from highway.

Lewis Creek looking downstream to multi-plate culvert inlet. Note severe bed aggradation. Culvert may be 4720mm span x 3070mm rise pipe arch or 4610mm diameter circular pipe.

Lewis Creek looking upstream from 100m downstream of highway.

Copper Joe Creek looking upstream from highway.

Copper Joe Creek looking upstream. Note angle-iron log deflectors and eroding left bank on right of photo.

Copper Joe Creek looking downstream from highway.

Copper Joe Creek flume extension at downstream end.

Duke River bridge from left upstream abutment.

Burwash Creek bridge looking downnstream at right abutment and right mid-channel pier. Note severe bed aggradation around pier.

Burwash Creek bridge looking upstream from left bank.

Burwash Creek bridge from downstream of right abutment.

Sakiw Creek culvert looking upstream at outlet. Note fill slumping and sag in culvert crown.

Williscroft Creek looking upstream at culvert. Note sharp bend in approach channel at upper centre/right of photo, bank erosion, large size of channel paving material.

Sakiw Creek looking upstream at approach channel.

Sakiw Creek looking west at existing crossing.

Kluane Lake shoreline looking northeast towards start of Alignment "B1". Note the lack of vegetation along the shore and potential for rockfalls from above the highway.

Yukon
Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix VI-1 Major Vegetation Types

February 2000

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Appendix VI-1 Major Vegetation Types (km 1664.5 - 1788.5)

The characteristic combination of plant species found in each vegetation type is taken from Stanek (1980) with additional accounts of frequently occurring species from the current field surveys. Vascular plant species names are from Cody (1996). Non-vascular plant species names are from MacKinnon *et al*. (1992). Vegetation community types are found in Volume II, Figures 6-1 to 6-7.

White Spruce - Rhododendron (*Picea glauca - Rhododendron lapponicum*)

Characteristic species

trees
Picea glauca
Picea mariana

shrubs
Arctostaphylos rubra
Alnus crispa
Dryas integrifolia
Ledum groenlandicum
Potentilla fruticosa
Rhododendron lapponicum
Salix glauca
Vaccinium uliginosum
Vaccinium vitus-idaea

graminoids
Carex concinna
Eriophorum vaginatum

non-vascular plants
Aulocomnium palustre
Hylocomium splendens

forbs
Amerorchis rotundifolia
Boschniakia rossica
Corallorhiza trifolia
Cypripedium passerinum
Dryas integrifolia
Equisetum scirpoides
Hedysarum alpinum
Pedicularis labradorica
Pyrola grandiflora
Tofieldia pusilla

White Spruce - Bearberry (***Picea glauca - Arctostaphylos rubra***)

Characteristic species

trees
Picea glauca

shrubs
Alnus crispa
Arctostaphylos rubra
Empetrum nigrum
Ledum groenlandicum
Linnaea borealis
Salix glauca
Vaccinium vitus-idaea

graminoids
Eriophorum vaginatum

non-vascular plants
Thuidium abietina
Hylocomium splendens
Hypnum procerrimum

forbs
Amerorchis rotundifolia
Arnica angustifolia ssp. *attenuata*
Cypripedium passerinum
Dryas integrifolia
Geocaulon lividum
Hedysarum alpinum
Lupinus arcticus
Mertensia paniculata
Peducularis sudetica
Platanthera obtusata
Valerian capitata

White Spruce - Kinnikinick (*Picea glauca - Arctostaphylos uva-ursi)*

Characteristic species

trees
Picea glauca
Populus tremuloides

shrubs
Arctostaphylos uva-ursi
Linnaea borealis
Rosa acicularis
Salix arbusculoides
Salix bebbiana
Salix glauca
Shepherdia canadensis

graminoids
Festuca altaica

non-vascular plants
Ceratodon purpureus
Peltigera canina
Thuidium abietnum

forbs
Anemone multifidia
Epilobium angustifolium
Geocaulon lividum
Mertensia paniculata
Platanthera obtusata
Pyrola grandiflora
Zygadenus elegans

White Spruce - Woodland Sedge (*Picea glauca - Carex concinna*)

Characteristic species

trees
Picea glauca

shrubs
Linnaea borealis
Salix glauca

forbs
Epilobium angustifolium

graminoids
Carex concinna

non-vascular plants
Drepanocladus uncinatus
Hylocomium splendens
Peltigera canina

Black Spruce - Labrador Tea (***Picea glauca - Ledum groenlandicum***)

Characteristic species

trees
Picea mariana

shrubs
Empetrum nigrum
Ledum groenlandicum
Vaccinium uliginosum
Vaccinium vitus-idaea

forbs

graminoids

non-vascular plants

Trembling Aspen - Common Yarrow (*Populus tremuloides - Achillea millefolium*)

Characteristic species

trees
Picea glauca
Populus tremuloides

shrubs
Arctostaphylos uva-ursi
Rosa acicularis
Shepherdia canadensis

forbs
Achillea millefolium ssp. *borealis*
Epilobium angustifolium

graminoids
Festuca altaica

non-vascular plants

Balsam Poplar - Broad-leaved Willowherb (*Populus balsamifera - Epilobium latifolium*)

<u>Characteristic species</u>

trees
Populus balsamifera

shrubs
Salix alaxensis
Salix planifolia
Shepherdia canadensis

forbs
Achillea millefolium ssp. *borealis*
Arnica lonchophylla
Artemisia alaskana
Epilobium latifolium
Erysimum inconspicuum
Hedysarum boreale
Potentilla bimundorum

graminoids
Calamagrostis purpurascens
Deschampsia caespitosa
Elymus calderi
Elymus trachycaulus
Festuca richardsonii
Juncus balticus

non-vascular plants

Balsam Poplar - Arctic Lupine (*Populus balsamifera - Lupinus arcticus*)

Characteristic species

trees
Populus balsamifera

shrubs
Arctostaphylos uva-ursi
Salix alaxensis
Shepherdia canadensis

forbs
Achillea millefolium ssp. *borealis*
Arabis holboellii
Crepis tectorum
Dryas drummondii
Epilobium angustifolium
Epilobium latifolia
Lappula occidentalis
Linum lewisii
Lupinus arcticus
Potentilla hyparctica

graminoids
Calamagrostis purpurascens
Deschampsia caespitosa
Elymus calderi
Festuca altaica

non-vascular plants
Peltigera canina

Bluegreen Willow **(*Salix glauca*)**

Characteristic species

trees
Picea glauca
Populus balsamifera

shrubs
Arctostaphylos rubra
Betula glandulosa
Salix glauca
Salix alaxensis
Salix nova-angilae
Salix planifolia

forbs
Astragulus alpinus
Hedysarum alpinum

graminoids
Carex aquatilis

non-vascular plants
Aulacomnium palustre

Tall Blueberry Willow (*Salix nova-angilae*)

Characteristic species

trees
Picea glauca
Populus balsamifera

shrubs
Arctostaphylos rubra
Salix brachycarpa
Salix nova-angilae

graminoids
Carex aquatilis
Eriophorum brachyantherum

non-vascular plants
Aulacomnium palustre

forbs
Astragulus alpina
Castilleja hyperborea
Crepis elegans
Equisetum palustre
Hedysarum alpinum
Parnassia palustris var. *neogaea*
Pedicularis sudetica
Platanthera obtusata
Pyrola asarifolia

Alaskan Willow **(*Salix alaxensis*)**

Characteristic species

trees
shrubs
Alnus crispa
Arctostaphylos rubra
Ledum decumbens
Linnaea borealis
Potentilla fruticosa
Salix alaxensis
Salix glauca

forbs
Anemone parviflora
Artemisia tilesii
Cysopteris fragilis
Equisetum palustre
Gentianella propinqua ssp. *propinqua*
Mertensia paniculata
Platanthera obtusata
Pyrola asarifolia
Senecio lugens
Solidago simplex
Tofieldia pusilla
Zygadeus elegans

graminoids
Calamagrostis purpurascens
Trisetum spicatum

Mountain Alder **(*Alnus crispa*)**

Characteristic species

trees
Picea glauca

shrubs
Alnus crispa

Salix alaxensis

forbs
Achillea millefolium spp. *borealis*
Artemisia alaskanum
Boschniakia rossica
Delphinium glaucum
Hedysarum alpinum
Valerian capitata

graminoids
Trisetum spicatum

non-vascular plants
Hylocomium splendens

Sagewort - Purple Reed Grass (*Artemisia frigida - Calamagrostis purpurascens*)

Characteristic species

trees

shrubs
Arctostaphylos uva-ursi
Rosa acicularis

forbs
Achillea millefolium ssp. *borealis*
Antennaria rosea
Artemisia frigida
Erigeron caespitosus
Linum lewisii
Penstemon gormanii
Penstemon procerus
Pulsatilla ludoviciana
Solidago simplex

graminoids
Calamagrostis purpurascens
Carex filifolia
Elymus calderi
Poa glauca

non-vascular plants
Caloplaca cirrochroa
Lecidea rubiformis

Sagewort - Glaucous Bluegrass (*Artemisia frigida - Poa glauca*)

Characteristic species

trees

shrubs
Arctostaphylos uva-ursi
Shepherdia canadensis

forbs
Antennaria rosea
Artemisia frigida
Conioselinum cnidiifolium
Epilobium angustifolium
Fragaria virginiana ssp. *glauca*
Potentilla rubricaulis
Pulsatilla ludoviciana
Solidago simplex

graminoids
Poa glauca

non-vascular plants

Drummond's Mountain Aven (*Dryas drummondii*)

Characteristic species

trees
Populus balsamifera

shrubs
Eleagnus commutata

forbs
Crepis elegans
Chamaerhodos erecta ssp. *nuttallii*
Dryas drummondii
Epilobium latifolium
Erigeron purpuratus
Erysimum inconspicuum
Oxytropis campestris ssp.*varians*
Oxytropis viscida
Silene involucrata ssp. *involucrata*

graminoids
Elymus trachycaulis ssp. subsecundus
Poa glauca

non-vascular plants
Tortula ruralis

Water Sedge (***Carex aquatilis***)

<u>Characteristic species</u>

trees

shrubs
Potentilla fruticosa
Rubus arcticus ssp. *acaulis*
Salix glauca

forbs
Equisetum fluviatile
Gentiana prostrata
Petasites sagittatus
Potentilla palustris

Rorippa palustris
Rumex occidentalis
Pedicularis sudetica
Potamogeton filiformis var. *borealis*
Potamogeton vaginatus
Senecio congestus

graminoids
Calamagrostis canadensis
Calamagrostis stricta ssp. *inexpansa*
Carex aquatilis
Carex atheroides
Deschampsia caespitosa
Eleocharis uniglumis
Juncus balticus

Boulder Fields

Characteristic species

trees

Picea glauca
Populus tremuloides

shrubs

Arctostaphylos uva-ursi
Artemisia dranunculus
Juniperus communis
Juniperus horizontalis
Salix glauca
Salix myrtillifolia
Salix planifolia
Shepherdia canadensis

graminoids
Calamagrostis purpurascens
Carex filifolia

non-vascular plants

forbs

Achillea millefolium ssp. *borealis*
Anemone multifida
Artemisia alaskana
Artemisia frigida
Aster alpinus ssp. *vierhapperi*
Aster alpinus ssp. *vierhapperi*
Braya humilis
Chamaerhodos erecta ssp. *nuttalii*
Cysopteris fragilis
Dryas drummondii
Dryas drummondii
Erigeron caespitosus
Lappula occidentalis
Linum lewisii
Penstemon gormanii
Plantago canescens
Potentilla pensylvanica
Pulsatilla ludoviciana
Senecio lugens
Solidago simplex

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ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix VI-2A Slims River Delta – Plant Species

February 2000

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Appendix VI-2A: Plant Species Observed on the Slims River Delta

Antennaria pulcherrima
Artemisia alaskana
Artemisia frigida
Aster yukonensis
Carex aquatilis
Carex microglochin
Carex maritima
Carex nardina
Carex parryana
Castilleja unalaschcensis
Deschampsia caespitosa
Elaeagnus commutata
Equisetum palustre
Eriophorum angustifolium
Euotia lanata
Hedysarum boreale
Hordeum jubatum
Juncus balticus var. *littoralis*
Juncus drummondii
Parnassia palustris var. *neogaea*
Plantago maritima
Platanthera hyperborea
Populus balsamifera
Puccinellia nutalliana
Pyrola asarifolia
Ranunculus cymbalaria
Salix alaxensis
Salix brachycarpa
Salix nova-angilae
Taraxacum ceratophorum
Triglochin palustre

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Appendix VI-2B Rare Plants - Jarvis River and Quill Creek

February 2000

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Appendix VI-2B: Rare Plants - Jarvis River and Quill Creek

Species	Common Name	Family	First Nation	Habitat *	Yukon Rarity Ranking **
Arnica chamissonis ssp. *incana*	Woolly Meadow Arnica	Asteraceae	CAFN, WRFN & KFN	roadsides, moist slopes, meadows	S3
Arnica diversifolia	Diverse Leopardbane	Asteraceae	KFN	moist, open woodland	S2
Artemisia rupestris ssp. *woodii*	Russian Sagewort	Asteraceae	KFN & CAFN	alpine slopes	S2
Aster borealis	Boreal Aster	Asteracea	CAFN, WRFN & KFN	bogs, wet meadows	S3
Aster yukonensis	Yukon Aster	Asteraceae	KFN	Slim’s River delta	S2
Astragalus nutzotinensis	Nultzotin Milk-vetch	Fabaceae	CAFN, WRFN & KFN	gravel outwashes, rocKFN screes	S4
Botrychium lanceolatum var. *lanceolatum*	Lance-leaved Grape Fern	Ophioglossaceae	CAFN	alpine meadows, grassy places	S3
Carex buxbaumii	Brown Bog Sedge	Cyperaceae	KFN	swamps, bogs, borders of lakes	S1
Carex lasiocarpa ssp. *americana*	Wooly Fruit Sedge	Cyperaceae	KFN	wet margins of peat bog ponds	S1
Carex maritima	Seaside Sedge	Cyperaceae	CAFN, WRFN & KFN	floodplains adjacent to Kluane Lake	S4
Carex microglochin	False Uncinia Sedge	Cyperaceae	KFN & CAFN	wet, springy places on calcareous soils (around Kluane Lake)	S3
Carex parryana	Parry’s Sedge	Cyperaceae	KFN & CAFN	silt and marl flats / birch-willow thickets on alkaline flats	S4
Carex stylosa	Long-style Sedge	Cyperaceae	KFN	muskeg	S1
Colpodium vahlianum	Vahl’s Colpodium	Poaceae	CAFN	wet seepages on slopes	S1
Comandra umbellata ssp.	Pale Comandra	Santalaceae	KFN	prairie grassland, dry open	S1

Species	Common Name	Family	First Nation	Habitat *	Yukon Rarity Ranking **
pallida				coniferous woodland near Kluane Lake	
Draba yukonensis	Yukon Whitlow Grass	Brassicaceae	KFN	open stony / grassy areas	S1
Eleocharis uniglumis	One-glumed Spike-rush	Cyperaceae	KFN & CAFN	calcareous or saline seeages on shores	S3
Elymus glaucus	Western Rye Grass	Poacea	KFN & CAFN	meadows and rocky woods	S3
Erigeron peregrinus ssp. *peregrinus*	Subalpine Fleabane	Asteraceae	KFN & CAFN	glacial moraines / subalpine slopes	S3
Erigeron uniflorus ssp. *ericephalous*	One-flowered Fleabane	Asteraceae	CAFN, WRFN & KFN	stony, gravely, calcareous soil	S3
Eurotia lanata	Winterfat	Chenopodaceae	KFN	steep mountain slopes adjacent Kluane Lake	S2
Geum aleppicum ssp. *strictum*	Yellow Aven	Roseaceae	KFN & CAFN	damp thickets, grassy clearings	S4
Helictotrichon hookeri	Hooker's Helictotrichon	Poaceae	KFN & CAFN	dry, grassy slopes near Duke River	S3
Koeleria macrantha	Prairie Koeler's Grass	Poaceae	KFN & CAFN	dry grassland, open woods, roadsides	S2
Lesquerella arctica ssp. *arctica*	Arctic Bladderwort	Brassicaceae	KFN & CAFN	calcareous cliffs, stony barrens	S3
Mertensia paniculata var. *alaskana*	Bluebell	Boraginaceae	KFN & CAFN	riverbanks, open woods and clearings	S2
Minuartia rossii	Ross' Stitchwort	Caryophylaceae	KFN & CAFN	gravelly, sandy calcareous barrens	S3
Myriophyllum verticillatum	Spiked Water-milfoil	Haloragaceae	CAFN	ponds and quiet streams	S3
Oxytropis sericea ssp. *spicata*	Rocky Mountain Locoweed	Fabaceae	KFN	grasslands / river terraces	S3
Phippsia algida	Ice Grass	Poacea	CAFN, WRFN &	wet alpine slopes and river	S3

Species	Common Name	Family	First Nation	Habitat *	Yukon Rarity Ranking **
			KFN	flats	
Phlox hoodii	Moss Phlox	Polemoniaceae	WRFN & KFN	dry prairies and foothills	S3
Plantago maritima	Maritime Plantain	Plantaginaceae	KFN	Slim's River delta	S2
Platanthera dilatata var. *dilatata*	White Rein Orchid	Orchidaceae	KFN & CAFN	muskegs and grassy meadows	S2
Poa arctica ssp. *williamsii*	Arctic Blue Grass	Poaceae	KFN	lakeshores and streambanks	S1
Poa cusickii	Mutton Grass	Poaceae	KFN & CAFN	open grassy slopes (Bear CreeKFN area)	S1
Potamogeton praelongus	White-stemmed Pondweed	Potamogetonaceae	KFN	deep waters of clear lakes	S3
Potentilla bimundorum	Two-world Cinquefoil	Rosaceae	WRFN & KFN	gravel lakeshores or outwash fans	S2
Potentilla bipinnatifida	Two-cleft Cinquefoil	Rosaceae	CAFN	open meadows and slopes	S3
Puccinellia deschampoides	Polar Alkali Grass	Poaceae	KFN	dry alkaline / saline flats	S1
Salix brachycarpa ssp. *brachycarpa*	Barren-ground Willow	Salicaceae	KFN & CAFN	low thickets near limestone screes	S3
Salix candida	Hoary Willow	Salicaceae	KFN	alkaline fens, birch-willow thickets bordering ponds, river terraces	S2
Salix setchelliana	Setchell's Willow	Salicaceae	CAFN, WRFN & KFN	gravely borders of glacial streams	S2
Saxifraga nelsoniana ssp. *pacifica*	Heart-leaf Saxifrage	Saxifragaceae	KFN & CAFN	moist open hillsides	S2
Scirpus rollandii	Dwarf Clubrush	Cyperaceae	KFN & CAFN	moist calcareous ground	S2
Senecio hyperborealis	Boreal Ragwort	Asteraceae	KFN	alpine calcareuos screes, slopes and floodplains	S3
Sisyrinchium montanum	Blue-eyed Grass	Iridaceae	KFN & CAFN	meadows, open hillsides and river banks	S2

Species	Common Name	Family	First Nation	Habitat *	Yukon Rarity Ranking **
Stipa nelsonii ssp. *dorei*	Nelson's Needle and Thread	Poaceae	KFN & CAFN	dry, open, grassy slopes	S3
Streptopus amplexifolius ssp. *americanus*	Clasping Twistedstalk	Liliaceae	KFN & CAFN	subalpine meadows and moist woods	S3
Suaeda calceoliformus	Sea-blite	Chenopodiaceae	KFN & CAFN	alkaline flats	S2
Thalictrum occidentale	Western Meadow Rue	Ranunculaceae	KFN & CAFN	meadows and moist woods	S3
Thellungiella salsuginea	Thellungiella	Brassicaceae	CAFN	saline meadows and lakeshores	S3
Townsendia hookeri	Easter daisy	Asteraceae	CAFN & KFN	dry slopes	S3
Woodsia ilvensis	Rusty Woodsia	Aspidiaceae	KFN	dry exposed acid rocks and crevices	S2

CAFN	Champagne and Aishihik First Nation
KFN	Kluane First Nation
WRFN	White River First Nation

Yukon Rarity Rankings:

S1	Critically imperilled in territory because of extreme rarity (1-6 locations)
S2	Imperiled in territory because of rarity (7-20 locations)
S3	Rare or uncommon in territory (21- 100 locations)
S4	Apparently secure in territory (100+ locations)
S5	Demonstrably secure in territory with many occurrences

* from Douglas *et al*. (1981) and Cody (1996)
** from Bennett (1999)

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Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix VI-3 Vegetation Survey Plot Data

February 2000

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Plot SV-1 (see Volume II, Figure 6-2)

Date: July 5, 1999
UTM Coordinates: 639,899 E 6,767,532 N
Slope: 3^0
Aspect: NW

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Picea	*glauca*	1
Populus	*balsamifera*	<1
Salix	*nova-angilae*	60

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Arctostaphylos	*rubra*	<1
Carex	*aquatilis*	60
Eriophorum	*brachyantherum*	*3*
Pedicularis	*sudetica*	<1
Pyrola	*asarifolia*	<1
Salix	*brachycarpa*	2
moss		5
leaf litter		25

Habitat / Wildlife Signs
hare pellets % browsing
Moose tracks & browsing

Plot SV-2 (see Volume II, Figure 6-2)

Date: July 5, 1999
UTM Coordinates: 640,231 E 6,767,307 N
Slope: 3^0
Aspect: NW

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Salix	*nova-angilae*	45

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Astragulus	*alpinus*	<1
Aulacomium	*palustre*	10
Carex	*aquatilis*	55
Castilleja	*hyperborea*	<1
Crepis	*elegans*	<1
Equisetum	*palustre*	<1
Hedysarum	*alpinum*	<1
Parnassia	*palustris*	<1
Platanthera	*obtusata*	<1
leaf litter		35

Habitat / Wildlife Signs
hare pellets & browsing

Plot SV-3 (see Volume II, Figure 6-2)

Date: July 6, 1999
UTM Coordinates: 642,512 E 6,767,754 N
Slope: 4^0
Aspect: NW

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
———	———	———

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Salix	*glauca*	80
Salix	*planifolia*	10

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Arctostaphylos	*rubra*	<1
Astragulus	*alpinus*	1
Hedysarum	*alpinum*	<1
moss		<1
leaf litter		65
bare ground		20

Habitat / Wildlife Signs
hare pellets
moose pellets & browsing

Plot SV-4 (see Volume II, Figure 6-2)

Date: July 6, 1999
UTM Coordinates: 637,427 E 6,764,633 N
Slope: 40^0
Aspect: N

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Alnus	*crispa*	10
Potentilla	*fruticosa*	2
Salix	*alaxensis*	30
Salix	*glauca*	15

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Arctostaphylos	*rubra*	20
Anemone	*parviflora*	5
Artemisia	*tilesii*	<1
Calamagrostis	*purpurascens*	2
Cysopteris	*fragilis*	<1
Equisetum	*palustre*	<1
Festuca	sp.	<1
Gentianella	*propinqua*	<1
Ledum	*decumbens*	2
Linnaea	*borealis*	3
Mertensia	*paniculata*	8
Platanthera	*obtusata*	<1
Pyrola	*asarifolia*	<1
Senecio	*lugens*	<1
Solidago	*simplex*	<1
Tofieldia	*pusilla*	<1
Trisetum	*spicatum*	1
Zygadenus	*elegans*	<1
moss		30
leaf litter		25

Habitat / Wildlife Signs
hare pellets & browsing

Plot SV-5 (see Volume II, Figure 6-2)

Date: July 6, 1999
UTM Coordinates: 636,893 E 6,764,646 N
Slope: 20^0
Aspect: NW

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Alnus	*crispa*	65
Salix	*alaxensis*	5

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Achillea	*millefolium*	<1
Artemisia	*alaskanum*	<1
Boschniakia	*rossica*	<1
Delphinium	*glaucum*	<1
Hedysarum	*alpinum*	<1
Trisetum	*spicatum*	3
Valerian	*capitata*	<1
leaf litter		30
bare ground		60

Habitat / Wildlife Signs
hare pellets & browsing
bear scat

Plot SV-6 (see Volume II, Figure 6-2)

Date: July 6, 1999
UTM Coordinates: 634,709 E 6,769,191 N
Slope: 40^0
Aspect: SE

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Rosa	*acicularis*	3

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Achillea	*millefolium*	<1
Antennaria	*rosea*	1
Arctosatphylos	*uva-ursi*	15
Artemisia	*frigida*	20
Astragalus	*williamsii*	1
Calamagrostis	*canadensis*	15
Carex	*filifolia*	3
Elymus	*calderi*	<1
Poa	*glauca*	1
Erigeron	*caespitosus*	<1
Linum	*lewisii*	<1
Penstemon	*gormanii*	2
Pulsatilla	*ludoviciana*	7
Solidago	*simplex*	<1
leaf litter		20
bare ground		10

Habitat / Wildlife Signs

sheep trail
ground squirrel bones

Plot SV-7 (see Volume II, Figure 6-5)

Date: July 6, 1999
UTM Coordinates: 602,818 E 6,809,168 N
Slope: 0^0
Aspect: neutral

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Shepherdia	*canadensis*	2

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Antennaria	*rosea*	2
Arctosatphylos	*uva-ursi*	25
Artemisia	*frigida*	25
Astragalus	*williamsii*	2
Conioselinium	*cnidiifolium*	<1
Epilobium	*angustifolium*	<1
Fragaria	*virginiana*	3
Poa	*glauca*	20
Potentilla	*rubricaulis*	1
Pulsatilla	*ludoviciana*	5
Solidago	*simplex*	<1
moss		10
leaf litter		5

Habitat / Wildlife Signs

ground squirrel burrows
moose tracks
horse tracks

Plot SV-8 (see Volume II, Figure 6-5)

Date: July 6, 1999
UTM Coordinates: 602,183 E 6,809,274 N
Slope: 0^0
Aspect: neutral

Overstorey (trees > 3.0 m)

Genus	Species	% Cover
______	______	______

Understorey (trees / shrubs 0.3 - 3.0 m)

Genus	Species	% Cover
Eleagnus	*commutata*	5
Populus	*balsamifera*	2

Ground Cover (trees / shrubs < 0.3 m, forbs, graminoids, bryophytes, lichens, wood & leaf litter, bare ground, water)

Genus	Species	% Cover
Anemone	*multifidia*	<1
Crepis	*elegans*	<1
Dryas	*drummondii*	45
Epilobium	*latifolium*	3
Fragaria	*virginiana*	2
Oxytropis	*campestris*	1
Poa	*glauca*	<1
leaf litter		10
bare ground		25

Habitat / Wildlife Signs
hare pellets & browsing

Yukon
Government

Community & Transportation Services
Transportation Engineering Branch

SHAKWAK PROJECT
ENVIRONMENTAL ASSESSMENT UPDATE
Km 1664.5 - 1788.5 ALASKA HIGHWAY #1

Appendix VII Socio-Economic Interview Questionnaires

February 2000

Prepared by:

ACCESS
CONSULTING
GROUP

SHAKWAK HIGHWAY BUSINESS QUESTIONNAIRE

STUDY ZONE (JARVIS TO QUILL CREEK)

INTRODUCTION:

We are evaluating the potential economic impact of the new construction to be completed between Jarvis Creek and Quill Creek. To do this job properly, we would like to understand the effect that the previous highway construction has had on your business. We would like you to answer a few questions regarding your experiences since the construction started. Any information you give us will be kept strictly confidential and we will not attribute anything to you or your business unless you explicitly want us to.

NAME:

LOCATION:

BUSINESS NAME:

	BUSINESS ACTIVITY	
CONSTRUCTION	**TOURISM RELATED**	**OTHER (PLEASE SPECIFY)**
Heavy equipment		
Rental/operation	Food Service	
Trucking	Hotel/Motel Accommodation	
Excavation	Retail/souvenirs	
Gravel & aggregate supply	Campground/RV park	
Carpentry	Service (fuel)	
Concrete	Mechanic	
Welding/Steel fabrication	Wilderness Tourism	
Mechanical/electrical	Travel Services	
Welding		

C1. How do you expect the actual highway construction to affect your business? Increased, decreased, (by how much?) no effect e.g. Dust, increased traffic flow, contracting opportunities.

C2. Do you forsee any opportunities during the highway construction for your business.

C3. How do you expect the new highway to affect your business once it is built? Increased, decreased, no effect

C4. In your opinion, what things could be done to ensure that your business and other local businesses will benefit?

C5. In your opinion, how could negative impacts on local businesses be minimized?

SHAKWAK HIGHWAY BUSINESS QUESTIONNAIRE

NORTH OF STUDY ZONE (QUILL CREEK TO BEAVER CREEK)

INTRODUCTION:

We are evaluating the potential economic impact of the new construction to be completed between Jarvis Creek and Quill Creek. To do this job properly, we would like to understand the effect that the previous highway construction has had on your business. We would like you to answer a few questions regarding your experiences since the construction started. Any information you give us will be kept strictly confidential and we will not attribute anything to you or your business unless you explicitly want us to.

NAME:

LOCATION:

BUSINESS NAME:

	BUSINESS ACTIVITY	
CONSTRUCTION	**TOURISM RELATED**	**OTHER (PLEASE SPECIFY)**
Heavy equipment		
Rental/operation	Food Service	
Trucking	Hotel/Motel Accommodation	
Excavation	Retail/souvenirs	
Gravel & aggregate supply	Campground/RV park	
Carpentry	Service (fuel)	
Concrete	Mechanic	
Welding/Steel fabrication	Wilderness Tourism	
Mechanical/electrical	Travel Services	
Welding		

N1. How did the highway construction affect your business? Increased, decreased, (by how much?) no effect

N2. During the highway construction, were there any opportunities you didn't get, but were qualified? Why? E.g. High bid, not invited to bid, etc.

N3. How has the new highway affected your business? (since the work was completed)
Increased, decreased, (by how much?) no effect

N4. It's been a short time since completion, how do you see your business being affected over the next five years?
Increased, decreased, (by how much?) no effect

N5. Before the highway was completed, how did you think the new highway would affect your business? E.g. fewer people stopping, faster traffic, no broken windshields, decrease in the number of flat tires, etc.
Increased, decreased, no effect

N6. **Were those expectations realized?**
Why, why not?

N7. **Before the construction started, how did you think your business would be affected during the actual construction period?**
Increased, decreased, no effect

N8. **Were those expectations realized?**
Why, why not?

N9. **Given your experience, how could things have been done to ensure that your business and other local businesses would have benefited more?**

N10. **What suggestions or approaches would you recommend for the next phase in construction that will maximize local benefits and/or minimize negative impacts on local businesses.**