# SOIL, TERRAIN AND WETLAND SURVEY OF THE CITY OF WHITEHORSE,

DRAFT REPORT WITH
MAPS AT 1;20,000 SCALE

PREPARED BY
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FOR
PLANNING SERVICES, CITY OF WHITEHORSE,
Whitehorse, Yukon Territory
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# 1. CHAPTER ONE: INTRODUCTION

## 1.1 PURPOSE AND USE OF THIS REPORT

The City of Whitehorse requires a comprehensive, reliable and consistent database of soil and terrain conditions to facilitate planning. Projects ranging from subdivision planning and green belt management to conservation issues will benefit with soil survey and terrain classification maps at the 1:20,000 scale. This scale allows for first cut planning and decision making. The information will facilitate relations with the public, and with other professionals from private or governmental agencies, such as engineers, biologists, planners and geologists. It provides first level information to classify and select land parcels according to their suitability or sensitivity, and helps define the range and extent of site specific investigation.

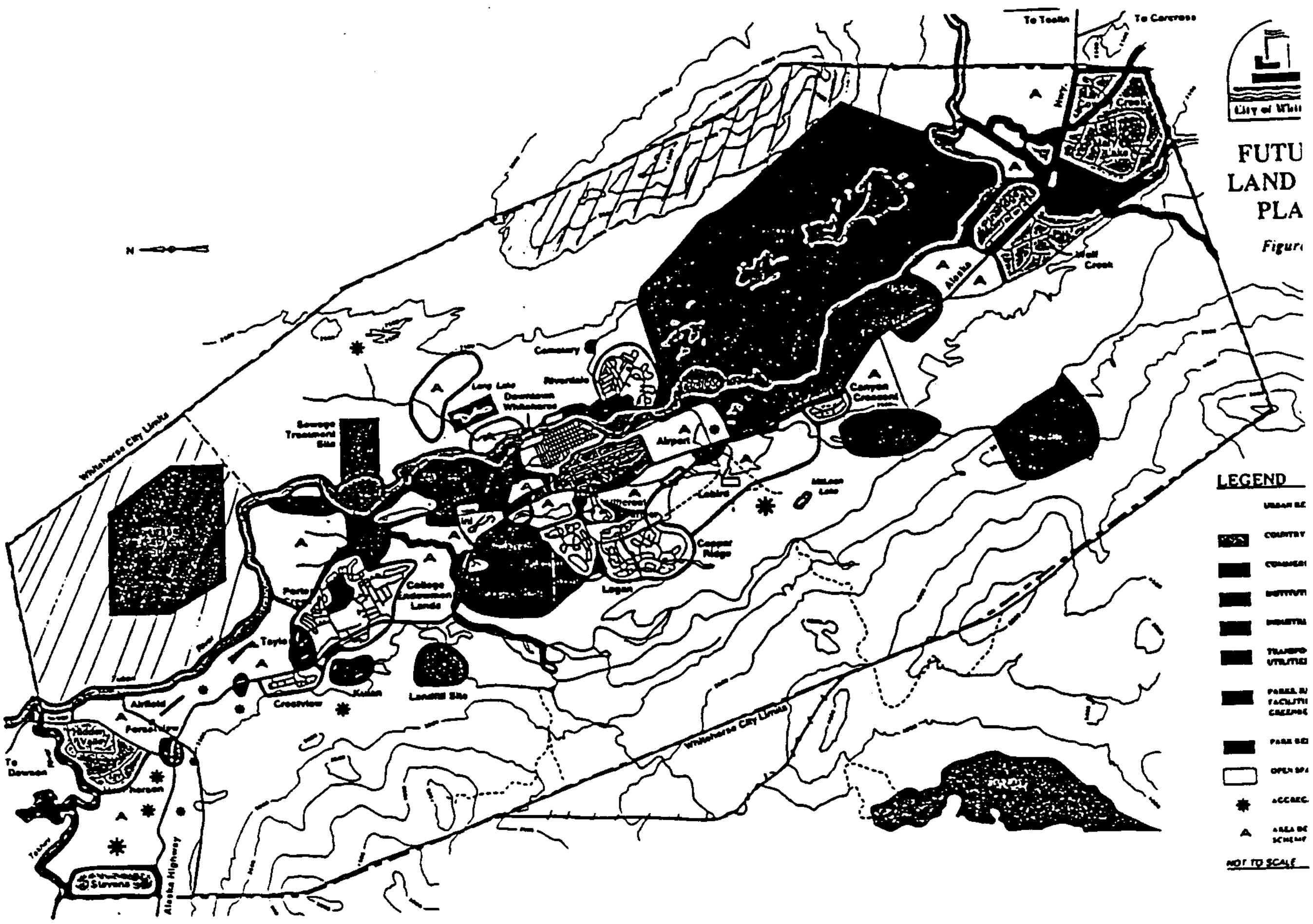
This project was initiated by the Planning Services Branch of the City of Whitehorse in January 1996. Financial co-operation of City of Whitehorse, Community and Transportation Services Branch of the Government of Yukon and the Yukon Land Resource Unit of Agriculture and Agri-Food Canada. In the spring of 1996, G. Tooley (City of Whitehorse), S. Smith (Agriculture and Agri-Food Canada) and C. Mougeot ( Mougeot GeoAnalysis) designed a mapping project to provide the city with planning scale (1:20,000) information on soil, terrain types and processes, as well as wetland classification and distribution on most land within the City of Whitehorse (Figure 1-1). The main effort was to concentrate on the production of a soil map which would be comparable with the soil surveys conducted in adjoining Takhini and Carcross valleys to the north and south of the city limits (Mougeot and Smith; 1992 and 1995). In addition, terrain and wetland distribution maps were identified as being required by the City of planning purposes..

This work does not replace site specific geotechnical investigations always necessary in construction projects. However, the scale and type of information provided on the accompanying maps can be extremely valuable to:

-reduce testing and sampling programs, investigations, discussions and evaluation of environmental components in any areas,

-provide the city with a consistent reliable data base to assist integrated planning of land selection, green belt use, risk of soil contamination, land-use restrictions, interpretive trails, recreational uses and trafficability of surfaces,

## Figure 1-1 Location Map



-enhance the usefulness of other GIS datasets by providing a biophysical layer for overlay and analysis.

## 1.2 PRODUCTS

The study delivers five major products: a soil survey map set, a wetland classification map set, a terrain classification map set, digital maps and database files and this report. The report describes methods, map unit construction and characteristics and provides additional background information not presented on the maps. The three map sets were digitized for GIS use by the City. In addition to the digital map and datasets, a hand drafted set of maps with field site inspections and air photo locations is also included in the product package.

The area mapped (Figure 1-1) included land within the City of Whitehorse but excludes the east side of the Yukon River north of the new sewage lagoon, uppermost slopes of Grey Mountain and urban and other developed areas. All maps were produced at 1:20,000 scale from 1:10,000 and 1:40,000 black and white aerial photographs.

### 1.2.1 TERRAIN CLASSIFICATION MAP SET

The terrain classification is based mainly on air photo interpretation with minimal ground truthing, due to cost and access considerations. It provides an estimate of material type and stratigraphy for the uppermost 5 meters of surficial material and deals with inactive and active geological processes. Potential terrain hazards are listed such as the presence of permafrost, surface erosion risk resulting from surface disturbance, mass movement hazards, presence of landslide, and zones of fluvial erosion and flooding. The processes are identified on the maps as either active or inactive. Their status is based on a combination of several factors including landform, parent material, site hydrology, and microclimate.

### 1.2.2 SOIL SURVEY MAP SET

The soil survey map set provides information on surface characteristics for most of the land within the city limits (approximately 415 square km). The legend includes for each soil association; the dominant textural class, most common accompanying soil associations, dominant soil classification (subgroup level) , drainage classes, comments on landform topography and sensitivity to development. In some cases comments on unit thickness or expected changes with depth are provided. Each map delineation (sometimes referred to as polygon) on a map includes general slope range and dominant and minor soil type when necessary. This map follows the same legend and style as the Takhini and Carcross valley maps (Mougeot and Smith 1992, and 1995) to ensure continuous coverage with the same level of information.

### 1.2.3 WETLAND CLASSIFICATION AND DISTRIBUTION MAP SET

The wetland classification maps provide wetland delineation and types. These map units share boundaries with the soil map polygons. A total of 130 wetlands large enough to be represented on the 1:20,000 mapping were identified in the study area. These range in size from 2 ha to over 100 ha. Wetlands are found throughout the City. Major wetlands occur along the eastern boundary of the City north of Grey Mountain, along Copper Haul Road south of the Fish Lake Road junction and north of the Marwell industrial area below the Takhini Trailer Park. We have chosen to use the Canadian system of wetland classification (National Wetlands Working Group, 1988) in this survey. The system works well in the study area to distinguish the different ecological conditions under which wetlands exist.

### 1.2.4 DIGITAL MAPS AND DATABASES

Digital versions of the maps were produced using AutoCAD software and then processed for use with the City of Whitehorse Claris® GIS environment. A flat file database was constructed for each map set from the map legend information attached to the hard copy maps and described in this report. For the terrain map, attributes describing the geologic material at the surface and at depth (if different) along with attributes on material texture and active or observed terrain processes are listed for each digital map polygon. For the soil survey maps, attributes list the soil association, drainage and slope conditions for each polygon. For the wetland maps, a database describing the dominant and subdominant class of wetland and modifying process are given for each map polygon. A separate report outlining the database structures and coding has been prepared by Gartner Lee LTD for the City of Whitehorse GIS group.

### 1.2.5 REPORT

The report provides background information on the formation of the Whitehorse area landscape, descriptions of the soil and terrain units, a discussion on each soil type or map unit and development consideration for each soil or terrain type.

Chapter 1 provides background information about the project methodology and general information about the area. Chapter 2 contains an overview of the principle landform building processes that have shaped the Whitehorse landscape. Chapter 3 describes the principles behind soil weathering and classification, and basic mapping procedures used by soil scientists. Chapter 4 contains soil association descriptions used in conjunction with the soil survey maps. Chapter 5, the last chapter, discusses the Canadian Wetland Classification system, major wetland types found in the City, and the wetland map.

Finally, the appendices provide; plates (Appendix 1), analytical data and technical specifications for soils (Appendix 2), the agricultural capability rating system used for soil mapping in the Territory (Appendix 3), vegetation lists done by C. Kennedy during the wetland survey (Appendix 4), and ceramic clay analysis(Appendix 5).

## 1.3 PROJECT METHODOLOGY

The project was designed by G. Tooley (City of Whitehorse), S. Smith (Agriculture Canada) and C. Mougeot (Mougeot GeoAnalysis). The map legends, methodology and priorities were discussed and agreed on in late spring 1996. In summer 1996, field work was conducted by C. Mougeot and M. King (Mougeot GeoAnalysis), S. Smith (Agriculture Canada) and C. Kennedy (Renewable Resources, Y.T.G.). In late fall 1996, J. Ham (City of Whitehorse) joined the discussion group to ensure that map and legend design could be translated into electronic products compatible with the City Of Whitehorse GIS environment. In the winter of 1996-1997, C. Mougeot completed the hand drafted map sets and F. Pearson (Gartner Lee LTD) in association with S. Francis (Applied Ecosystem Management) produced digitized maps and database to accompany this report.

The maps were drafted from field observations and air photo interpretation. Areas not easily accessible by road or boat were mapped entirely through air photo interpretation. All mapping was transferred from aerial photographs to City of Whitehorse orthophoto base maps sheets 2, 3 and 4. Each of the soil, terrain and wetland map sets share this common base. Aerial photographs at 1:10,000 and 1:40,000 scales were used to define soil polygon boundaries. Polygons were delineated by C. Mougeot based on criteria such as drainage conditions, landform type, slope, surface form and parent material.

Ground truthing (field checks) occurred during the summer of 1996 and was conducted by C. Mougeot, S. Smith and M. King. Soil profiles were described to one meter in depth. Soil inspection density and procedures followed Agriculture Canada recommended procedures. Exposures such as road cuts, river banks and excavation walls were used as often as possible to complete the understanding of the parent material variability and the general stratigraphy of deposits.

Inspection density averaged one inspection per 1.2 $km^2$. The distribution of the inspection sites varied throughout the mapped area. Soil terrain units with wider ranges of properties or with complex soil associations required a higher density of inspections. Other units proved to be rather uniform and were therefore visited with less frequency. Access was also an important factor; only areas accessible by road, boat or by short foot traverses were covered as no helicopter was used.

Following field work, all air photographs were reviewed and improved using the field data. Lines were then transferred onto stable mylar photo mosaic bases provided by the City of Whitehorse. At that stage of the project, topographical information was not available on the photo-mosaic bases and topographical maps at the 1:50,000 scale were used. Once the editing and verification of map units boundaries and map unit labels was completed, the maps were digitzed and databases constructed.

## 1.3.1 SOIL MAPPING PROCEDURE

A preliminary legend was developed by compiling information from previously published surveys (Rostad, Kozak and Acton; 1977; Day; 1962, Davies et al.; 1983, Smith et al.; 1985 and Mougeot and Smith; 1992 and 1995) in the region. Most soil association names are taken from previous surveys with modifications in their definitions needed for the more detailed 1:20,000 scale mapping published with this report. Information about individual soil profiles is organised into classes of soils called soil associations. Each soil association consists of a grouping of individual soils that share similar properties. These properties include similar parent materials, landform, soil drainage and soil classification. Each association is given a name which was usually based on some local geographic feature. The soil map legend lists the soil associations and information on ranges of soil and landscape properties.

To confirm the initial air photo interpretation, a formal inspection site or polygon check supplied basic and systematic information on the topography, drainage and soil association. These formal sites were plotted on a photo-mosaic base and possess an identification number. Site inspections were also performed when information was needed to document the spatial variability of individual soil associations. Several polygons containing the same soil association but geographically separated map were checked to establish property ranges. A total of 370 formal site observations were collected.

Numerous informal site notes were taken and this information was also considered during the final drafting of the maps. At least as many of these less systematic sites were noted as formal ones. Most informal site locations were plotted on the photo-mosaic base maps to allow the survey teams to monitor mapping progress and site inspection density.

## 1.3.2 TERRAIN MAPPING PROCEDURES

Terrain maps are constructed based on shallow pits (less than a meter), any exposure encountered during the soil survey (road and river cuts, pit walls and any other excavation), air photograph interpretation and modeling. Terrain modeling involves reconstructing the glacial history of the Yukon Valley and the possible resulting deposits by understanding glacial processes. Modeling requires the ability to incorporate and extrapolate ground point data obtained during the field truthing with contour maps and landforms identified on aerial photographs. For example, if a lake bottom reached the elevation of 715 meters, it is highly improbable to encounter fine-grained lake deposits at a higher elevation. Similarly, by tracking where the geographical position of a glacier terminus sat for a significant period of time, one can predict where more complex deposit sequences are likely to exist, (both with depth - stratigraphically- and at the surface -laterally).

By recreating the history of the Yukon Valley from exposures and knowledge of adjoining parts of the valley, one can start to tie the stratigraphy ( layers of sediments) with specific geological events and to predict or extrapolate the sediment distribution and composition between exposures. This is discussed further in Chapter 2.

Because of the extensive use of this modeling technique to infer knowledge about the terrain composition, the terrain maps are not considered as accurate as the soil maps which are drawn mainly from direct observations of the uppermost meter of soil material. However, the terrain maps do provide a general distribution of areas of complex stratigraphy and the possible composition of material to a depth of up to 6 meters. Interpretive tables in Chapter 4 provide planners with relationship of terrain types with soil associations and with specific expected conditions or priorities of each type found within the City limits. Excavating and/or drilling at various points would help confirm stratigraphic predictions and are necessary at the site specific investigation levels.

### 1.3.3 WETLAND MAPPING PROCEDURES

Field work was also done in summer 1996. C. Kennedy, plant ecologist with Renewable Resources, Yukon Territory Government, accompanied either C. Mougeot, M. King or S. Smith in the field. Polygons with very poor to imperfect drainage conditions on the soil maps were identified as potential wetland units. Subsequent re-interpretation using 1:10,000 aerial photos helped to classify each wetland and select representative types for field sampling. During field visits the crew selected soil and vegetation sampling sites based on the vegetative zones within wetland polygons. Soil materials were cored with a hand-held peat auger and the type and thickness of the materials collected by the auger were recorded. At each site, plant species lists were also prepared (data from representative sites of each of the major types of wetlands identified in the survey are presented in appendix 4).

The wetlands were classified using the Canadian Wetland Classification. Wetlands not visited during the field season were classified based on air photographs interpretation.

## 1.4 GENERAL DESCRIPTION OF THE SURVEY AREA

The area described in this report is located in the southern Yukon between approximately 135° 15' and 134° 50' W longitude and 60° 50' to 60°30' N latitude. The study area includes most of the land within the City of Whitehorse limits with the exception of the northern portion of the land east of the Yukon River (Figure 1-1).

### 1.4.1 PHYSIOGRAPHY AND DRAINAGE

The Yukon River is the major river system which drains the survey area. Tributaries of the Yukon River include Cowley Creek, Wolf Creek, McIntyre Creek and Porter Creek as well as several unnamed creeks and gullies which drain into the Yukon River. The few lakes included in this area are well known to residents: Long Lake, Chadburn Lake, Schwatka Lake and Ear Lake.

The Yukon Valley is a broad, terraced landscape. This area is composed of low relief glaciolacustrine, fluvial and aeolian material dissected by the Yukon River. Elevation of the valley floor ranges between 660 m and 690 m above sea level.

## 1.4.2 VEGETATION

Typical vegetation is a mixed forest of white spruce, lodgepole pine, aspen and willow. Elevations below one thousand meters support a semi-arid montane forest composed of trembling aspen (*Populus tremuloides*), white spruce (*Picea glauca*), and lodgepole pine (*Pinus contorta*). Wetter and higher elevation sites support black spruce (*Picea mariana*)(rare), subalpine fir (*Abies lasiocarpa*) and paper birch (*Betula papyrifera*). On south-facing slopes aspen parkland communities and grassland ecosystems composed of juniper, kinnikinick and grasses are locally quite extensive. The area has been classified as belonging to the Northern Boreal Cordilleran ecoclimatic region of Canada (Ecoregions Working Group 1989). The area falls within the Yukon Southern Lakes ecoregion as described in the national ecological classification framework for Canada (Ecological Stratification Working Group, 1995). The lower elevations most closely correlate to a dry subzone of the Boreal Black and White Spruce biogeoclimatic zone as defined for north-western B.C. (B.C. Ministry of Forests, 1988). Higher elevations correspond to the Spruce Willow Birch biogeoclimatic zone.

Forest communities within the study area have been described by Oswald and Brown (1986). Forest fires are common in the region and are a controlling factor of both the distribution and the age of forest communities. While white spruce is the predominant tree species in the region, lodgepole pine and aspen prevail at lower elevations following fire. Feathermoss, willows, shrub birch, Labrador tea and grasses may form the undergrowth of communities either singly or in combination. Meadows of shrub birch and willow (i.e. buckbrush) occur in scattered depressional areas on most landscapes in the survey area. Tall and medium scrub vegetation can become predominant in wetlands and at elevations above 1000 m asl.

## 1.4.3 CLIMATE

The region has a cold, semi-arid continental climate that is modified by marine influences from the Gulf of Alaska. Summers are mild. Winters are long but, except for occasional cold snaps, are relatively mild for the latitude. The mean annual temperature for Whitehorse area is approximately -1$^{\circ}$C. The region lies within the rain shadow of the Coast Mountains; precipitation is generally light and scattered. Monthly temperature and precipitation values for within the survey area are presented in Figure 1-2.

Mean monthly temperatures are below freezing for six months and freezing can occur throughout the survey area any month of the year. Frost is recorded once every eight years in July and most years in June and August. These summer frosts make vegetable field crop production risky without some sort of frost protection. Total growing degree-day values (GDD >5°deg C) have varied from 800° to 1000° during the last decade making cereal production marginal in the agricultural area around the city. Very warm temperatures (>30°C) are recorded occasionally during the summer months. However, compared to most Canadian agricultural regions the mean monthly temperatures during the growing season are low (11-14°C).

Short outbreaks of very cold arctic air are experienced in the winter months. Mean monthly temperatures are moderated by maritime weather systems from the Gulf of Alaska. Depending on whether the arctic or maritime systems dominate, winter temperatures may vary widely from year to year for any given date. December extremes vary from 10 to -50 °C. The daily variation in winter temperatures in the Whitehorse area is the greatest for anywhere in Canada (Climates of Canada, 1990).

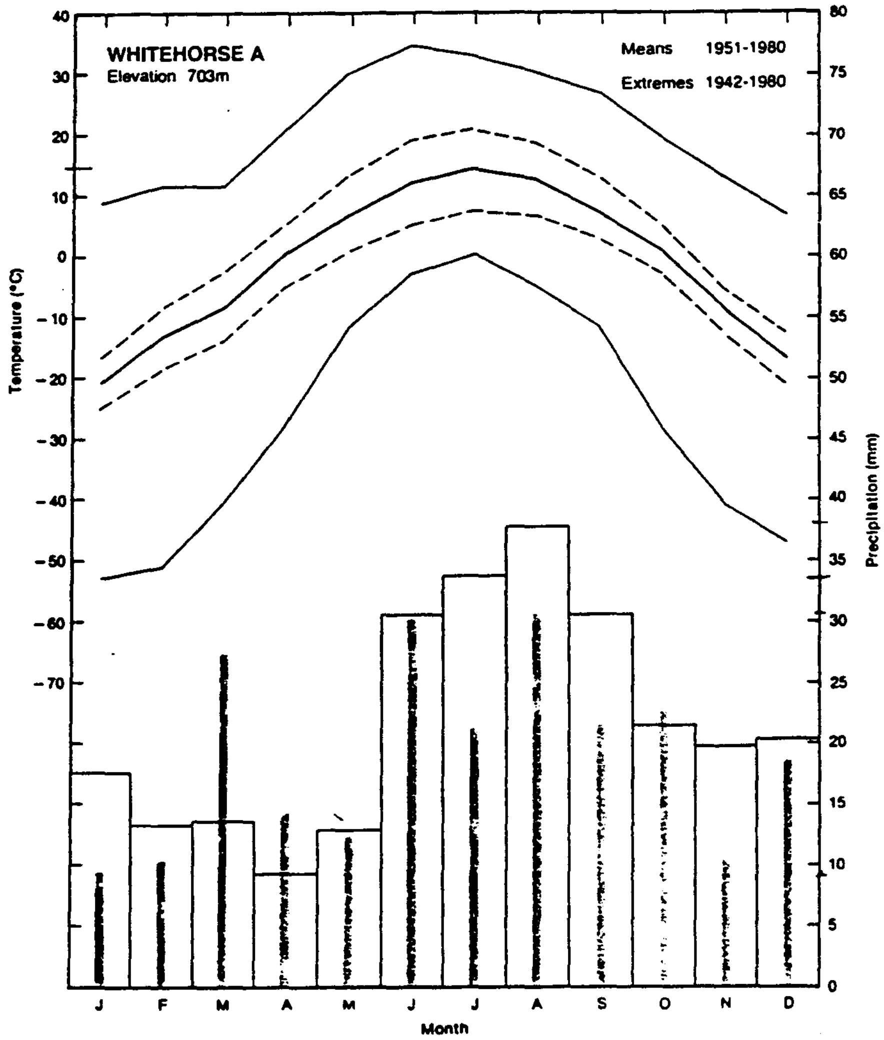
The survey area lies within the rain-shadow of the Coast Mountains. Local precipitation is affected by topography and valley orientation. The rain-shadow effect is pronounced in the Yukon Valley where annual precipitation is greater than 300 mm (11-13"/yr.). The spring is the driest time of the year and summer and early fall are usually the wettest.

Climate is the major limitation to agriculture in the survey area. Both the cool temperatures and the lack of total growing season rainfall limit the range of agricultural production in the region which results in a marginal (Class 5) agroclimatic rating. Even the most favourable soils can produce only as well as the climate allows. The highest rating that land can have in the survey area is Class 5. Within the national context, this is considered marginal for cultivated agriculture. For a complete review of the agricultural land rating system see Appendix3.

## 1.4.4 SOIL TEMPERATURE AND PERMAFROST

Soil temperatures in the survey area are cold compared with soils in southern Canada. The upper 50 cm of soil are frozen for about half the year and temperatures near the surface may drop to -15 °C during cold spells in mid-winter. The principal factor controlling annual soil

## Figure 1-2 Temperature and precipitation means and extremes



temperature variation is the depth of snow cover. Snow acts to insulate the soil and can maintain soil temperatures at or just below freezing for extended periods. During the summer, if the soil surface is bare, temperatures may reach 20°C, but such extremes are dampened considerably at depth. At 50 cm depth the average soil temperature seldom rises above 10°C.

Soil temperatures have been monitored for eight years in the Takhini Valley, adjacent to the Yukon Valley. Information on these soils is given in Smith (1990). Two cultivated soils have been monitored in detail. The first soil is an imperfectly drained clay loam soil supporting a perennial brome grass stand. The temperatures in this soil are given by date and depth in Figure 1-3. The soil in the root zone (10 cm) thaws in late April and rises to seed germination temperature (5°C) by the end of May. Soils refreeze again in October.

Daily monitoring of soil temperatures within a cultivated sandy loam soil (Lewes soil association) suggests that soils cool over a period of many months culminating in minimum temperatures reached at depth in April and May. This lag effect explains why water and sewer lines buried at depth often do not freeze until spring. It takes that long for the cold of January to reach a depth of one and a half meters. Soils tend to warm very rapidly over a period of a few weeks in May and June. The speed of this effect would be reduced under vegetation cover. Therefore, in the Whitehorse area, soils cool over long periods of time in the fall and winter and then warm very rapidly in the late spring.

### 1.4.5 GENERAL COMMENT ON PERMAFROST

Permafrost within the survey area is scattered and discontinuous (Brown; 1978). In the region, permafrost is confined to fine-grained sediments and is estimated to underlie less than a quarter of the landscape (Burn 1995). The presence of permafrost is influenced by surface vegetation cover and by the thermal nature of the soil materials. In the Takhini Valley, directly west of this survey, most permafrost and associated ground ice is found within the glaciolacustrine deposits (Rampton; 1972; Klassen; 1979). Similar deposits within the City of Whitehorse could contain large amount of frozen sediments as well. Drilling would be required to detect these areas if they are indeed present. The gravelly glaciofluvial deposits are largely permafrost-free (Burn; 1987). Morainal deposit on the western side of the Yukon Valley, when covered by thick organic material where often found to have shallow permafrost. Creek bottoms also have abundant permafrost-rich zones, where there is no standing water.

### 1.4.6 GENERAL COMMENT ON SEISMICITY

One magnitude 4-5 earthquake and three magnitude 2-3 earthquake epicenters have been recorded in the southern portion of the Whitehorse map area (N.T.S. map sheet 105 D). No evidence of landslide activity or fault movement related to these events has been noted. There is, however, concern over the presence of clay and silt substratum under the City of Whitehorse, since they are a good transmitter of S-waves. The effects of large magnitude earthquakes in the Gulf of Alaska are, as a result, commonly felt in the City of Whitehorse. Site specific information on seismic activity is reported in Dorherty, Mougeot and Walton (1993).

### 1.4.7 GENERAL COMMENT ON FLOODING RISKS

Flooding in the Whitehorse area is caused by unusually high precipitation, snow melt runoff or ice jams during break up time. Ice jams commonly occur along the Yukon River, below Lake Laberge (Underwood McLelland; 1983). The Marwell area, and several gravel bars and islands have flooded during late fall and early spring because of ice dams on the Yukon River. Minor flooding may occur at the mouth of the Takhini River into the Yukon River. Because both rivers are fed by meltwater, peak flows occur in late summer not in the spring like non-glacierized systems.

# 2. CHAPTER TWO: QUATERNARY GEOLOGY

## 2.1 INTRODUCTION

The Quaternary is the geologic period from two million years ago to the present. Within the Quaternary, there were periods of cold temperature accompanied by high precipitation. These conditions produced glacial ages. During glacial ages continental ice sheets or mountain glaciers expanded and advanced. Between glacial ages were periods of warmer climate commonly called interglacial ages. During interglacial ages, glaciers decreased in volume and in most cases disappeared entirely.

The landforms of the Whitehorse area are attributable to the last ice age estimated to have existed between 35,000 and 10,000 years ago (Wheeler, 1965). We can reconstruct the glacial and post glacial history of the area by examining the composition and position of the various glacial sediments present. These sediments form the parent materials for the modern soils that are described in this report. The Whitehorse area has a complex sequence of glacial, glaciofluvial and glaciolacustrine deposits that are typical of deglaciation in mountainous terrain. Table 2-1 presents the sequence of events leading to the present Quaternary geology of the Yukon River Valley. We did not attempt to date or relate this sequence of events to other areas in Yukon.

Soil properties and their variability are related to the soil parent material (i.e. the glacial sediments). Other properties such as slope and drainage are tied to the landform on which they lie. The general history, geomorphology and composition of glacial deposits which occur in the survey area are described in this chapter. A detailed description of deposit types and local characteristics are presented in section 2.3.

## 2.2 GLACIAL HISTORY

At least four major glacial and interglacial stages are identified throughout northern United States and Canada. During the Quaternary, Central and Southern Yukon was covered by at least four Cordilleran (i.e. mountain) ice sheets (Bostock 1966). Bostock named those four glaciations, from the oldest to the youngest, the Nansen, the Klaza, the Reid and McConnell (Figure 2-1). The landforms in the survey area are attributable to the youngest of the Yukon glaciations, the McConnell glaciation.

### 2.2.1 MCCONNELL GLACIATION

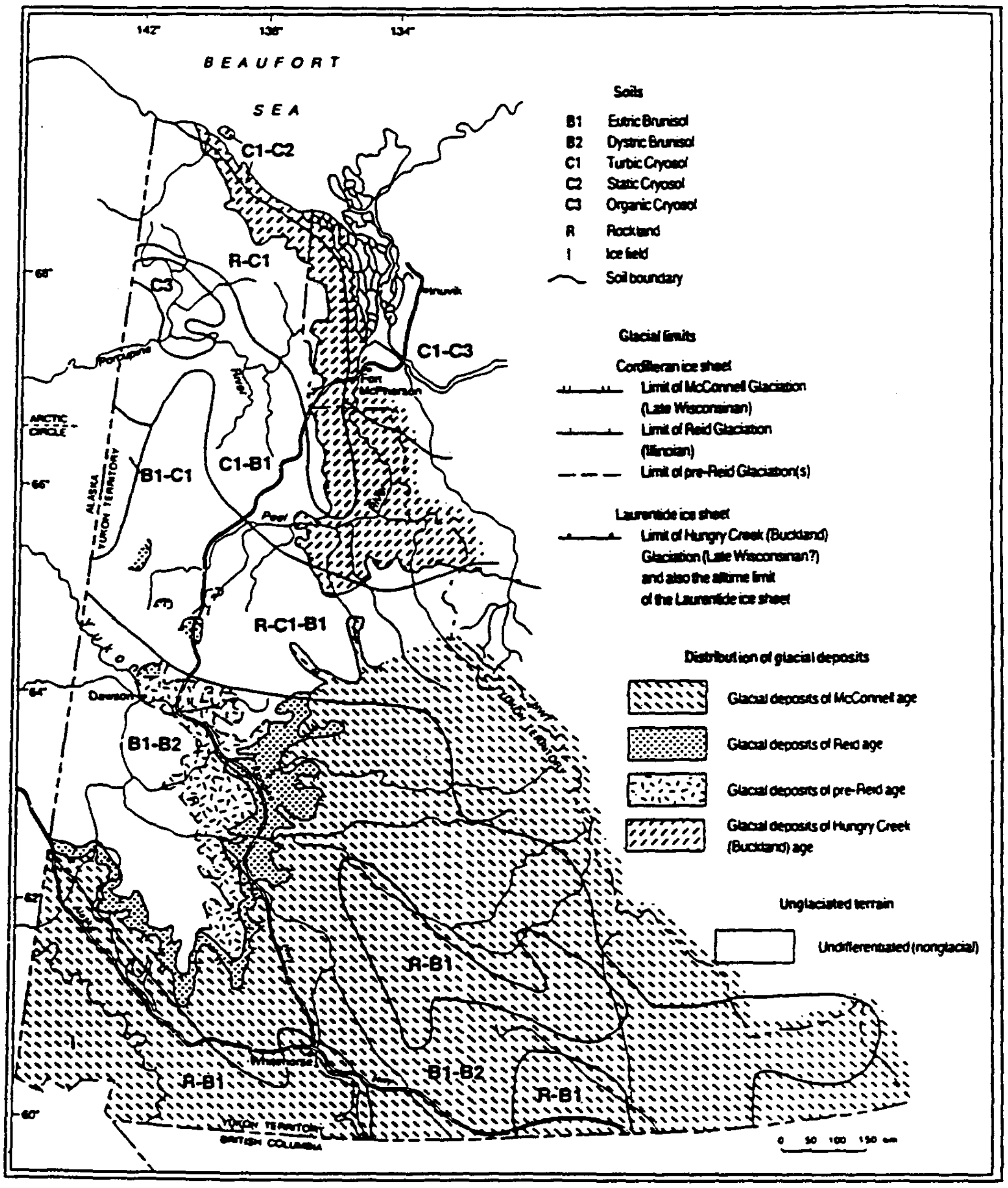
During the McConnell glacial age, the glaciers moved downslope from the Coast Mountains and flowed regionally from the south and south-east towards the north and north-west. This ice mass, called the Cassiar lobe, is assumed to have been thicker towards its

**Table 2-1 Summary of major events associated with the late Quaternary, Yukon River Valley**

| Approximate time and major event | Significant processes | Impact on landform formation | Example of local landform |
|---|---|---|---|
| Glaciation, McConnell Ice (35,000 to 14,000 years ago) | Erosion and incorporation of debris in the ice | Drumlins, scoured rock faces, Material transport, Nunataks are unaffected | Drumlin south of Fish Lake road<br>Montana Mountain nunatak |
| Deglaciation McConnell Ice (approximately 14000 years ago) | Ice retreat; melting ice masses release debris | Deposition of moraine | Moraine deposits east and west of Yukon River at elevation between 820 and 950 M. |
| | Flowing melt water | Deposition of sand and gravel outwash<br>Incision of meltwater channel and deposition of kame deposits | Gravel deposits of Long and Chadburn Lake areas<br>-meltwater channels like McIntyre Creek at elevations between 900 and 1000 m. |
| Formation of glacial Lake Champagne | Water is damned in the Yukon and takhini valleys | Deposition of bottom silt and clay deposits and sandy beach lines | Fine grained deposits around downtown and airport area |
| | Ice fluctuation and retreat | Deposition of sandy gravel over glacial Lake Champagne sediments, in some areas | Low relief sand and gravel deposits south of airport |
| Drainage of lake Champagne (Approximately 10,000 years ago | Drainage of the lake | Formation of deep gullies in some areas, Beginning of permafrost establishment | Small gullies flowing roughly transverse into the Yukon River |
| Ongoing river and colluvium formation | Yukon River drainage reestablishes itself | Incision through friable glaciolacustrine sediments, formation of terraces along the river | Formation of cliffs surrounding down town area<br>Formation of terrace east of Porter Creek (Golf Course) and along Wickstrom road |
| | Colluviation | Colluvium forms on fresh steep slopes in abandoned meltwater channels and other locations | Old landslide along McIntyre Creek and other meltwater channels. colluvium blanket on valley flanks. |
| White River Ash 1300 Years ago | Plume of air-born volcanic ashes from Alaska falls on southern Yukon | Thin layer of white to grey ash, 3 to 10 cm in this area, visible near the surface of most soils. | White band near surface visible on many road cuts along roads and highway. |

## Figure 2-1 Ice Limits of Yukon

from Morison and Smith , 1987.



origin, thinning slowly towards the north-east. Glaciers covered the Whitehorse area between approximately14,000 and 35,000 years ago. Locally, glacial ice is estimated to have reached elevations of 1825m to 1975m, leaving high peaks exposed as small bedrock islands called nunataks(Figure 2-2). Montana Mountain, located south of the study area, would have then appeared as a peak breaking through the icefield and local mountains such as Grey Mountain and Golden Horn would have been covered by the ice.

As the glacier advanced it eroded and incorporated material from lower valley walls and floors. It then transported this material either under the ice or as debris-rich bands within the glacier ice. Avalanche and slide debris that fell on the glacier surface from upper valley walls were also transported by the ice stream and later deposited when the glacier melted. The wide array of transported rocks, hard granites, less resistant sandstone, siltstone and limestone, is reflected in the composition of the glacial deposits and soils of the area. This also explains why many soils in the survey area have a very high lime content even when limestone is not present nearby. Glacial erosion also widened valleys into trough-like, U-shaped valleys. The action of glacial movement has left streamlined or fluted features parallel to the ice flow direction on many valley walls. These features, often called drumlins, are useful to identify the presence and general direction of glacier movement. They can be made of eroded rock or moulded till. A bedrock-cored, till-covered drumlin found west of the Alaska Highway and south of the Fish Lake Road is shown on the terrain map sheet 3.

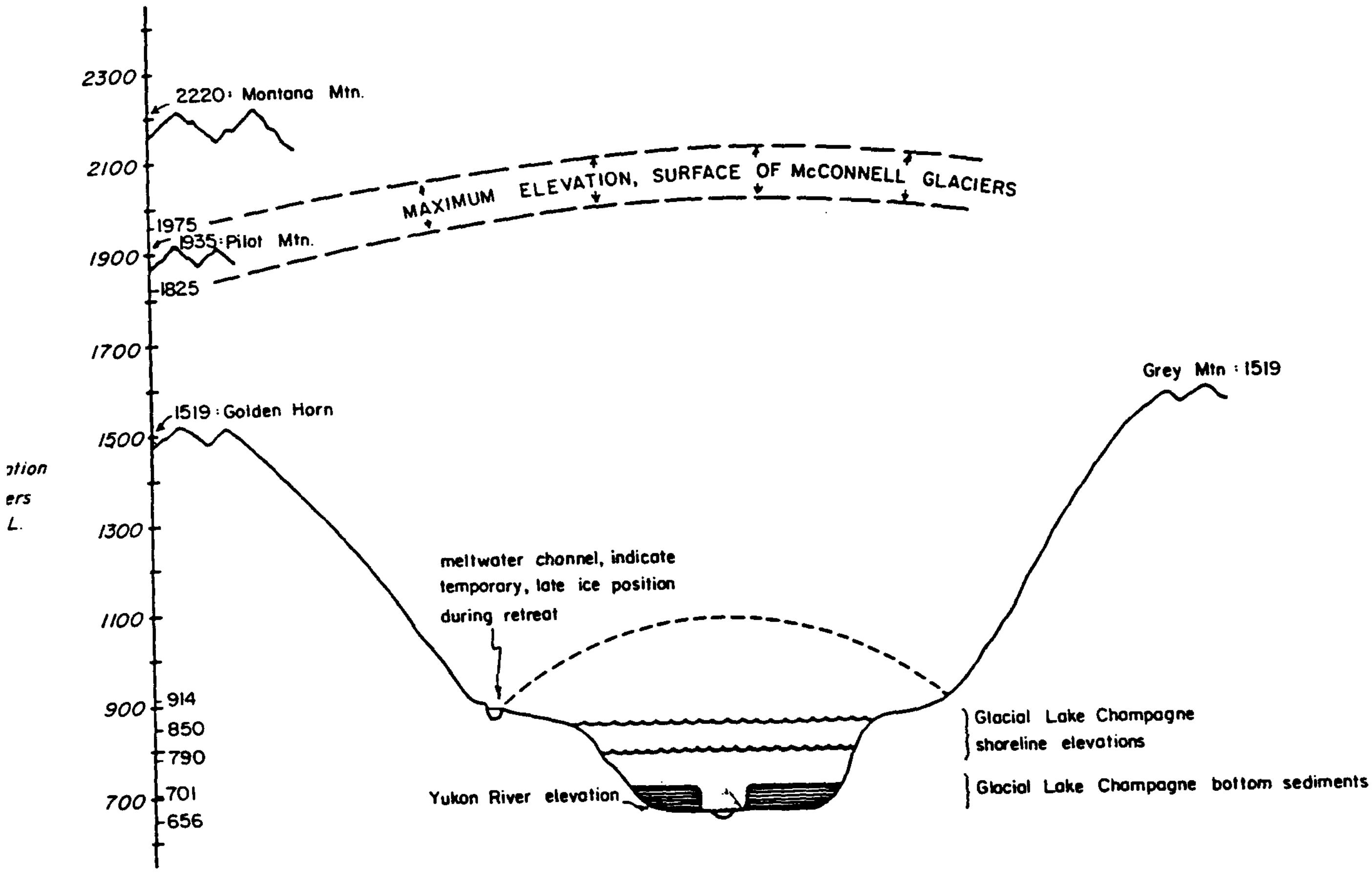
## 2.2.2 DEGLACIATION

### 2.2.2.1 Morainal and glaciofluvial deposits

When the climatic conditions changed and warmed, melting caused the ice mass to decrease in thickness and extent, and the lateral and frontal margins to recede. The main ice mass was segmented into smaller valley glaciers. In the Yukon River Valley, the Cassiar lobe retreated towards the south and south-east. As the ice thickness decreased, the ice flow became confined and controlled by the local topography and the valley walls (Figure 2-2).

The melting of the ice released water and sediments trapped within the ice. The resulting deposit is called moraine. It consists of till, a well-graded, unsorted to very poorly sorted mixture of material composed of particles from clay to boulder size (Plate 2-1). Till composition can vary from valley to valley and from region to region, and contains boulder, gravel and matrix which reflect both remote and local bedrock types (lithologies). Till textural composition, the proportion of clay, silt and sand in the matrix and of pebbles, cobbles and boulders in coarse component, also varies locally, depending on the way the till was deposited. The term moraine refers to terrain formed by sediment deposited directly by the glacier ice. It is composed mainly of till but may include other sediments associated with the same landform or terrain type, such as small gravelly deposits, debris flow and other saturated sediments

**Figure 2-2 Relationship between elevation and major glacial events in the Yukon River Valley, close to Whitehorse.**

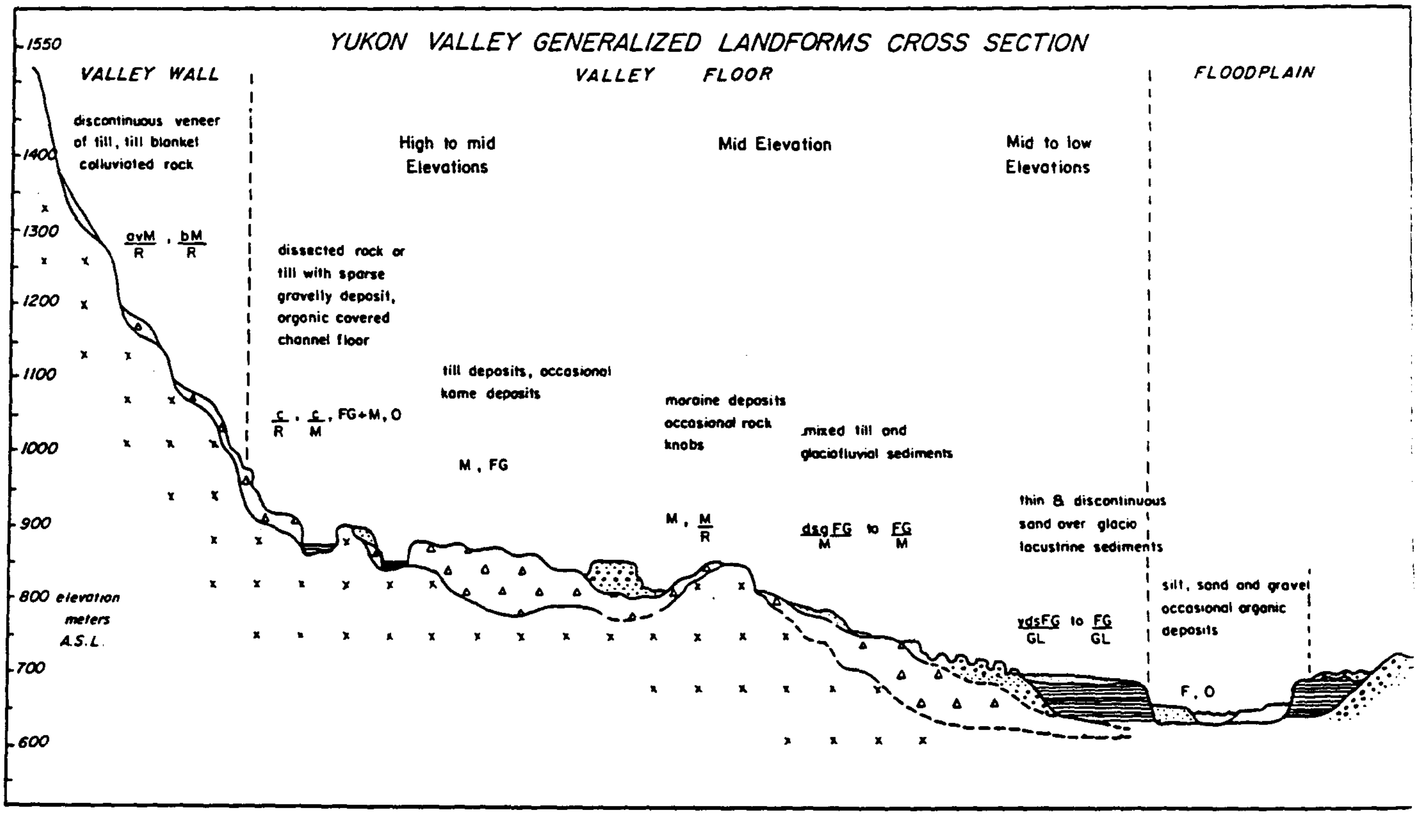


reworked by gravity. In this report, the term `till' is used to describe "a sediment that has been transported and subsequently deposited by or from glacier ice, with little or no sorting by water" (Dreimanis, 1983). Generally, in this area, till deposits thicker than 5 metres are most common between elevations of 820 m and 950 m (Figure 2-3). At elevations higher than this, till deposits are often controlled by the bedrock topography and vary in thickness, but generally are no thicker than a few metres (Figure 2-3).

Occasionally, blocks of ice were separated from the fragmented snout of the thinning glacier. These huge chunks of ice were subsequently buried by the sediments released by the main glacier. Over the following hundreds of years, the buried ice blocks melted from within the sediments leaving holes or kettles. This resulting landform is call stagnant ice moraine (Figure 2-4) when composed of till, or stagnant ice outwash when composed of sand and gravel, but it can be found in any type of glacial deposits. Such reverse topography is seen in many area on the east side of Yukon River, particularly along the cliff by Schwatka Lake where glaciolacustrine beds tilt into depression-like features. The area around Chadburn and Long Lakes are also stagnant ice or reverse topography landforms, with steep sloped ridges and deep irregular kettles. (Plate 2-2). The lakes themselves, and the area on which the Riverdale residential subdivision is built, are probably large depressions with the same origin. Such depressions are different than thermokarst kettles or lakes, where the melting of underground ice or permafrost is ongoing and produce active, unstable surfaces. Thermokarst kettles were identified in a few channel or pond bottoms such as the ponds along the north-eastern boundary of terrain map 2. They are very small features in areas where development would not likely be considered because of poor drainage.

A melting and retreating glacier releases huge volumes of water. This water flows away from the ice either from its surface, front, sides or floor, and carries sediment of all size. The result is the creation of glaciofluvial deposits. Sands and gravel are the main constituents of these glaciofluvial deposits. The meltwater which carries and deposits these sands and gravel is subject to daily, seasonal and annual fluctuations of discharge and sediment load. The fluctuation is reflected in the texture and structure of the glaciofluvial deposits. In general, the stream energy level and sediment load is greatest close to the ice mass. Glaciofluvial deposits in contact with or close to the glacier margin consist of stratified, poorly sorted gravel and sandy gravel. As the water travels further away from the ice front, it usually carries sand and silt sediments. A complex system of channels develops into a braided river environment which produces a broad outwash plain (Eyles and Miall, 1984). Pitted outwash plains with steep sided kettles around Chadburn Lake, Long Lake and Ear Lake are good examples of the stagnant ice topography formed in glaciofluvial material as described earlier. Most of the sand blankets found in the Whitehorse area were probably part of a broad outwash plain. The gravel deposits found between Ear Lake and Mary Lake are also part of a large glaciofluvial system (Plate 2-3).

**Figure 2-3 Yukon River Valley near Whitehorse, Generalized Cross-section.**



Eskers, kames and kame terraces are ice-contact glaciofluvial features. Eskers are long sinuous ridges with steep sides that are usually oriented parallel to their valley. They are the preserved beds of meltwater streams which flowed in tunnels under the ice mass or at the contact between ground and ice. Their composition ranges from fine sand to coarse gravel. Many eskers and complex esker ridges are present on the floor of the Yukon River Valley outside the Whitehorse City limits (Mougeot and Smith; 1992 and 1995).

Kame terraces are steep sided, discontinuous terraces formed by meltwater deposition between the glacier and the valley walls. This ice-contact feature is usually modified when the supporting ice wall or ice core melts. They are usually composed of gravelly sand and coarse gravel that reflect the high water discharge and direct ice contact conditions that exised during deposition. The deposits may have a significant amount of boulders and may also contain large inclusion of till-like material. The gravel deposits close to McLean Lake (and the flat topped ridge called the "Sleeping Giant") were part of such a system.

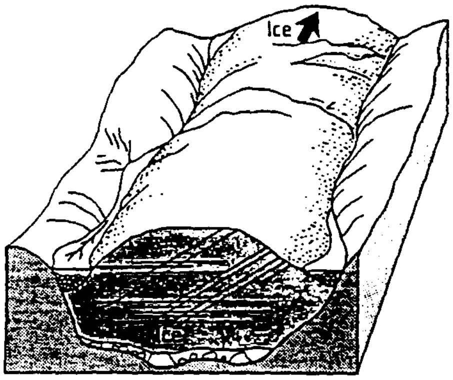
Meltwater channels form deeply incised channel, ususally parallel to the valley, in bedrock, moraine and in other sediments at the side of the glacier. These channels reflect the locations of temporary ice margin elevations (Figures 2-2 and 2-3) and are now supporting smaller streams (Plate 2-4). Well-developed channels cut partially in bedrock by such meltwater streams are visible on the north wall of the Yukon River (west of Wolf Creek and Mary Lake country residential subdivisions) valley between elevation of 900 and 1000 m a.s.l. A similar network of channels cut into moraine runs roughly parallel to the Alaska Highway and Haul Road close to the Fish Lake Road. Small gravel and sand deposits can be associated with these channels. Inactive rock slides were mapped along this feature. The slopes probably became unstable following the dissection of steep walls into friable or fractured rock.

#### 2.2.2.2 Glacial Lake Champagne

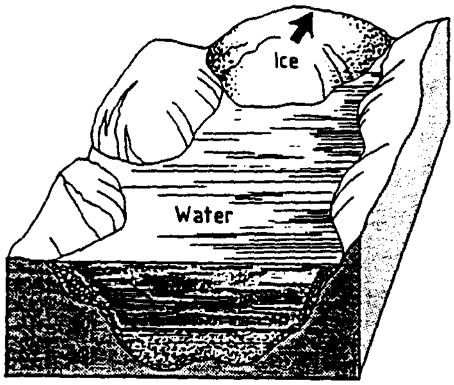
Glaciers often disrupt the pre-existing drainage system by blocking drainage outlets and by releasing large volumes of water. When the outlet is dammed downvalley by a topographic obstacle or by another ice mass, a glacial lake forms and occupies the bottom of the valley (Figure 2-4). Lakes can vary in size, depth and duration and can be at some distance from the ice front or in direct contact with it. Generally, when meltwater enters into the lake, coarse sediment (sand and gravel) is deposited rapidly. Fine sand, silt and clay are carried further into the lake and deposited as alternating layers (Figure 2-5) called laminae (Plate 2-5).

Generally, these silt and clay beds are constant throughout the lake basin, with a tendency to become finer-grained farther away from the ice front. Silt and fine sand with a low clay content make up the vast majority of the glaciolacustrine deposits in the Whitehorse area. Occasional pockets of pebbles, cobbles or gravel exist within these fine-grained sediments.

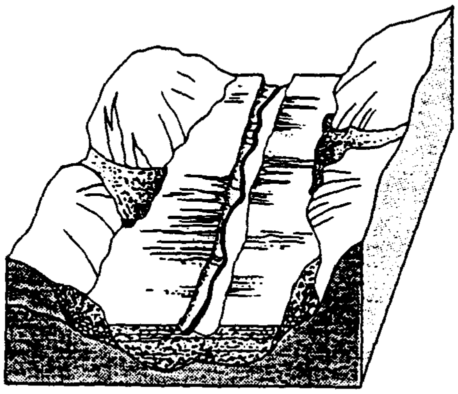
## Figure 2-4 Deglaciation and Formation of Glacial Lake Champagne, Takhini and Yukon River Valleys




The McConnellice retreated. Morainal and glaciofluvial materials were deposited on the margin of the ice.



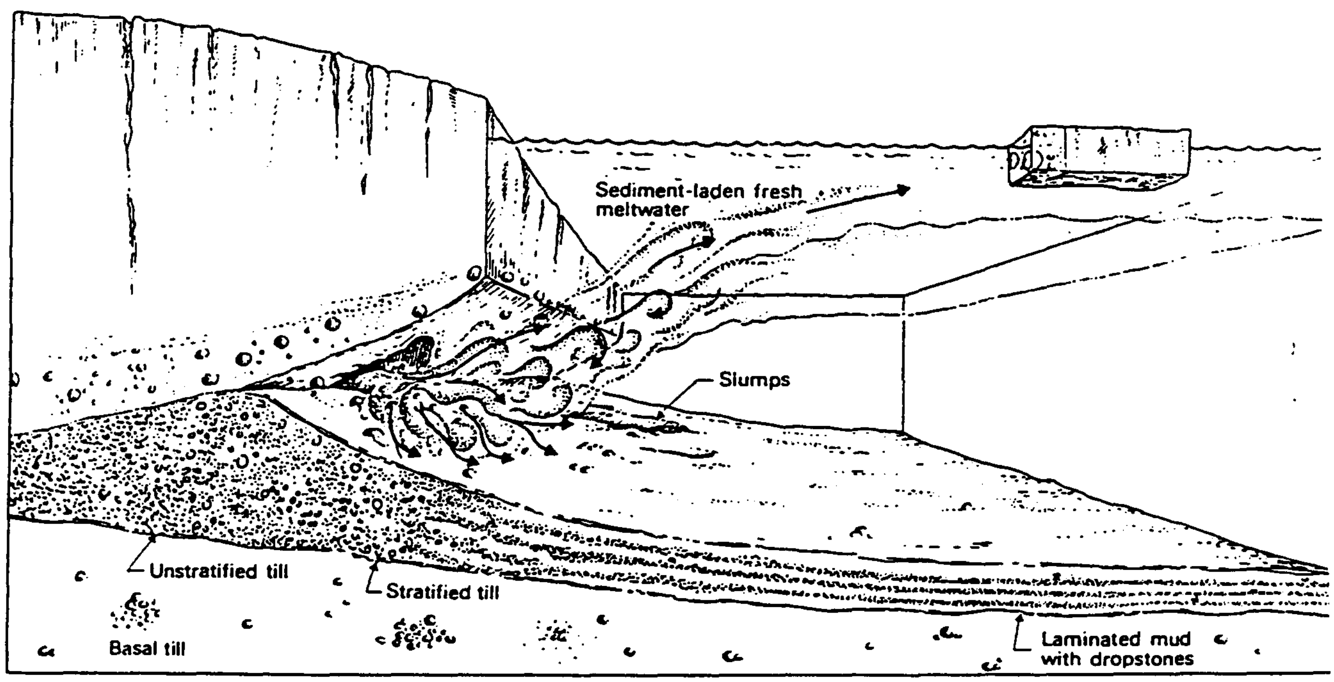

As the ice melted, large volumes of water were dammed and formed Glacial Lake Champagne. Thick glaciolacustrine silty and clayey deposits covered the bottom of the valley.



After the glacial lake drained, fluvial systems started to erode downward and laterally. Fluvial sands and silts were deposited. Fluvial terraces were formed.

**Figure 2-5 Sedimentation in a glaciolacustrine environment**

modified from Reading, 1984.



They originate from icebergs detached from the ice mass or from shoreline ice afloat in the lake. As the ice blocks melt, the debris frozen in the ice drops to the bottom of the lake and forms small gravelly deposits. Closer to the shore, icebergs sometimes melt in such a position to result in the formation of pockets of gravel within the shoreline deposits.

Towards the valley sides, sandy beds can be deposited within the fine grained glaciolacustrine sediments by a tributary drainage system into the lake. Occasional slumping of material from the valley sides can also create irregular textural changes within the lacustrine deposits. These coarser sediments have higher porosity than the glaciolacustrine silt and clay and may provide an aquifer or path for groundwater. The incorporation of mud-like layers within the glaciolacustrine sediments is visible along deep gullies on the east side of the Yukon River (Plate 2-6).

Much of the Yukon River Valley floor is composed of glaciolacustrine sediments up to 40 meters thick. These were deposited in a large proglacial lake called Glacial Lake Champagne. This lake formed about 9,000 to 11,000 years ago during the latter stages of deglaciation (Wheeler, 1968). Meltwater was trapped between the ice front retreating towards the south-east in the Yukon River Valley and by another glacier to the west of the Takhini Valley. The lake drained towards the north through the Yukon River Valley and Lake Laberge. Between 790 to 850 m elevation, horizontal benches or beach deposits outline former lake levels (Figures 2-2 and 2-3). These features are usually composed of gravel or sand and are visible in the Takhini River Valley. The lake floor is at an approximate elevation of 715 to 725 m.

During the life of the lake, the ice occupying the Yukon River receded and readvanced at least once into the lake. The sand and gravel blanket overlying glaciolacustrine deposits for several kilometres, and in some areas, overlain again by glaciolacustrine silt and clay attest to the close proximity of the ice front. This layering of sand and gravel within the lake deposits make the subsurface stratigraphy quite complex in some areas, particularly along a belt running slightly north of the Porter Creek residential subdivision, and on the east side of the Yukon River as far south as the Chadburn Lake area.

### 2.2.2.3 Post glacial history

Once Glacial Lake Champagne had drained, the valley drainage systems were re-established. Creeks and rivers eroded the soft glaciolacustrine silts and clays and deposited sediments in their channels. The cliffs surrounding downtown Whitehorse were created as the Yukon River established its modern floodplain. The lower reaches of the creeks south of the McCrae subdivision are examples of tributary channels that also quickly eroded through the glacial lake-bottom sediments leaving knobs and tabular hills of glaciolacustrine sediments (with glaciofluvial sand cap) standing out from the valley floor.

The remainder of the valleys were, and still are, subjected to other erosion processes. These processes include wind erosion, water erosion, slope failure and in some limited areas, permafrost melting.

Fluvial sediments are those deposited by rivers, both past and present. Fluvial systems are subject to seasonal discharge fluctuation which impact channel geometry, bedforms, sediment grain-size, and deposit thickness. Generally, high energy streams will carry and deposit larger particles and lower energy streams finer particles. Meandering rivers like the Yukon and Takhini have low slope gradient, high sediment load, and cohesive banks. Erosion occurs along the outer bank of a river bend where the current is strongest. Deposition occurs along the inside of the river bend where the current is slowest. This process is repeated as the river moves laterally in its plain. Resulting fluvial landforms include many low terraces, abandoned meanders or oxbow lakes.

The grain-size of the fluvial deposits of Yukon River varies. Many deposits are composed of mixed sediments of sandy loam or silt loam texture. With depth, the sediment type and texture may vary.

Aeolian processes (i.e. wind erosion and deposition) are very active in glacial and post glacial environments. Large temperature and elevation gradients associated with large ice sheets create strong regional wind patterns (katabatic winds). These katabatic winds can often rework the unvegetated surface of glacial and glaciofluvial deposits. Silt and fine sand can be transported appreciable distances by the wind and deposited as well sorted massive blankets called loess. In the Yukon River Valley, discontinuous loess (silty aeolian material) up to 15 cm thick is very common on glaciofluvial and morainal deposits.

Unvegetated sandy glaciofluvial plains that are subjected to strong winds act as a source of aeolian material. These sands can be transported and reworked by the wind into sand dune fields. The dunes are usually composed of well sorted fine to medium-grained sands. The topography is hummocky, and the dunes can have a rough crescent shape pointing downwind . There is a large, well known dune field located along the KV Sawmill road northeast of the survey area.

Finally, very localised aeolian deposits exist area immediately above exposed bluffs throughout the survey. These active cliff-top dunes are composed of silt and sand, such as the small field of dunes above the Riverdale area. In these cases, strong winds pick up fine grained material from the cliff wall and deposit it on top of the bluff. Winds may also rework existing glaciofluvial sand blankets overlying the glaciolacustrine deposits into dunes. These deposits are often too small to be represented on a map.

Throughout southern Yukon, soils are capped with a veneer of white volcanic ash. This material is composed of sand and silt-sized grains of glass-like material that fell about 1200 years ago following a volcanic eruption in the headwaters of the White River in the Alaska Range. This volcanic ash layer is often used to roughly estimate the presence and rate of erosion. For example, a slope where the ash layer is buried 35 cm below the surface is considered to be more active than a slope where the ash lies directly under the vegetation. Fluvial terraces missing this marker bed in their soil profile are evaluated to be younger than 1200 years B.P. Occasionally, this ash also provides the soil enthusiast with photographic opportunities, such as a dramatically cryoturbated soil profile which shows convoluted white bed of ash. The White River ash can be interpreted as a time line for recent process activity.

## 2.3 TERRAIN UNIT DESCRIPTIONS

In this section the major types of deposits used on the terrain maps area are described with comments as to their local characteristics. They are described in the order in which they appear on the Terrain map legend (Table 2-2).

The geological units and their stratigraphic distribution are based on models developed from the soil maps and exposures. The legend (Table 2-2) includes deposit genesis, general texture (grain-size), landform description as well as possible terrain hazards and/or active or modifying processes. Ground truthing (drilling or excavating) and sampling of the Quaternary geology units is required to confirm their properties and extent.

### 2.3.1 COLLUVIAL DEPOSITS (C)

Geological Description

Colluvial deposits (map symbol C) are formed by the downslope movement of material generated by slope erosion, bedrock weathering and frost shattering. Colluvium is generally an unsorted mixture of silt to gravel size sediment with a high content of local bedrock clasts. Gravelly sediments often show a strong clast imbrication (overlapping orientation) in a downslope direction and the deposit morphology (form) follows the underlying bedrock surface topography when the colluvium thickness is less than a few meters. Active slope erosion is often identified by gullying (map symbol C : T V), sheet erosion (map symbol C : TE) or actively slumping areas which have unvegetated, fresh exposures of unconsolidated sediments.

Colluvium composition and behavior varies greatly. However a few generalizations can be made. The colluvium covered slopes associated with meltwater channels, west of the Haul Road are composed of reworked moraine and friable rock (grus). They appear particularly

**Table 2-2 Terrain Map Legend**

**Genetic Component**

| Map Symbol | Description | Comments |
|---|---|---|
| A | Anthropogenic | Gravel pit, road, airport, developed area, mine, other surfaces modified by man. |
| C | Colluvium | Usually mixed material, from silt to boulder size, usually found on slopes steeper than 20% |
| E | Aeolian landform | Usually consists of fine sand with minor silt- landform surface is hummocky (dunes) |
| F | Fluvial deposits | Include silt to gravel size material, |
| FG | Glaciofluvial deposits | Usually consists or well graded sand and gravel- varies from deposits to deposits. It is common to find a silt or/and sand veneer over the gravely sediment. |
| GL | Glaciolacustrine deposits | Usually consists of fine sand and silt with minor clay (less than 10%) and occasional sandy to gravelly pockets. |
| M | Morainal deposits | Usually consists of pebbly to bouldery gravel with a silty, sandy matrix. Clay content in matrix is low. Matrix at depth (deeper than 1 m.) is usually rich in carbonates. |
| O | Organic deposits, mostly humic | Organic deposits vary from fibric to humic, are usually thinner than .5 m. |
| R | Rock | Variable. In some areas, the bedrock consists of altered granite or grus and can behave like a poorly graded pebbly gravel with low matrix content. |
| W | Water | Lake, pond, river, etc. |

**Table 2 cont'd**

## Process component

~~O Process~~ ~~Process(es) Observed in the field~~

| Map Symbol | Description |
|---|---|
| B | Beaver dams observed, drainage and vegetation subject to change |
| EA | Active, observed erosion |
| F | Flooding, seasonal to occasional |
| FA | Flooding, actively flooded most spring to mid-summer, variable |
| K | Active thermokarst |
| R | Bedrock present within 3 m from surface |
| r | Bedrock possibly present within 5 m from surface |
| O | Organic veneer, irregular, discontinuous |
| S | Slow mass movement, usually related to permafrost, soil creep or solifluction |
| T | Steep slope, often steeper than 30% |
| V | Gullied, rilled, partially unvegetated, gullying likely to worsen if disturbed |
| W | Very poor drainage, water table very close to or at surface part of the year |
| Z | Permafrost present within 1.5 m from surface |
| 0 | no observed processes, surfaces unlikely to be at risk under most land uses |

| [illegible] | [illegible] |
|---|---|
| d | potential wind erosion(re-activation of sand dunes) |
| e | Surface susceptible to erosion if surface vegetation is disturbed |
| f | Flooding, occasional, low frequency |
| k | Thermokarst may develop if surface vegetation is removed or surface water conditions change |
| r | Bedrock may be present within 5 m of surface |
| s | Solifluction or slow mass movement may develop if surface vegetation removed. |
| t | Moderate slope, often between 20% and 30% |
| v | Gullying likely to develop if the surface vegetation is removed or disturbed. |
| w | Weater table may be within 1.5m of the surface part of the year |
| x | Permafrost probably present within 3m from surface |
| 0 | No potential process under normal land use practices. |
| | |

sensitive to vegetation removal and are likely to develop deep gullies. On some slopes (map symbol C: TG), very old trails and roads were associated with deep, steep gullies( map symbol C: TV). Colluvial surfaces covered by thick layers of surface organic material may contain permafrost pockets and would also be sensitive to removal of surface vegetation which would affect ground temperature, hydrology and long-term stability of the slope.

Colluvial fan slopes often have active downslope movement of sediment with a wide range of textures. Upper colluvial slopes tend to be coarser grained with rapid drainage while mid to lower colluvial slopes tend to have finer sediments with lower permeability and poorer drainage characteristics. Inactive colluvial aprons and fans are often sites where thick organic soils develop with ice rich permafrost on north facing, poorly drained lower slopes.

Considerations for Development

Colluvial deposits are, by definition, actively eroding surfaces. During field work we observed that colluvium originating from fine grained material was looser, more porous and would be sensitive to removal of vegetation. Colluvium associated with morainal landforms was noticeably looser than the till surfaces, contained a much lower percentage of coarse fragment and a higher fine sand and silt content which made it more sensitive to gullying and sheet erosion if vegetation was removed. Clasts are often imbricated parallel to the slope.

Colluvial fans are often undergoing active erosion and sedimentation and consequently have unstable slopes. Colluvial fans are subject to debris flow sedimentation and stream erosion, particularly during spring run-off and during storm events. A systematic evaluation of colluvial fan landforms should be conducted prior to construction to avoid areas which show evidence of debris flow, debris torrent and/or braided stream sedimentation. In addition, permafrost may be present at higher elevations and in mid to lower north facing slopes. Finally, steep colluvial slopes with chutes are paths for avalanches and should be assessed for this hazard before developing in these areas.

Thin colluvial blankets also occur on rolling terrain. These types of deposits have a range of physical characteristics (i.e. porosity, permeability, drainage and texture). In addition, bearing strength is usually weak due to the low compaction and friable nature of the sediments. In most cases, the behavior of landform surfaces covered by thin colluvial deposits is related to the underlying bedrock and/or unconsolidated sediments.

2.3.2 FLUVIAL DEPOSITS (F)

Geological Description

Fluvial or alluvial deposits range from fine silty sediments to gravelly deposits of variable depth and extent. They form the modern or Holocene stream deposits(Plate 2-7. Fluvial deposits in the City of Whitehorse include finer-grained sediments associated with the Yukon River and the coarser deposits which form broad gravel bars and islands, as seen close to the downtown area. It is common to find a silt blanket over gravelly or sandy fluvial deposits. Topography in this map unit tends to be gently inclined to gently undulating with low terraces and low ridges which are probably related to flood events. A thin cap of organic material is commonly found on fluvial sediments.

Considerations for Development

The lowest terraces of the Yukon River are more susceptible to flooding than the higher terraces and usually have a shallow water table. Islands, gravel bars, back channels of some of the terraces are subjected to seasonal flooding (map symbol F:Fto F;FA)

Meltwater channels, now occupied by small streams are also partially covered by organic and fluvial deposits. Permafrost is usually absent below active channels but is common in fine grained sediments and it is possible that thermokarst subsidence (as in map units F: k) would develop if the surface is disturbed (Plate 2-7). Most channels and streams within the study area have been colonized by beavers and the impacts of dam construction, flooding and vegetation changes are evident.

### 2.3.3 GLACIOFLUVIAL DEPOSITS (FG)

Geological Description

For the purposes of this report, glaciofluvial deposits are grouped into ice contact and outwash deposits. Ice contact deposits such as eskers and kames, are deposited directly in contact with the melting ice. Bouldery and cobbly gravel are very common in these deposits, as well as pockets of silty, sandy gravel. These deposits are usually limited in their surface extent but their thickness can exceed 20 meters (Plate 2-8). These landforms occur as groups of sinuous ridges, pitted terrain or as high level terraces with depressions (e.g. kettles). In the study area glaciofluvial ice contact sediments are found associated with a few meltwater channels such as the McLean Lake depositsand the gravel deposits along the Haul Road and Fish Lake Road. Ice proximal glaciofluvial gravel and sands are associated with Chadburn, Long and Ear Lakes, and the ridge by McCrae industrial subdivision.

Glaciofluvial outwash (Plates 2-3) has a variable thickness and a high content of clast sizes. They are commonly composed of cobble to pebbles size gravel with sandy beds and a silt cap. Sandy outwash blankets capped the glaciolacustrine sediments over most of the Porter Creek area, part of the Whitehorse airport and many flat topped surfaces in the southern half of the City (Plate 2-9).

Considerations for Development

The ice contact deposits are a usually good source of aggregate for road construction. As outlined above, ice contact deposits tend to be of limited surface extent, often with steep topography. As such these steeply-sloped deposits are not suitable for most land uses involving construction of structures despite the favorable drainage conditions and bearing strength. Permafrost is not considered to be a limiting factor with respect to development on these landforms. The high degree of porosity and rapid drainage makes ice contact deposits unsuitable as waste disposal sites.

Glaciofluvial outwash deposits also have a high degree of porosity and rapid percolation, and consequently they are also unsuitable targets as waste disposal sites. However, gravelly outwash deposits generally have good bearing strength and favorable surface topography and are as a result are favorable areas for road construction and facilities and/or housing construction (including septic facilities). In excavations of outwash deposits, high walls will be of variable cohesion and internal strength and will remain unstable until an equilibrium is achieved through slumping. When thick enough, these deposits also are a good source of aggregate. Finally, ice-rich permafrost is usually absent from glaciofluvial outwash deposits.

In the Whitehorse area, because of the fluctuating ice front of the glacier and the proximity of the ice front into Glacial Lake Champagne, the low relief glaciofluvial sediments are often less than 5 meters thick and overly either silt and fine sand (usually at elevation close to 750 meters and less, as is the case in the airport area), or is mixed with or overlie moraines (at elevation close to 800 meters, as is the case of area west of Wolf Creek).

### 2.3.4 GLACIOLACUSTRINE DEPOSITS (GL)

#### Geological Description

Glaciolacustrine deposits are an important stratigraphic unit, as they are often found within a few meters from the ground. They are often capped by glaciofluvial sand and gravel Plate 2-5). Exposures of glaciolacustrine sediments are familiar to all residents. They form most the cliffs along the Yukon River and around the downtown area. Sediment thickness range from 20 to 60 meters.

Glaciolacustrine sediments are dominantly composed of well-sorted, well-stratified laminae of clay, silt and very fine sand in various proportions. Two textural analysis of the sediments indicate sand and silt content of 54% to 58 % and clay content of 41 to 45 % at depth of 3 to 4 meters. Surface samples (15 to 30 cm.) from the Takhini Valley show a greater range in texture, with fine sand from 30 to 50 %, silt from 10% to 50%, and clay from 20% to 40 %. In general the sand content increases closer to the source of sediments, in this case, the ice front or incoming streams into the lake. The clay content usually increases towards the deeper portion of the lake basin, in this case, westwards. Where there has been a steady ice retreat with no readvances, lateral and stratigraphic trends in the general composition of the sediment is fairly predictable. However, within this mapping area, the ice front stagnated and possibly fluctuated generating a complex and varied set of deposits. Inclusions of sand and gravel may be found in at depth in several belts or zones, particularly close to the Porter Creek subdivision on both sides of the river.

Considerations for Development

The high silt content, low perviousness and low permeability make glaciolacustrine deposits potentially susceptible to frost heaving, possibly to liquefaction and a poor septic system site. In areas with sufficiently high clay content, traficability on exposed surfaces in the spring and after rainstorm is poor to very poor. Slumping and sliding along river and road cuts are common. Unvegetated slopes are often deeply gullied and slope wash, slow mass movement are commonly seen along the river banks, cliff and excavated walls. the fine and friable nature of these deposits make its difficult to stabilize (Plate 2-5).

In the summer, the dry surfaces can be rather unfriendly to seedling and dessication fractures can develop at the crest of cliff, folowed by slumping of blocks as large as 4 to 5 cubic metres. Although no permafrost was detected during this field season, similar sediments in the Takhini River Valley contain large ice lenses (Burn, 1985) and therefore similar conditions could exist. The ice-rich silt and clay could be several metres below the surface and up to 20 metres thick.

Clay mineralogy and fired and unfired tests for ceramic clay potential were performed on Glacial Lake Champagne sediments in the areas adjoining the City of Whitehorse limits (Mougeot, 1994). In summary, the sediments showed sufficient clay content, good plasticity and food workability. The main clay minerals present include kaolinite (40 to 45 %), illite (45%), chlorite (10%) and traces of montmorillonite (less than 5%). Other minerals such as plagioclase felspar and calcite are also present. Limitations for ceramic potential are an extremely short firing range (less than 25 degrees) and a high calcite content. The high content of calcite will eventually weaken the structural strength of the ceramic product. Results of analytical testing of the glaciolacustrine sediments for their use in ceramics are presented in Appendix 5.

## 2.3.5 MORAINE DEPOSITS (MV AND MB)

Geological Description

Moraine are dominantly composed of till, which is usually a mixture of gravel, sand, silt and clay size particles termed diamicton or boulder-clay. In the Whitehorse area, morainic deposits typically have a coarse loamy sand to sandy loam matrix (this implies a low clay content) with a high content (more than 70 %) of pebbles, cobbles and boulders. A silt veneer of loess commonly caps these morainic deposits. Lenses or pockets of coarse sand and gravel are common (Plate 2-10). The thickness of moraine deposits can be greater than 10 metres. In the study area, moraines are generally exposed at elevations higher than 730 m on the valley sides. Morainal material is also associated with bedrock outcrops or walls (Plate 2-11)

Morainic blanket deposits thought to be greater than 1 meter thick but less than 3m have the map symbol Mb. An Mv symbol indicates morainic deposit is less than 1 meter thick. The Mv symbol is used mainly for discontinuous veneer, on valley walls at elevations above 900 m. In many cases, at these elevations, the morainic map unit may include colluviated diamicton and colluviated rubbly and weathered bedrock. In the case of thin morainic deposits, the surface topography is controlled by the underlying bedrock.

The morainal deposits located west of the Haul Road and in the Wolf Creek and Mary Lake areas appeared to be coarser and much gravelier than those located at slightly lower elevations. The presence of meltwater channels becoming poorly defined with lower elevation suggest that running water may have winnowed fine particles away from the till, without really large volumes of true gravel. It is possible that small volumes of this coarse till can be used as a source of gravel, but the quantity and quality of the gravel could vary within short distances. This could also be the case of morainal surfaces close to meltwater channels particularly between elevations of 800 m and 900 m.

Considerations for Development

Generally, moraines in southern Yukon have moderate to good percolation rates and the risk of frost heavingor subsidence is very low. In addition, bearing capacity is favorable and consequently morainic deposits are generally considered to be suitable for the construction of facilities and structures. The overall permeability will depend principally on the silt and clay content of the matrix sediment and the presence or absence of sandy and gravely inclusions (e.g. intrabeds). The suitability of a site for waste disposal areas in morainic deposits depends on physical characteristics such as depth to bedrock, sufficiently low permeability and relationship with subsurface features such as aquifers or streams. The present Whitehorse landfill is located on morainic deposits with areas of shallower bedrock south and west of Porter Creek.

A typical limiting criteria for morainic deposits is the presence of large boulders which can hinder excavation. Morainic landforms with a low gradient slope can also provide an adequate base for road construction. Permafrost tends to be sporadic in morainic deposits with the higher potential on northerly facing slopes with spruce forest cover and organic ground cover. Permafrost is more likely to occur as small pockets of frozen sediment with a low volume of interstitial ice. Large segregated ice lenses are not common. Thermokarst is not commonly associated with morainal landforms due to relatively low ice content, the lack of clay size sediments and the proximity of bedrock. Gullied morainic deposits (M -V) may have unstable slopes and can act as drainage conduits during the spring snow melt, heavy rainfall runoff or debris torrents. High natural radon emission has been measured in residential subdivisions built on moraine deposits (Wolf Creek, Mary Lake ).

### 2.3.6 ORGANIC DEPOSITS (O)

Geological Description

Organic deposits are formed of decomposed vegetation. They develop in areas of poor drainage. They are often referred to as peat or muck deposits. Organic deposits are usually associated with landform depressions or channels where abundant moisture is present. In many cases they mark the outline of former lake basins that have dried up or drained away. In these cases the organic deposit may be composed of marl, a mixture of snail shells, lime and clay. These are referred to as limnic deposits. Organic deposits usually cover small surfaces with nearly flat to gently sloping surface topography. They are defined as having thickness of at least 0.4 meters. There are few deposits thicker than 1.0 meter in the City. In many areas, the organic materials are frozen until late in the summer or are permanently frozen. The underlying mineral material can range from silt to bouldery gravel.

All organic deposits in the City of Whitehorse are associated with wetlands (Chapter 5). Wetlands are classified according to their hydrology, parent materials and surface vegetation. In most cases (but not all) organic deposits are one of the dominant materials found in the wetlands. In several flat bottomed creeks, such as McIntyre Creek and the creek west of the Logan residential subdivision, limnic organic sediments are thicker than 3 meters.

Development Considerations

Organic deposits are usually poorly to very poorly drained, have low bearing strength and are unsuitable for development. They often are underlain by permafrost and are sensitive to changes in the vegetation cover. Wetland ecosystems associated with organic deposits are important in controlling run-off, filtering water and provide important habitat for a variety of organisms.

### 2.3.7 BEDROCK (R)

Geological Description

The bedrock geology of this area is described by Wheeler (1961). It was not the objective of this study to map bedrock and /or to evaluate competency of rock. It should be noted however that grus, a friable, even loose weathered granite is found in many areas west of the Alaska Highway within map sheet 2 and 3. Basalt beds with columnar structure form the stepp walls of Miles Canyon (Plate 2-12).

Development Considerations

Detailed bedrock mapping would be required to comment of fissility, presence and type of fractures, competency of rock types found in this valley. Grus can behave more like a poorly graded coarse to pebbly sand. Radon emission (natural) are believed to be related to bedrock type or alrge boulders contained in till. Several houses located on the Mary Lake and Wolf Creek subdivisions have had high emission rates measured.

# 3. CHAPTER THREE: SOIL FORMATION AND CLASSIFICATION

## 3.1 INTRODUCTION

In this chapter , the influences of climate, geologic deposits, time and topography are described relative to the formation of soils in the Whitehorse area. Soil scientists use a system to classify the types of soil development that result from these influences. This overview is intended to help report and map users understand the principals of soil formation and how soils are classified in the process of preparing soil and interpretive maps.

## 3.2 SOIL FORMATION

Distinct soils form at the surface of the earth as a function of natural factors that affect the rate and type of soil weathering (or formation). Soil is the product of climate, vegetation, organisms and topography acting on the underlying geologic material over a period of time.

The glacial history of the survey area is the controlling factor in the nature of the soils and their landscape distribution. Soils have formed on a variety of glacial parent materials since deglaciation approximately 10,000 years ago. Major influences on soil formation are parent material properties such as clay, silt and sand content (described as texture), mineral content and salts.

Climate is another important factor in soil formation. Climate determines the type of vegetation cover as well as the amount of permafrost, frost action, and water that can act on the parent material. The topography influences erosion and water run-off characteristics which can also affect soil development.

Weathering develops colour in the soil. Dark surface colours develop through the incorporation of vegetative products (humus) and reddish brown colours develop in the subsoil as a result of mineral oxidation. Very wet soils may show dull colours as a result of reducing conditions(i.e. lack of oxidation). Very young soils may show no weathering features at all. These soils are found where fresh materials are constantly being deposited on the earth surface. Some examples are river bars and areas along steep slopes where erosion is very active.

Weathering processes produce what soil scientists call "horizons" which represent zones of weathering. They are named by letter designation as A (surface horizons), B (subsurface horizons) and C (underlying unweathered parent material). The sequence and depth of horizons combine into what is referred to as the "soil profile". Each soil has a distinctive soil profile and associated characteristics. A schematic soil profile showing the typical range of horizons that may be present is illustrated in Figure 3-1.

Some special soil features common to most sites observed during the mapping exercise are worth mentioning. First, the entire area is covered by a thin layer of volcanic ash. Throughout southern Yukon, soils are capped with a veneer of white volcanic ash. This material is composed of sand and silt-sized grains of glass-like material that fell about 1200 years ago following a volcanic eruption in the headwaters of the White River in the Alaska Range. This ash is included in most soil profiles; it appears within the Ah horizon or between the Ah and the first Bm horizon as a 1 to 4 cm thick light grey to whitish band with a silty to loamy texture (Figure 3-1). In soils where recent deposition has occurred, it may be present deeper in the profile. The presence of this ash is partially responsible for the loamy texture of the first 5 cm from the surface in most soils.

Secondly, mixing of soil horizons by animals, tree uprooting or frost action is almost always observed. Since deglaciation, recurrent forest fires have caused intense uprooting of trees which is directly related to many of those disturbances. Burrowing, grazing and scratching of the surface by animals also contribute to the irregular appearance of near surface soil horizons. In soils underlain by permafrost, cryoturbation (frost churning) produces mixed horizons. Also, relic cryoturbation is also common in fine-grained soils.

## 3.3 SOIL CLASSIFICATION

### 3.3.1 THE CLASSIFICATION OF INDIVIDUAL SOILS

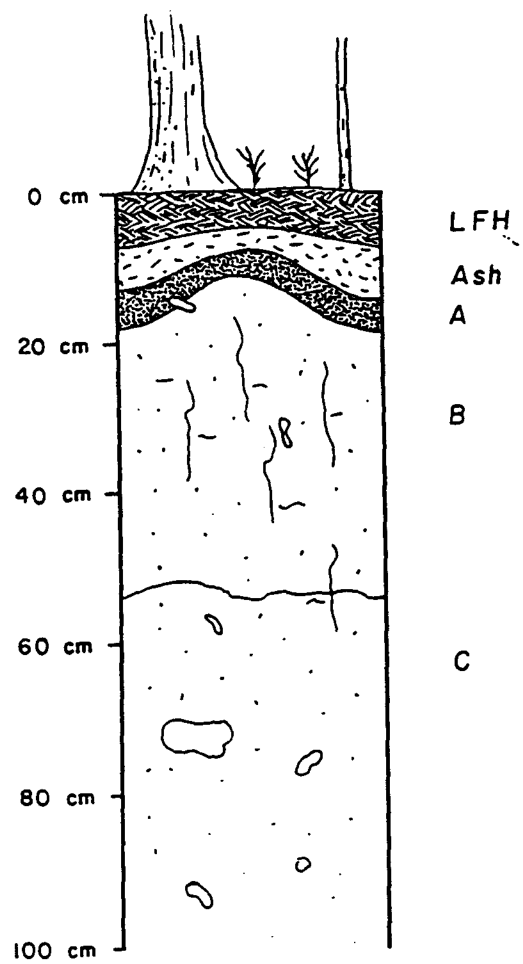
Soil classification is the orderly arrangement (or grouping) of individual soil profiles into categories called taxonomic classes. These categories are established according to the dominant weathering processes displayed by the soil profile. At each inspection site during the soil survey of the Whitehorse area, individual soils were classified according to the Canadian System of Soil Classification (ACECSS 1987).

The first level of classification is the "soil order". There are four soil orders represented in the Whitehorse area. The soil orders are subdivided into many soil subgroups. These are listed on the legend for each soil. The orders and associated subgroups found in the survey area are as follows:

Brunisols are soils which show the effect of oxidation in the B horizon. All of the well-drained soils in the survey area belong to this order. More specifically, these are all classified as belonging to the Orthic Eutric Brunisol subgroup. This subgroup contains all rapidly to

## Figure 3-1 Schematic Soil Profile

A typical sequence of soil profile for this area. The partially decomposed forest litter at the surface is usually thin. The volcanic ash is often mixed with either the A or B horizons.



moderately well drained soils that are not strongly acidic (pH>5.5). Where considerable accumulation of humus is evident in the A horizon they are classified as Orthic Melanic Brunisols. Soils that show the effects of temporary saturation and dull colours are classified as Gleyed Eutric Brunisols.

Gleysols are soils which show the effect of permanent saturation. This condition can result from either flooding or high water-table. These soils are often a dull grey colour. If they contain a thick humus-rich A horizon they are classified as Orthic Humic Gleysol. If such humus is lacking, they are classified as belonging to the Orthic Gleysol subgroup.

Cryosols are soils which contain near-surface permafrost. Typically the soil is permanently frozen within 1 meter of the surface and most of these display the effects of frost mixing (cryoturbation). These soils are classified as Orthic Turbic Cryosols. Soils with permafrost that are found in very wet locations are classified as Gleysolic Turbic Cryosols. Near-surface permafrost is restricted to north-facing slopes under heavy forest canopy and usually Cryosolic soils have a thick build-up of moss or litter on the surface which acts to insulate the soil against summer thawing. Often, forest fires remove surface insulating layers of moss causing permafrost to recede from the soil profile. Hence, Cryosols are most common in areas that have not experienced recent forest fires.

Regosols are soils that do not show evidence of soil formation. They are usually associated with recent alluvial deposits or slump deposits on eroding escarpments. These soils are restricted to specific landforms. They are most often classified as Orthic Regosols except where they are subject to prolonged saturation or flooding in which case they are classified as Gleyed Regosols.

### 3.3.2 SOIL ASSOCIATIONS

Soil orders and subgroups organise information about soil formation as seen in individual soil profiles. However, a soil profile is the arrangement of horizons at only one specific landscape location. In order to link information about one site to an entire landscape area on a map, soil scientists have developed the concept of "soil associations". Soil associations combine information about the parent material, drainage and topography with that of the individual soil profile. Soil associations group soils with similar properties and uses. Each soil association is given a name usually derived from a local geographic feature where the soil was first described. For instance, all moderately well drained soils formed on glaciolacustrine sediments belong to the "Champagne" soil association. The soil was first described in the Takhini-Dezadeash Valleys during soil surveys in the late 1950's (Day 1962).

The soil association is described on the soil map legend. A map delineation (sometimes called polygon or map unit) is described as containing one or two soil associations.

These soil associations act as part of the map unit or polygon label. A listing of the soil associations on the Whitehorse area maps is found in chapter 4.

### 3.3.3 SOIL INTERPRETATION METHODS

### 3.3.4 SOIL PROPERTIES IMPORTANT TO INTERPRETATION

To assist the planner in understanding how these interpretations were made, three fundamental soil properties are reviewed. These are the differentiating properties of the soil associations and are the key to establishing ratings for each map polygon.

Soil Association: is the name given to generalised groups of soils that have similar soil profile characteristics, weathering features (i.e. belong to similar soil orders or subgroups), parent materials and landscape form. Interpretations are summarised by soil association.

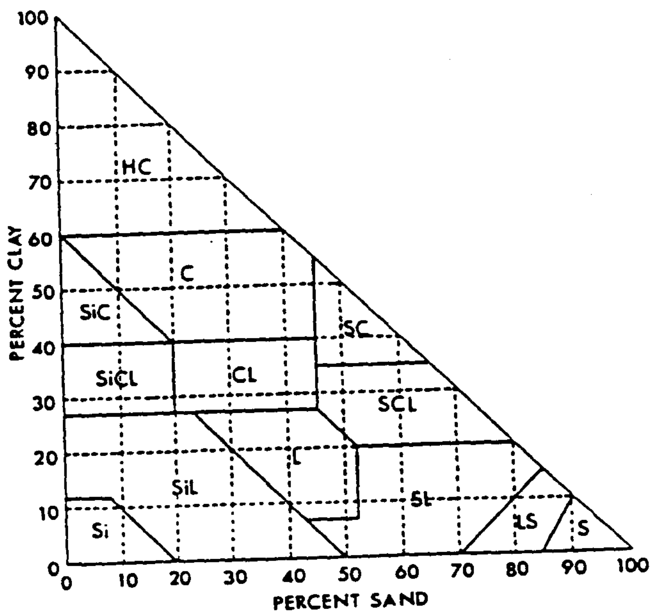
Soil drainage: refers to the amount and persistence of water within the soil profile. Moisture conditions are grouped into 7 classes of soil drainage. Each of these seven classes is defined and outlined in Table 3-1. Moisture conditions are a very important consideration in making interpretations for residential suitability, roads and agriculture. Moisture can limit agriculture both by its absence (droughty soils) and by its excess (waterlogged soils).

Soil texture: refers to the proportion of sand, silt and clay found in the soil. This property is dependent on the parent geological material. Figure 3-2 displays the "textural triangle". Every soil can be placed into a textural class which is named according to the dominant particle size represented. Loam is the textural class that is a mixture of sand, silt and clay. Sandy loam is the textural class that is a mixture of sand, silt and clay but sand is the dominate particle size within the mix. Soil texture is further described according the size and volume of coarse fragments (gravel and stones) in the profile. Most soil associations include individual soil profiles with horizons that will have a range of textural classes present. Texture determines the amount of water storage capacity in a soil, nutrient storage capacity, percolation rate and hydraulic conductivity of a soil. Texture affects the shrink-swell capacity and soil susceptibility to frost heaving. Texture is therefore an important consideration for both agricultural and engineering uses of soil.

Slope: refers to the percentage rise of land over a given run (distance). Therefore a land surface with 10 m of rise measured over a distance of 50 m is said to have a 20% slope. Because the landscapes in the survey area are composed of an array of individual slopes, slope classes defined by a range in slope values were defined for mapping purposes. These are defined on the map legend. Slope classes and their description is given in Table 3-2. Interpretations for both agricultural capability and residential suitability are based, at least in part, on slope.

**Figure 3-2 Textural Classes for Soils**

Soil texture as described in the soil description and map legend refers to percentages of silt, clay and sand (of the matrix only , in case of gravel).



## Table 3-1 Soil Drainage Classes

| Class | Drainage | Description |
|---|---|---|
| 1 | very rapidly drained | Water is removed from the soil very rapidly in relation to supply; excess water flows downward very rapidly if underlying material is pervious; subsurface flow may be very rapid during heavy rainfall provided the gradient is steep; source of water is precipitation. |
| 2 | rapidly drained | Water is removed from the soil rapidly in relation to supply; excess water flows downward if underlying material is pervious; subsurface flow may occur on steep gradient during heavy rainfall; source of water is precipitation. |
| 3 | well drained | Water is removed from the soil readily but not rapidly; excess water flows downward readily into underlying pervious material; these soils commonly retain optimum amounts of moisture for plant growth after rains of addition of irrigation water. |
| 4 | moderately well drained | Water is removed from the soil somewhat slowly in relation to supply; excess water is removed somewhat slowly because of low perviousness, shallow water table, lack of gradient or some combination of these; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils |
| 5 | imperfectly drained | Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season; excess water moves slowly downward if precipitation is the major supply; if subsurface water or groundwater , or both is the main source, the flow rate may vary but the soil remains we for a significant part of the growing season. |
| 6 | poorly drained | Water is removed from the soil so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen; excess water is evident in the soil for much of the time; subsurface water or groundwater , or both in addition to precipitation are the main sources, there may also be a perched water table |
| 7 | very poorly drained | Water is removed from the soil so slowly that the water table remains at or on the surface for most of the time the soil is not frozen; subsurface water or groundwater are the main sources, precipitation is less important except where there is a perched water table. |

## Table 3-2 Slope Classes

| Slope Class | Description | Gradient % |
|---|---|---|
| 1 | level | 0-0.5% |
| 2 | nearly level | 0.6-2% |
| 3 | very gentle slopes | 2 %-5% |
| 4 | gentle slopes | 6-10% |
| 5 | moderate slopes | 11-15% |
| 6 | mod. strong slopes | 16-25% |
| 7 | strong slopes | 25-30% |
| 8 | very strong slopes | 30-60% |
| 9 | steep slopes | 60%+ |

# 4. Chapter Four SOIL ASSOCIATION DESCRIPTIONS AND INTERPRETATIONS

## 4.1 SOIL ASSOCIATIONS AS MAPPING UNITS

In this chapter we describe how soil associations are used as mapping units. We also provide detailed information about each soil association and discuss the land use limitations. Table 4-1 summarizes the relation between parent material and soil associations. Figure 4-1 is a close relative to Figure 2-3: the schematic cross-section accros the Yukon River Valley ties landscape/terrain type to the soil association most commonly encountered on the landform.

Although the map scale is sufficient to allow representation of detailed soil conditions, small features cannot be represented at this scale. An "on-site" map symbol, such as the escarpment or terrace symbol, is used to show site specific features. The use of these symbols however is not always possible due to scale. For this reason, the maps are designed to be used at the planning scale (1:20,000 or smaller) and do not replace the need for site specific geotechnical investigation or site specific land use design. The maps can be used to alert planners to general soil, drainage and slope conditions and to basic material at the surface. They allow for city-wide evaluation of possible land use restrictions or capabilities

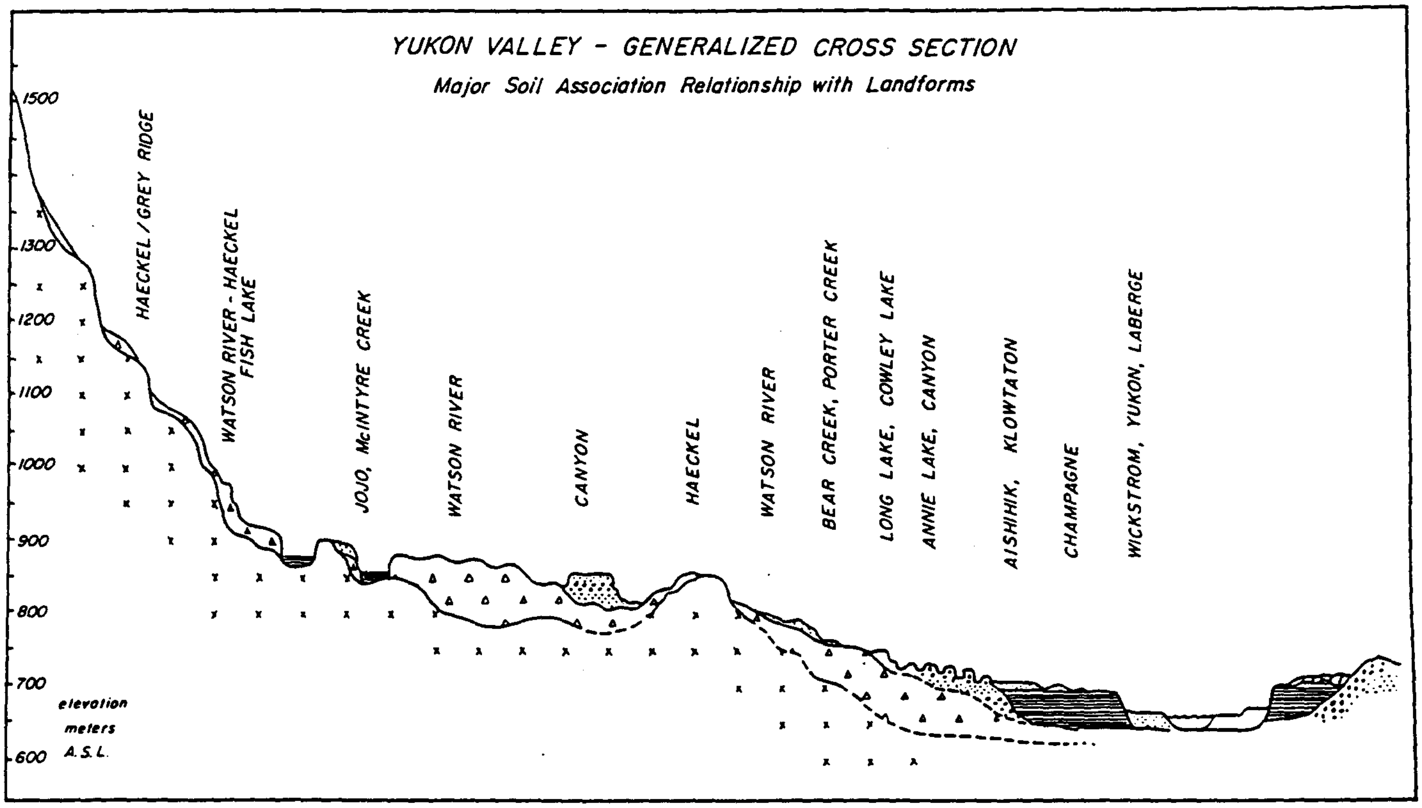
The legend on the soil map has four main components; a soil association code, a drainage class code, a slope class code, and when appropriate, a modifier which adds information about significant landscape conditions encountered within a map unit, such as sensitivity to erosion , presence of permafrost etc. A single soil association code indicates that more than 80% of the map polygon is represented by that association. In some cases, a complex map symbol consisting of two such codes is used as a polygon label. When two association names are separated by a single slash (/), the first association covers approximately 60% of the polygon, and the second association represents approximately 40%. Associations separated by a double slash (//) indicates the first association covers up to 80% of the polygon and the second association covers approximately 20%. Nature is hardly ever a case of "black and white" conditions. Maps can never includes every small modification in slope or drainage, or small inclusion such as small pond. The polygon symbol should however be representative of the general conditions present within its delineation.

The maps are compatible with soil survey maps of the adjoining Takhini Valley (Mougeot and Smith; 1992) and Carcross Valley (Mougeot and Smith; 1995) and therefore provide broad, consistent information over a wide regional area. The soil association analytical data presented in Appendix 2 are derived from the earlier work on these adjacent map sheets. Soil associations first described and analyzed in these outlying areas are expected to be

## Table 4-1 Relation between Parent Material and Soil Association , Yukon River Valley

| Soil association | Dominant Texture | Drainage | Topography |
|---|---|---|---|
| **Moraine** | | | |
| **Watson Lake** | gravel. c. loam to sdy loam | well drained | gentle to strong |
| **Bear Creek** | gravel. c. loam to sdy loam | well drained | gentle to strong gentle to strong |
| **Porter Creek** | gravel. c. loam to sdy loam | mod. well to well drained | gentle to strong |
| **Haeckel** | gravel. sdy loam/bedrock | rapidly drained | irreg. bedrock control |
| **Fish Lake** | organic over moraine | imperfectly to poorly drained | slopes,permafrost |
| **Glaciofluvial** | | | |
| **Aishihik** | sand | well to rapidly drained | level to moderate |
| **Annie Lake** | sand | well to rapidly drained | strong to steep |
| **Buck** | sand | imperf. to very poorly drained | nearly level |
| **Cowley Creek** | gravel and sand | rapidly to very rapidly drained | gentle to strong |
| **Disappointment** | gravel and sand | rapidly to very rapidly drained | nearly level, grassy |
| **Long Lake** | loamy sd veneer/ gravel | rapidly to very rapidly drained | gentle to strong |
| **Canyon** | gravel and sand | rapidly to very rapidly drained | strong to steep |
| **Glaciolacustrine** | | | |
| **Champagne** | silty clay loam to loam | mod. well drained | nearly level |
| **Lewes** | loam over silty c. loam | moderately well | nearly level |
| **Klowtaton** | disc. sand over silty c.loam | mod. well to well drained | nearly level |
| **Fluvial** | | | |
| **Croucher** | silt loam to sandy loam | mod. well to well drained | nearly level |
| **Laberge** | silt loam to sandy loam | v.poorly to imperf. drained | nearly level |
| **Yukon** | loamy sand to sand | well drained | nearly level |
| **Haines** | sandy gravel | rapidly drained | variable |
| **Wickstrom** | silt to sand over gravel | rapidly to well drained | nearly level |
| **Popes** | peat, silt loam to sd /sd | imperfectly to very poorly drained | pitted, thermokarst |
| **Colluvial** | | | |
| **Gray Ridge** | variable | variable | mod. to strong |
| **Organic** | | | |
| **Jojo** | Peat | poorly to v.poorly drained | level to hummocky |
| **McIntyre Creek** | Marl | poorly to v poorly drained | nearly level |
| **Aeolian** | | | |
| **Whitehorse** | sand | well drained | hummocky |

**Figure 4-1 Schematic Cross Section, Relation between Landscape and Soil Association**



## Table 4-2 Summary of Soil Association Characteristics

| Map Symbol | Soil Association | Parent Material | Drainage Classes | Dominant Texture | Soil Subgroup | General Topography |
|---|---|---|---|---|---|---|
| **AHK** | Aishihik | Glaciofluvial | 2-3 | Loamy sand to sand | Orthic Eutric Brunisol | undulating |
| **ALK** | Annie Lake | Glaciofluvial | 2-3 | m to c loamy sand to sand | Orthic Eutric Brunisol | pitted, ridged, kettled |
| **BCE** | Bear Creek | Glaciofluvial over Morainic | 3-4 | Loamy sand to sand over grv sdy loam | Orthic Eutric Brunisol | undulating to rolling |
| **BUC** | Buck | Glaciofluvial | 4-6 | m to c loamy sand to sand | Gleysolic Turbic Cryosol<br>Orthic Turbic Cryosol | undulating, depressions |
| **CAK** | Cracker | Fluvial | 4-6 | loam to sandy loam | Gleyed Eutric Brunisol<br>Orthic Humic Gleysol | undulating |
| **COW** | Cowley Lake | Glaciofluvial | 2-3 | grv sand and grvl | Orthic Eutric Brunisol | undulating to rolling |
| **CPG** | Champagne | Glaciolacustrine | 4 | silty clay to clay loam | Orthic Eutric Brunisol | level to undulating |
| **CYO** | Canyon | Glaciofluvial | 1-2 | grv sand and grvl | Orthic Eutric Brunisol | ridged, hummocky, pitted |
| **DIS** | Disappointment | Glaciofluvial | 2-3 | silt loam to sdy loam on sd and grvl | Orthic Eutric Brunisol | undulating |
| **FIS** | Fish Lake | Organic/Moraine | 4-7 | up to 50 cm of organic over gravelly sandy loam | Organic Cryosol<br>Turbic Cryosol | east and north facing slopes, permafrost |
| **GRY** | Grey Ridge | Colluvial | 1 to 7 | variable | | slopes |
| **HIS** | Haines | Fluvial | 1-2 | sand and gravel | Orthic Eutric Brunisol | undulating |
| **HKL** | Haeckel | Morainic over rock | 2 | grv loamy sd and rock, bouldery | Orthic Eutric Brunisol | steep and irre topo |

| | | | | | | |
|---|---|---|---|---|---|---|
| **JOJ** | Jo-Jo | Organic | 5-6 | peat | Terric Fibrisol<br>Fibric Organic Cryosols | nearly level, micro mounded |
| **KLW** | Klowtaton | Glaciofluvial | 3-4 | sdy loam to sd over silt loam | Orthic Eutric Brunisol | undulating |
| **LBG** | Laberge | Fluvial | 5-7 | silt loam to loamy sd | Orthic Humic Gleysol<br>other Gleysols | undulating |
| **LOL** | Long Lake | Fluvial over Glaciofluvial | 2-3 | silt loam to fine loamy sand over gravel | Orthic Eutric Brunisol | Undulating to slightly rolling |
| **LWS** | Lewes | Glaciolacustrine | 3-4 | silt loam to loamy sd over silty clay loam | Orthic Eutric Brunisol | nearly level to undulating |
| **MCI** | McIntyre Creek | Organic over fluvial | 5 -7 | marl and peat | Limno Fibrisol<br>Limno Mesisol | depressions, nearly level |
| **POP** | Popes | Fluvial | 5-7 | silt loam to f sd and peat over loamy sd | Gley. Turbic Cryosol<br>Terric Fibrisol | pitted, kettled micro mounded |
| **POR** | Porter Creek | glaciofluvial over Morainic | 4 | silt loam to sdy loam over grv sdy loam | Orthic Eutric Brunisol | undulating to rolling |
| **WAS** | Watson River | Morainic | 3-4 | grv loamy sd to grv sdy loam, boulders | Orthic Eutric Brunisol | rolling to hummocky |
| **WCK** | Wickstrom Road | Fluvial | 1-3 | silt to fine loamy sand over gravel | Orthic Eutric Brunisol | undulating to terraced |
| **WHS** | Whitehorse | Aeolian | 2-3 | Loamy sand to sand | Orthic Eutric Brunisol<br>Cumulic Regosol | hummocky |
| **YUN** | Yukon | Fluvial | 2-3 | loamy sand to sand | Orthic Eutric Brunisol | undulating |
| **ZAL1** | Fluvial | Fluvial | 5-7 | silt loam to sand | Regosol | terraces |
| **ZAL2** | Fluvial | Fluvial | 5-7 | gr sd to grvl | Orthic Regosol<br>Rego. Gleysol | very low terraces. islands |
| **ZCS** | Colluvial | Colluvial | 3-6 | variable | Orthic Regosol<br>Rego. Gleysol | slump area |
| **ZES1** | eroded slope | | 2 | variable | Regosol | steep slopes 40%+scarp |
| **ZES2** | e. s. and creek bottom | | 1-4 | variable | Regosol | steep slopes and creek bottom |

Table 4-3: Soil Associations and Their General Characteristics and Limitations for Use.

| Soil Association | Aquifer Recharge or Discharge | Sand Potential top metre | Sand Potential below top metre (est) | Gravel Potential top metre | Gravel Potential below top metre est. | Topsoil Potential and Depth | Saline | Slumping Potential | Wetlands | Active Floodplains | Steep Slopes | Septic Tank Suitability | Residential Suitability | Main (est) below Top Metre | Agriculture Capability | Other Considerations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aishihik | Recharge | High | High | No | Medium pockets | No | No | Raveling | No | No | | Suitable | Suitable | Sand to gravel | 6 M | |
| Alluvium 1 | Active floodplains-not suitable for development | | | | | | | | | | | | | | | Flooding |
| Annie Lake | Recharge | High | High | No | Medium | No | No | Raveling | Potholes | No | Occasional | Suitable slope prob. | Suitable | Sand | 6 MT | |
| Bear Creek | Neutral to either location specific | Medium | Till | Low | Medium | Medium in depressions | No | No | Yes | No | Occasional | Generally suitable | Generally suitable | Till | 6 M | |
| Buck | Discharge | Sometimes | Sandy | Low | Medium - lens layer of gravel | Yes - peat at surface 50 cm of peat | Yes | No | Yes | No | | Unsuitable poor drainage | Unsuitable | Sand to occasional gravel lens | 5 CM | |
| Canyon | Recharge | Good | Good | Good | Good | No | No | Raveling | No | No | | Suitable percolation too fast | Suitable | | 7 MT | |
| Champagne | Neutral | Low | Low | Low | Low | No | No | Yes - near escarpment | No | No | | Unsuitable low percolation | Unsuitable - subject to site study | | 5 CM | Random permafrost within 15 metres |
| Cowley Lake | Recharge | High | High | High | Medium to high | Low | No | No | No | No | | Suitable | Suitable | | 6 M | |
| Craker | Discharge | Low | Soil is below water table | Soil is below water table | Soil is below water table | Yes, often thin, less than 20 cm | Yes | | Yes | Yes | | Unsuitable | Unsuitable | | 5 S | |
| Croucher | Recharge | Medium | Medium | No | No | Yes, variable to 20 cm | No | No | In depressions | Not active | No | Suitable | Suitable | | 5 - 5 W | |
| Disappointment | Recharge | Medium | High | Medium | Medium to high | No | No | Raveling | No | No | | Suitable percolation too fast | Suitable | | 6 M | |
| Fish Lake | Discharge | No | No | No | No | No | | No | Yes | Beaver activity | No | No | No | Organic limnic | 5 W to 7 W | Possible permafrost |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gray Ridge | Recharge but has springs on side of mountain | No | No | Possible | Possible | No | No | Yes - old landslides | | | Yes | Unsuitable | Unsuitable | | 6 P to 7 RT | Slopped Deposits - Rubbly Material over Bedrock |
| Haeckel | Recharge | Pockets- generally no | Till over bedrock | Till over bedrock | Till over bedrock | No | No | Possible on steep slopes | No | No | Yes | Limited to difficult | Limited to expensive | | 6 RT to 7 RT | Requires site specific study |
| Haines | Recharge | High | High | High | High | Low to no | No | No | No | No | | Suitable but has rapid percolation | Suitable | | | Source of gravel- risk of flooding |
| JoJo | Discharge | No | No | No | No | Peat in depressions - up to 1 m. | Occasional | | Yes | No | | Unsuitable | Unsuitable | Clay | 6 WZ to 7W | Permafrost good for topsoil |
| Klowtaton | Recharge | Yes | Clay | No | No | No | No | Yes | Generally no | No | No | Suitable subject to site specific study | Soils variable b | Sands over Clay | 5 CM to 6 M | |
| Laberge | Discharge | High | Sand & silt below river level | No | Possible - active floodplain | Yes - up to 15 cm of peat and humus | Occasional | | Backchannels | Yes | | Unsuitable | Unsuitable | Sand & silt | 5 W to 7 W | Permafrost -high watertable |
| Lewes | Neutral | High | Low | Low | Low | No | No | Near escarpment | No | No | | Unsuitable low percolation | Unsuitable subject to site study | | 5 CM | Random permafrost within 15 m |
| Long Lake | Recharge | Yes | No | Yes | Yes | No | No | No | No | No | No | Suitable possible fast percolation | Suitable | Gravel | 6 M | Possible gravel source |
| McIntyre Creek | Discharge | No | No | No | No | Yes. Peat surface 20 cm | No | Yes detachment slides | No | No | No | No | Moderate | Till | 6 MP to 6 Z | Permafrost |
| Popes | Discharge | No | No | No | No | Yes- up to 50 cm of peat | Yes | | Yes | Yes | | Unsuitable | Unsuitable | River deposits of silt & sand | 6 Z to 7 W | Permafrost on floodplains |
| Porter Creek | Sometimes discharge | No | Till | No | Till | No | Occasional | | Meadows | No | | Depends on discharge - suitable | Suitable depends on discharge | Till | 5 M to 6 MP | |
| Watson River | Recharge | Till | Till | Till | No | No | No | Possible | No | No | Yes | Suitable | Suitable | | 6 MP | |
| Whitehorse | Recharge | Yes | Yes - very clean and uniform grain size | No | No | No | No | Raveling | No | No | Yes | Suitable- fast percolation | Suitable | 5 to 9 metres of sand over clay-dunes | 6 M | Dunes - possible tourist attraction excellent for mortar and cement |
| Wickstrom | Location specific | Medium to high | Low | Medium | Medium | No | No | Yes river banks | No | Lowest reaches | No | Water table may be shallow | Suitable depends on water table | Gravel | 6 M | |
| Yukon | Recharge | Moderate silty sand | Moderate | No | No | Low | No | Raveling | No | No | Terraces | Suitable | Suitable | Sand & silt | 5 M to 6 M | High terraces |

comparable to the ones found within the City of Whitehorse limits. A summary of soil association characteristics is presented on Table 4-2. Summary of consideration for development for each soil association presented on Table 4-3. The stratigraphy and more importantly the underying sediment type impact of site characteristics particularly when structures or excavations are part of the development plan. The reader should refer to the terrain map as well and ensure that the subsurface conditions are also compatible with the land use being considered.

## 4.2 SOIL ASSOCIATION DESCRIPTION

### 4.2.1 AISHIHIK SOIL ASSOCIATION (AHK)

General Description

The Aishihik Soil Association is composed of Orthic Eutric Brunisols developed on well drained glaciofluvial and deltaic sediments. Its texture can range from loamy sand to gravelly sand, but is most commonly fine to medium sand, and is well to rapidly drained. The average thickness of the A horizon is less than 5 cm and the soils have a neutral reaction.

The topography of the Aishihik map unit is usually low relief and undulating and is when associated with outwash plains. This soil is often associated with Klowtaton or Long Lake soils.

Consideration for Development

Aishihik map units are usually suitable for residential development (see Table 4-3). Bearing strength should be acceptable. Frost heaving and poor drainage should not be a problem. The sands are poorly to well graded with local variations of grain size and sorting that may affect the ease of excavation and excavation wall strength. Occasional slopes greater than 15% are still acceptable but may entail more preparation. The installation and maintenance of septic filter tank system should not present major problems if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates should be acceptable. If the sand is thin and underlain by silt and clay, as is the case isn the area close to Pine Ridge, poor percolation and poor drainage at depth may present problem. Wind erosion could be activated if the vegetation cover is removed.

Capability for Cultivated Agriculture

The sandy texture of the Aishihik soil reduces moisture retention and the soils are droughty. The soil is generally rated class 6M, and occasionally 6M/5CM. Wind erosion could be activated if the vegetation cover is removed.

## 4.2.2 ANNIE LAKE SOIL ASSOCIATION (ALK)

### General Description

The Annie Lake Soil Association is composed of Orthic Eutric Brunisols developed on well drained glaciofluvial and deltaic sandy sediments . Its texture can range from loamy sand to gravelly sand, is most commonly fine to medium sand, and is well to rapidly drained. The average thickness of the A horizon is less than 5 cm and the soils have a neutral reaction.

The topography of these soils is pitted, kettled or ridged, with steep slopes alternating with crests or bands of flatter surfaces. The pitted units are formed from deposits derived from a stagnant ice environment such as the Chadburn, Long and Ear Lakes areas. In most cases the thickness of the sand deposits ranges between 2 and 6 meters. At the crests of cliff-tops, these sediments are often reworked by the wind and sand dunes form belts as wide as 50 m. such as the area east and north of Riverdale. This soil is often associated with Canyon soils.

### Consideration for Development

Slope is the major factor to consider. Frost heaving and poor drainage should not be a problem. The sands are poorly to well graded with local variations of grain size and sorting that may affect the ease of excavation and excavation wall strength. Map units with slopes of 15% to 25% are acceptable for development but may entail more excavation and grading costs. Units with slopes greater than 25% will create a significant cost increase and a special design for house and road construction may be required to prevent excessive erosion and slope instability. Slopes of less than 15% are not common for the Annie Lake soil association.

The installation and maintenance of septic filter tank system should not present major problem if the deposit is thicker than 4 meters and has slopes close to 15%. Percolation rates should be acceptable. Units with slopes greater than 20% are considered unacceptable for septic system as rapid drainage and surface run-off may cause problems. Wind erosion could be activated if the vegetation cover is removed. Steep slopes are also a deterrent to the removal of surface vegetation which could cause soil erosion.

### Capability for Cultivated Agriculture

The sandy texture of the Aishihik soil reduces moisture retention and the soils are droughty. The soil is generally rated class 6MT or 6T, and occasionally 6M/5CM. Wind erosion could be activated if the vegetation cover is removed. Steep slopes are also a deterrent to the removal of surface vegetation which could cause soil erosion.

## 4.2.3 BEAR CREEK SOIL ASSOCIATION (BCE)

### General Description

The Bear Creek Soil Association is composed of Orthic Eutric Brunisols developed on a loamy sand to sand veneer overlying gravelly sandy loam (morainal deposits). This soil is usually well drained and occasionally moderately well drained. The thickness of the sandy veneer is irregular and varies from 15 cm to 40 cm. The parent material is morainal with a matrix composed of unsorted, massive loam to coarse loamy sand with a high percentage of pebbles, cobbles and boulders. Large boulders are often visible at the surface.

This soil association covers morainic terrain of low to medium relief with undulating to hummocky topography. It is usually located on the side of hills and valley walls. This soil is often associated with the Watson River and Porter Creek soil associations.

Consideration for Development

This map unit is usually suitable for residential development. The material at depth is usually a well graded gravel or sand with good bearing strength, very low susceptibility to frost heaving and good drainage. Boulders may be a problem during construction. Map units with slopes less than 15% are considered to have no restrictions. Slopes of 15% to 25% may entail more costs and slopes greater than 25% may create a serious cost increase and require special design for house and road construction. The installation and maintenance of septic filter tank systems should not present major problems if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates should be acceptable. Units with slopes greater than 20% are considered unacceptable for septic system as rapid drainage and surface run-off may cause problems.

Capability for Cultivated Agriculture

Coarse texture and high content of coarse fragment, stones and boulders within the first 20 centimetres from the surface justify the rating 6M/6P usually assigned to this unit. Topography can also be a problem when slopes are steeper than 20% and those map units are usually rated 6MP/6T or 6MT.

### 4.2.4 BUCK SOIL ASSOCIATION (BUC)

General Description

This soil association covers the areas common to the buckbrush meadows found in a few locations within the survey area .The Buck soil association is composed predominantly of Gleysolic Turbic Cryosol , Orthic Turbic Cryosol, and occasionally, of Orthic Humic Gleysols, and Gleyed Eutric Brunisols. It is developed on moderately well to poorly drained glaciofluvial and deltaic sands. Its texture is generally a loamy sand to medium sand. This soil is found in depressions and in spite of its high perviousness, the soil is subject to the influence of high water table. The high water table produces imperfectly drained conditions in the periphery of the depression and poorly drained conditions towards the center. This soil association is usually found in landscape depressions surrounded by either Aishihik or Klowtaton map units. The Buck soil association is confined to these specific landscape positions and therefore covers only a small portion of the total survey area.

Consideration for Development

Considerations for development are very similar to the Aishihik soils, but poor drainage conditions must be taken in considerations. The A horizon is generally thicker than 5 cm and soil reaction is slightly alkaline with lime found near the surface. The surface of these soils are sometimes utilized as small topsoil deposits because of the high humus content of the A horizon.

Soil Capability for Cultivated Agriculture

Excess water is the main limiting factor of this soil association. Salinity is sometimes associated with Buck soils and is another limitation. Rating of the Buck map units ranges from class 5W to 7W or from 5NW to 7NW. The agriculture rating is variable for the Buck association depending on the site-specific conditions.

### 4.2.5 CANYON SOIL ASSOCIATION (CYO)

General Description

The Canyon Soil Association consists of Orthic Eutric Brunisols developed on coarse glaciofluvial material. This gravelly soil is very rapidly to rapidly drained, lightly calcareous and has a stony surface with occasional boulders. The Canyon soil is developed on ice contact glaciofluvial features such as eskers, kames and kame terraces. Vertically, the parent material texture is very variable within a short distance and varies from coarse sand to gravel. Discontinuous beds and lenses of well-sorted fine sand often cap very coarse sands and gravel beds. Often, the upper 30 centimeters of soil contain a high amount of pebbles and cobbles. The A horizon is very thin or non-existent and the soil reaction is neutral. Canyon soils are associated with Annie Lake soils.

Consideration for Development

These map units almost always include steep slopes. When topography is not a problem, the poorly graded and silty to sandy gravel do not present major construction problem. Small amount of boulders may be present. This material may be an adequate source of aggregate if the deposit is large enough. The installation and maintenance of septic filter tank system may not present any major problem if the deposit is thicker than 4 meters and has slopes less than 15% however percolation rates can be higher than 5 min/25mm and the site may require modification to slow down this rapid drainage. Units with greater than 20% slope are considered less acceptable for septic system as rapid drainage and surface run-off could cause problems.

Capability for Cultivated Agriculture

The dry, very coarse texture and high coarse fragment content of this soil are the major limiting factors for agriculture and Canyon soils are generally not considered arable. In addition, they are generally located on landforms with steep slopes. These map units are usually rated 6MP to 7M or 7MP, and occasionally 7T.

4.2.6 CHAMPAGNE SOIL ASSOCIATION (CPG)

General Description

The Champagne Soil Association consists of Orthic Eutric Brunisols developed on moderately well drained glaciolacustrine deposits. Texture ranges from loam to heavy clay, but generally the soil has a loam surface with a silty clay loam to silty clay subsoil. This soil is moderately well drained and moderately to slowly pervious. The subsoil is moderately calcareous to strongly calcareous. Under undisturbed conditions, a thin to discontinuous cover of surface organic matter is present overlying a generally thin Ah horizon.

Champagne soil association occupies low relief, undulating to hummocky glacio-lacustrine plain.

Consideration for Development

The main limitation of the Champagne map units is material composition. The silty clay and silt have low to high susceptibility to frost heaving and to liquefaction. It has a poor surface for motorized vehicle when wet, after a rainstorm or during spring melt-out. It is usually a poor to unsuitable material for development which involves structures and excavations. Detailed geotechnical investigation may find suitable sites for the construction of individual houses. Map units with slopes less than 15% are considered as having no restrictions due to topography. Slopes of 15% to 25% are still acceptable but may entail more costs and slopes greater than 25% will create serious cost increase and design for house and road construction. The slow permeability and run-off make this soil association costly or even unsuitable for installation and maintenance of septic tank system. Percolation rates are estimated to be less than 30 min/mm.

Occasional landslides occur on some of the steep slopes of Champagne map units along the river due to undercutting by the Yukon River. Permafrost may be present at depth greater than 1.5 meters in heavily forested areas. It is impossible to predict the depth, ice content, extent and location of permafrost without subsurface investigation. It is possible that deforestation through fire or clearing may trigger melting of subsurface ice masses (thermokarst action).

Capability for Cultivated Agriculture

Within the climatic restrictions and with adequate agricultural inputs such as the use of fertilizer and irrigation, the Champagne soil is suitable for annual and perennial forage and vegetation production and is rated class 5C. They are among the best soils for agriculture in the survey area. Map units with slopes greater than 20% are rated 6T: steep slopes hinder access from machinery or irrigation equipment and may cause erosion on upper slopes and crests. In polygons with hummocky topography, the lower slopes and depressions can be poorly drained in the spring and delay field access.

### 4.2.7 CRACKER SOIL ASSOCIATION (CAK)

#### General Description

The Cracker Soil Association consists of Orthic Humic Gleysols, Orthic Gleysols and Gleyed Eutric Brunisols developed on fluvial deposits (Fig. 4-1). Texture ranges from loamy sand to medium-grained sand, with occasional gravelly beds. The soils are imperfectly to poorly drained, are always calcareous to the surface and saline in most cases. Salt crystals are often visible in profiles, but salt crusts are not always visible at the surface as this unit is usually vegetated. Cracker soils are often mapped in complex polygons with Croucher or Laberge Soils.

#### Consideration for Development

These map units are usually rated as poor for residential development and for the installation of septic system. The silty and fine sandy texture of the Cracker soils can make them susceptible to frost heaving and poor drainage can cause excavation and site maintenance problem. Access could be difficult and expensive during part of the year.

The fine texture of the material, poor drainage, proximity to floodplains and depth to water table usually less than 3 meters are the main factors restricting installation and maintenance of septic tank system.

#### Capability for Cultivated Agriculture

Despite their attractive location, topography and texture, Cracker soils have poor drainage and a medium to high salinity content. They are usually rated 5NW or 6NW. Soils with low salinity content should be monitored regularly for change of salinity and managed under perennial forage.

### 4.2.8 CROUCHER SOIL ASSOCIATION (CRO)

#### General Description

The Croucher Soil Association consists of Orthic Melanic and Orthic Eutric Brunisols developed on fine-textured fluvial deposits. Texture ranges from silt loam to loamy sand, with occasional coarse sandy or gravelly beds but is most often loam to sandy loam. Croucher soils are usually well to moderately well drained and non- calcareous. When these soils are located below terraces or at the foot of steep slopes, they may have a poor drainage. Croucher soils are often mapped in complex polygons with Yukon or Laberge Soils.

Consideration for Development

These map units provide variable conditions for the development of residential facilities. Croucher soils can be susceptible to frost heaving. Drainage could be adequate in most cases and topography is usually not a problem for excavation and construction.

The fine texture of the material, its proximity to major rivers and the shallow depth of the water table (often less than 4 m) are the main factors restricting installation and maintenance of septic tank system. Subsurface investigation and percolation tests are required to ensure adequate drainage and to avoid contamination of shallow aquifers and water bodies.

Capability for Cultivated Agriculture

The moisture holding capacity and drainage of the Croucher soils make this association suitable for cultivated agriculture. Climate is the only limiting factor of this soil and it is usually rated 5C with occasional minor component of 5CM. The proximity to the river is an added advantage for ease of irrigation for these soils. Microclimatic factors can affect the productivity of some map units. When the soil association occurs in depressional areas at the lowest elevations, it can act as a frost pocket. Southern exposures are significantly warmer than northern exposures.

### 4.2.9 COWLEY LAKE SOIL ASSOCIATION

General Description

The Cowley Lake Soil Association consists of Orthic Eutric Brunisols developed on coarse glaciofluvial material. This gravelly soil is very rapidly to rapidly drained, lightly calcareous and has a stony surface with occasional boulders.

This soil is developed on undualting, low relief glaciofluvial landforms. Vertically, the parent material texture is very variable within a short distance and varies from coarse sand to gravel. Discontinuous beds and lenses of well-sorted fine sand often cap very coarse sands and gravel beds. Often, the upper 30 centimeters of soil contain a high amount of pebbles and cobbles. The A horizon is very thin or non-existent and the soil reaction is neutral. Cowley Lake soils are often associated with Long Lake soils.

Consideration for Development

When topography is not a problem, the poorly graded and silty to sandy gravel do not present major construction problems, however, small amounts of large stones an boulders may be present. This material may be an adequate source of aggregate if the deposit is large enough.

The installation and maintenance of a septic filter tank system should not present any major problem if the deposits is thicker than 4 meters and has slopes less than 15%. Percolation rates can be higher than 5 min/25mm and the site may require modification to slow down this rapid drainage. Units with slope greater than 20% are considered less acceptable for septic systems as rapid drainage and surface run-off could cause problems.

Capability for Cultivated Agriculture

The very coarse texture and high content of coarse fragment of this soil are the major limiting factors for agriculture. These map units are usually rated 6MP to 6M.

## 4.2.10 DISAPPOINTMENT SOIL ASSOCIATION

General Description

The Disappointment Soil Association consists of Orthic Eutric Brunisols developed on well to rapidly drained glaciofluvial sand over gravel with a surface texture ranging from silty loam to sand overlying gravelly sand and gravel. Sand thickness over gravel varies from 15 to 100 cm with an undulating contact. This soil is slightly calcareous and very permeable with a low moisture holding capacity and is rapidly to well drained. The surface A horizon is very thin or not present. The soil is slightly alkaline and non-saline. This soil covers a very small portion of the survey area.

Consideration for Development

This soil association is usually suitable for residential facilities. The variable texture of the upper 3 m of material may create a mixture of very suitable sites and less suitable sites within a polygon. Most map units have slopes less than 15% and are considered as having no restrictions due to topography. Small amounts of large stones and boulders may be present. This material can be an adequate source of aggregate if the deposit is large enough. The installation and maintenance of septic filter tank system should not present major problems if the deposit is thicker than 4 meters.

Capability for Cultivated Agriculture

The sandy to gravelly texture and low holding moisture capacity of the Disappointment soil are the major limiting factors for agriculture. This soil is generally rated class 6M or occasionally 6M//6MP where surface stoniness is a problem.

## 4.2.11 FISH LAKE SOIL ASSOCIATION (FIS)

### General Description

This soil consists of Cryosols developed on morainic parent material. The surface of the soil us usually covered with 10 to 30 cm of peaty organic material overlying loamy gravelly sand with a cobble content greater than 50%. Permafrost often occurs within 50 cm from the surface. These map units are usually located on gentle to moderate northeast to east-facing slopes. Drainage is usually imperfect.

### Consideration for Development

The presence of permafrost and poor drainage must be considered when planning any developments on this soil association. Permafrost will quickly retreat from this soils once the surface vegetation is removed. Abundant subsurface cobbles and seepage may affect ease of excavation, and percolation rates and general suitability of these sites for residential development.

### Soil Capability for Cultivated Agriculture

Due to stoniness, poor drainage, and presence of permafrost, this soil association is unsuitable for agriculture. The soil association is generally rated class 6PW or 6PZ.

## 4.2.12 GRAY RIDGE SOIL ASSOCIATION (GRY)

### General Description

The Gray Ridge Soil Association consists of Gleyed Melanic Brunisols and Orthic Humic Gleysols to Regosols developed on rapidly to poorly drained colluvial deposits. The Ah thickness is variable and can range up to 24 cm and can be associated with thick accumulations of forest humus layers (duff) overlying cobbly to bouldery sandy loam colluvial materials. Gray Ridge soils located on a north facing slope often remain partially frozen late in the summer because of their thick organic surface cover. It is possible under these conditions that some Gray Ridge soils are underlain by permafrost at depths greater than 1m.

The Gray Ridge soil association has limited coverage within the survey area which is largely valley bottom landscape. They are often associated with Fish Lake and Haeckel soils.

### Consideration for Development

Poor drainage and steep, possibly unstable, slopes makes this soil generally unsuitable for residential development.

### Capability for Cultivated Agriculture

Stoniness, poor drainage, and in some cases, steep slopes make the Gray Ridge soil association unsuitable for agriculture. The soil association is generally rated class 6PW or 6P.

## 4.2.13 HAECKEL SOIL ASSOCIATION (HKL)

### General Description

The Haeckel soil association consists of Orthic Eutric Brunisols on thin and discontinuous moraine and exposed bedrock. The soils form on a very thin veneer of gravelly sandy loam or gravelly sandy clay over bedrock. Soils are rapidly drained. Exposed bedrock may cover more than 60% of the surface and boulders and stones are common. The association is confined to steep bedrock hillslopes along the major valley sides and occasional rock outcrops.

### Consideration for Development

Steep slopes and exposed bedrock are the limiting factors for housing development.. The installation of a traditional septic field system would be impossible in most cases. Access is difficult except on the lowest reaches of the valley and on outcrops with lower slope gradients.

### Capability for Cultivated Agriculture

The rockiness, stoniness and steep topography of the Haeckel soils make this soil association unsuitable for cultivated agriculture. These soils are generally rated 6RT to 7RT.

## 4.2.14 HAINES SOIL ASSOCIATION (HIS)

### General Description

The Haines Soil Association consists of Orthic Eutric Brunisol and minor Orthic Gleysols developed on coarse fluvial deposits. The soil texture ranges from sand to bouldery, gravelly sand. This soil is usually rapidly to very rapidly drained, highly pervious and slightly calcareous, with very poor drainage in creek beds. It is restricted to a few creek deposits and covers a very small portion of the survey area.

### Consideration for Development

The Haines soil association is usually located very close to streams that can have a high spring discharge and resultant local flooding. Variations in material texture require appropriate testing within a polygon to determine suitability. The Haines soil association is very likely to show a mixture of site suitability. Most map units have slopes less than 15% and have no restrictions due to topography. Small amounts of large stones and boulders may be present. This material can be an adequate source of aggregate if the deposit is large enough.

The installation and maintenance of septic filter tank system is not recommended. The proximity to streams and high permeability of the parent material increase the risk of contaminating streams and shallow aquifers. In map units where water courses are not present, system installation and maintenance may be possible if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates may be very variable the site may require technical modifications to alter excessive permeability.

Capability for Cultivated Agriculture

The very coarse texture, low moisture holding capacity and high stoniness of this soil make it unsuitable for agriculture. It is usually rated class 6M, 6MP or 7M. Some Haines map units are rated class 6WI or 7I; they are located very close to the active river channel where seasonal flooding and/or a high water table can be a severe limitation to agriculture.

### 4.2.15 KLOWTATON SOIL ASSOCIATION (KLW)

General Description

This highly variable soil association consists of Orthic Eutric Brunisols developed on glaciofluvial sands overlying glaciolacustrine silt and clay. It could be described as a transitional soil between Champagne and Aishihik soils. Texture may vary from sandy loam to sand at the surface to silty clay loam in the C horizon. The soils are stone free and gently sloping to level. A contact with silty clay loam material commonly occurs within one meter of the surface and, in some cases, fine-textured material may occur at the surface. This soil is well to moderately well drained and slightly to moderately calcareous at depth.

Klowtaton map units are associated with the contact or the transition between glaciolacustrine and glaciofluvial or deltaic environment. In some cases, glaciolacustrine silt and clay fill depressions within a hummocky glaciofluvial terrain and the result is a landscape of sandy ridges and hummocks with depressions filled with fine textured material. In others cases, sands were deposited interbedded or on top of the glaciolacustrine material. This soil is often associated with Champagne and Aishihik soils.

Consideration for Development

This map unit make it difficult to rate is for residential capability due to its variable texture. Parts of a polygon may be sandy and well drained, with pervious material present at depth greater than 3 meters. In this case, the excavation and construction of houses and the installation of septic systems should not present major problem. Others part may be composed mostly of glaciolacustrine silt and clay, in which case the limitations are the same as for the Champagne Soil Association.

Capability for Cultivated Agriculture

The mixture of fine and coarse texture and of well and moderately well drained soils is typical of this map unit. Due to the discontinuous and irregular distribution of materials within a polygon the soils are rated 6M/5C, 5C/6M or 5CM depending on the field observations and estimated proportions of surface material. Based on field experience gained during the mapping, site specific conditions are often an unpredictable mixture of 6M and 5C throughout the map unit.

### 4.2.16 LABERGE SOIL ASSOCIATION (LBG)

General Description

The Laberge Soil Association consists of Orthic Humic Gleysols and Orthic Gleysols developed on imperfectly to very poorly drained loamy fluvial deposits. Texture ranges from silt loam to fine loamy sand at depth. A seasonal water table may fluctuate within 20 cm of the soil surface. The soils are without stones and are generally slightly alkaline in reaction. Drainage within a polygon may vary seasonally or with the topography. Soils supporting heavy, closed vegetation with thick moss cover either remain frozen late in the summer or possibly even have permafrost present within 2 meters from the surface. Some Laberge soils may show severe cryoturbation (frost-churning).

Consideration for Development

This soil is usually unsuitable for the installation of residential facilities. The silty texture of Laberge soils makes them susceptible to frost heaving. Poor drainage can cause excavation and site maintenance problem. Because these map units are located at the lowest elevation in the valley, they are often accessible only through steep. The fine texture of the material, poor drainage, proximity of the river and shallow water table (possibly less than 3 m) are the main limiting factors.

Capability for Cultivated Agriculture

These soils are usually rated 5CW and site inspection is recommended to determine the depth to water table and seasonal variation of the drainage. Poorly to very poorly drained Laberge soils are usually rated 6W to 7W.

### 4.2.17 LEWES SOIL ASSOCIATION (LWS)

General Description

The Lewes Soil Association consists of Orthic Eutric Brunisols developed on fine-textured fluvial deposits overlaying glaciolacustrine material. A characteristic of this soil association is its textural variability. The Lewes soil is correlated with veneers and inclusions of fluvial sediments resting on glaciolacustrine silt and clay and on eroded, washed or redeposited glaciolacustrine deposits. In some polygons, the thickness and texture of the loamy and sandy fluvial deposits is uniform over the silt and clay. However in most polygons, any combination of these types can occur over a few meters. The common characteristic seemed to be the presence of the silty clay loam to silty clay at 1.5 meters from the surface and the loamy texture of the first 15 cm of the surface. Textures between these depths include interlayered silt, sand, or loam.

Lewes map units are usually moderately well drained and lightly to moderately calcareous and stone free. This soil association is usually located on gently undulating plains with slopes averaging less than 5% and is often associated with transition between glaciolacustrine and glaciofluvial landforms..

Consideration for Development

The main limitation of Lewes map units is material composition. The silt and very fine sandy silt have moderate to high frost susceptibility. On-site geotechnical investigation is required to determine suitability for construction sites.

Low soil permeability of the underlying glaciolacustrine materials may limit the suitability of this soil forthe the installation of septic tank system.

Capability for Cultivated Agriculture

Within the climatic restrictions and adequate agriculture management such as use of fertilizer and irrigation, the Lewes soil is very suitable for perennial forage and cold-season vegetable production. They are limited primarily by climate and are rated 5C//5CM. They are one of the better agriculture soils in the survey area.

4.2.18 LONG LAKE SOIL ASSOCIATION (LOL)

General Description

The Long Lake Soil Association consists of Orthic Eutric Brunisols developed on well to rapidly drained glaciofluvial fine loamy sand over sandy gravel. Loam or sand thickness over gravel varies from 15 to 100 cm with an undulating contact. This soil is moderately permeable with a low moisture holding capacity and is well drained. The surface A horizon is very thin or not present. The soil is slightly alkaline and non-saline. It is present in association with Annie Lake, Canyon Lake and Cowley Creek soils.

Consideration for Development

This map unit is usually rated as suitable for residential facilities. The variable texture of the upper 3 m of material may create a mixture of very suitable sites to slightly less suitable sites within a polygon. Most map units have slopes less than 15% and are considered as having no restrictions due to topography. Small amounts of large stones and boulders may be present. This material can be an adequate source of aggregate if the deposit is large enough.

The installation and maintenance of a septic filter tank system should not present major problems if the deposit is thicker than 4 meters and has slopes less than 15%.

Capability for Cultivated Agriculture

The sandy to gravelly texture and low moisture holding capacity of this soil are the major limiting factors for agriculture. This soil is generally rated class 6M.

### 4.2.19 MCINTYRE CREEK SOIL ASSOCIATION (MCI)

General Description

The McIntyre Creek Soil Association consists of Limno Fibrisols and Limno Mesisols that dominate the wetlands of the survey area. These "fen' wetlands are predominantly found in meltwater channels that contain small creeks or year-round seepage such that the water-table is at or near the surface throughout the growing season. The soil drainage is poor to very poor. The soil typically have 20 to 40 cm of peat underlain by up to 50 cm of intermixed marl and peat or occasionally fluvial silts. The accumulation of marl occurs in shallow water bodies through the precipitation of CaCO3 from alkaline waters and the accumulation of shells and shell fragments from the aquatic biota. The wetlands form as the water levels drop over time or fill in with peaty vegetation. These soil map units ma be periodically flooded as the result of beaver pounding. Many of the McIntyre Creek soils are associated with Gleysolic Turbic Cryosols which occur around the periphery of wetland map units.

Consideration for Development

The permanently high water table make this soil association unsuitable for residential development. They are often important landscape units in terms of water retention and transmission, controlling hydrologic flow in many associated streams and often provide special habitat for various forms of wildlife. Filling or draining the wetlands would be required before any infrastructure development could take place

Capability for Cultivated Agriculture

Due to high water table these soils are unsuited for agriculture and are rated class 6w or 7w. However, in some instances, with artificial drainage and or subsurface tile drainage, these soils can be developed for specialty agriculture. Some McIntyre Creek soils have been utilized for topsoil or peat resources.

### 4.2.20 POPES SOIL ASSOCIATION (POP)

General Description

The Popes Soil Association consists of Orthic Humic Gleysols, Gleysolic Turbic Cryosols and Terric Fibrisols developed on thermokarsted fluvial deposits. Texture ranges from loam to fine loamy sand occasionally overlain by peat. These soils are imperfectly drained to very poorly drained and the drainage within a polygon may vary seasonally or with the topography. Map units located on heavily vegetated north facing slope were either frozen late in the summer or had permafrost present within 1.5 m of the surface. They are often mapped in complex polygons with Croucher or Laberge soil associations. A major feature of this soil association is the presence of thermokarst ponds scattered within most map units. Underlying permafrost has high ice content and the land surface is subject to subsidence following disturbances to the soil surface.

Consideration for Development

This soil is usually rated as unsuitable for the installation of residential facilities. The presence of thermokarst depressions, fine texture of the material, poor drainage, proximity of the river and depth to water table being possibly less than 4 meters are the main limiting factors restricting installation and maintenance of septic tank system. The land surface tends to be unstable and subject to localized collapse upon permafrost melting.

Capability for Cultivated Agriculture

These soils are usually rated 6K because of the presence of thermokarst ponds and underlying permafrost.

### 4.2.21 PORTER CREEK SOIL ASSOCIATION (POR)

General Description

The Porter Creek Soil Association consists of Orthic Eutric Brunisols developed on a veneer of glaciofluvial or glaciolacustrine sediments over coarse textured morainal deposits. The surface texture ranges from silt loam to fine sandy loam and can be as thick as 45 centimetres and as thin as 10 centimetres. The soil is usually well to moderately well drained. Boulders are common at the surface and at depth. This soil is usually moderately to highly calcareous.

The parent material is a moraine with a matrix composed of unsorted, massive loam to coarse loamy sand and with a high percentage of pebbles, cobbles and boulders. This soil association is correlated with morainic terrain of low to medium relief with undulating to hummocky topography. It is usually present along valley walls, large bedrock outcrops or hill sides. This soil is usually mapped in association with Watson Lake, Bear Creek or Long Lake soils.

Consideration for Development

This map units can be good to suitable for residential development. The material at depth is usually a well graded gravel or sand with good bearing strength, very low susceptibility to frost heaving and good drainage. Boulders may be a problem during construction. Map units with slopes less than 15% are considered to have no restrictions. Slopes of 15% to 25% may entail more costs and slopes greater than 25% will create serious cost increase and require special design for house and road construction.

The installation and maintenance of septic filter tank system should not present major problem if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates are usually acceptable. Units with slopes greater than 20% are considered unacceptable for septic system as rapid drainage and surface run-off may cause problems.

Capability for Cultivated Agriculture

Coarse texture and high content of stones and boulders within the first 20 centimetres from the surface result in this association being usually rated as 5CM/6P. Topography can also be a problem when slopes are steeper than 20% whereby these map units are rated 6MP/6T or 6MT.

### 4.2.22 WATSON RIVER SOIL ASSOCIATION (WAS)

General Description

The Watson River Soil Association consists of Orthic Eutric Brunisols developed on well drained coarse textured morainal deposits. Boulders are common at the surface and at depth. This soil is usually neutral in reaction and non-saline. The Ah horizon is thin to non-existent. The soils are well drained, slightly to moderately stony and exist on variable slopes. They may contain inclusions of gravel.

The parent material is morainal with a matrix composed of unsorted, massive loam to coarse loamy sand and with a high percentage of pebbles, cobbles and boulders. All coarse material is subrounded to angular. The uppermost 15 cm of soil is occasionally loamy textured, probably due to a thin loess veneer over many of these soils. Watson River soil association is correlated with morainic terrain with low to medium relief undulating to hummocky topography. It is usually present along valley walls, large bedrock outcrops or ridges at mid-elevations.

Moraine thickness varies between 2 and 7 meters and usually rest on bedrock. It may include small glaciofluvial and colluvial deposits.

Consideration for Development

The Watson River map units can be good to suitable for residential development. The material is usually a well graded gravel or sand with good bearing strength, very low susceptibility to frost heaving and good drainage. Boulders may be a problem during construction. Map units with slopes less than 15% are considered as having no restrictions. Slopes of 15% to 25% may entail more costs and slopes greater than 25% will create serious cost increase and require special design for house and road construction. The installation and maintenance of septic filter tank system should not present major problem if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates should be acceptable. Units with slopes greater than 20% are considered less acceptable for septic system as rapid drainage and surface run-off may cause problems. Natural radon emission may be of concern at some subdivision built on these soils.

Capability for Cultivated Agriculture

Coarse texture and high content of coarse fragment, stones and boulders justify the rating 6MP usually assigned to this unit. Topography can also be a problem when slopes are steeper than 20% and those map units are usually rated 6MP/6T or 6MT.

### 4.2.23 WHITEHORSE SOIL ASSOCIATION (WHS)

General Description

The Whitehorse Soil Association consists of Orthic Eutric Brunisols and Cumulic Regosols developed on aeolian deposits. Whitehorse map units are related to glaciofluvial deposits reworked by the wind into sand dunes. The composition of the sand dunes is mostly fine sand with thin beds of loamy sand, sandy loam. Occasionally, thin buried Ah horizons were found in the soil profiles. This soil is rapidly pervious and well drained. Depressions between the hummocks can be moderately well drained.

The sand dunes are roughly crescent shaped (parabolic) or simple ridges with slopes ranging from 6 to 30%. Local relief is 2 to 5 meters.

Consideration for Development

Whitehorse map units are usually suitable to residential development. Geotechnical test are definitely needed to identify the grade of the sand, bearing strength and excavation. Drainage is not a problem except in some depressions. Care should be taken not to remove vegetation needlessly. Any unvegetated surfaces should be revegetated with drought tolerant grasses as soon as possible. Map units with slopes less than 15% are considered as having no restrictions due to topography. Some landscapes of Whitehorse soils have many short slopes of 15% to 25% may entail more costs and special design for house and road construction.

The installation and maintenance of septic filter tank systems should not present major problem if the deposit is thicker than 4 meters and has slopes less than 15%. Percolation rates may exceed tolerable limits. Units with slopes greater than 20% are considered unacceptable for septic system as rapid drainage and surface run-off could cause problems.

Soil Capability for Agriculture

The sandy texture and topography of the Whitehorse soils results in their ratings as 6M to 6MT. Aeolian erosion and deposition process are very likely to be reactivated if the vegetation cover is removed. Improper management could easily create conditions inhospitable to any vegetation and the rating of such surfaces could degrade to a class 7.

### 4.2.24 WICKSTROM SOIL ASSOCIATION (WIC)

#### General Description

The Wickstrom Soil Association is composed of Orthic Eutric Brunisols formed on level low lying terraces of the Yukon River that are composed of sand and gravel. The soils are highly permeable and are considered to be well to rapidly drained. The soils may have a thin veneer (20 cm) of silt to fine loamy sand overlying the gravel.

#### Consideration for Development

This map units can be good to suitable for residential development. The material at depth is usually a well graded gravel or sand with good bearing strength, very low susceptibility to frost heaving and good drainage. Boulders may be a problem during construction. Map units with slopes less than 15% are considered as having no restrictions. The installation and maintenance of septic filter tank system may present problems when sites are in close proximity to the Yukon River or occasionally if the water table is to close to the surface or if materials are too permeable.

#### Soil Capability for Cultivated Agriculture

Coarse texture and high content of coarse fragments, stones and boulders within the first 20 centimetres from the surface justify the rating 5CM/6P usually assigned to this unit.

### 4.2.25 YUKON SOIL ASSOCIATION (YUN)

#### General Description

The Yukon Soil Association consists of Orthic Eutric Brunisols developed on well drained sandy fluvial deposits. This soil occupies fluvial terraces where parent material texture ranges from loamy sand to coarse-grained sand, with occasional gravelly beds. Ancient meanders and terrace scarps are visible and sometimes linked to slight texture and drainage variations. Low, steep scarps and ridges are often present but do not compose a major portion of the map units. They occur in association with Croucher and Laberge soils.

#### Consideration for Development

The sandy textures of the Yukon soils make them suitable for construction and excavation. Site drainage is adequate in most cases and topography is usually not a problem for excavation and construction. The perviousness of the material, the proximity to water bodies and the depth to water table (when less than 4 meters) are the main factors restricting installation and maintenance of septic tank system. Subsurface investigation and percolation test are required to insure adequate drainage and to avoid contamination of shallow aquifers and water bodies.

Capability for Cultivated Agriculture

The low moisture holding capacity and sandy texture of the Yukon soils result in a rating of 6M with occasional minor component of 5CM usually in association with Croucher soils. When these soils are irrigated they usually represent inclusions of somewhat less productive soils within Croucher dominated fluvial terraces.

## 4.3 Miscellaneous Land Types

Five miscellaneous land types have been defined for the survey area. These are areas where soil surface is very unstable and no mature soil formation occurs. These miscellaneous land types are all lists with three letter codes that begin with the letter Z. ZAL1 and ZAL2 are used to cover bars and beaches along major rivers and creeks that are composed of silty sand or gravel respectively. The codes ZES1 and ZES2 cover cliff faces and actively eroding bluffs either without or with active streams associated with them respectively. The code ZCS is used for areas of steep rubble along channels cut into bedrock by glacial meltwater streams. Because these land types lack mature soil profile development (i.e. A and/or B horizon) they are classified as Regosols and where they are permanently saturated are classified as Rego Gleysols.

These units cover site-specific features large enough to map at the 1:20,000 scale. They generally cover small areas. Miscellaneous land type polygons are unsuited for any sort of development.

# 5. Wetlands

## 5.1 INTRODUCTION

Wetland is defined as "land that has a water table at, or above the land surface, or which is saturated for a long enough period to promote wetland and/or aquatic processes. These processes are indicated by hydric (saturated) soils, hydrophytic (water-loving) vegetation and various kinds of biological activity that are adapted to the wet environment" (Tarnocai 1980). Greater than 10% of Canada is estimated to be covered by wetlands, most of this area being in the Hudson Bay Lowlands of Ontario and Manitoba and the subarctic regions of the Northwest Territories (National Wetland Working Group 1988). The Yukon is estimated to have 3% of its area as wetlands, most of this in the northern Yukon (Old Crow, Bell River and Bonnet Plume basins). Wetlands are not extensive in the drier southwestern portions of the territory. In this survey , we estimate that significantly less than 3% of the area of the City of Whitehorse would be considered wetland.

## 5.2 WETLAND CLASSIFICATION

Wetlands, being complex dynamic ecosystems, are difficult to categorize and classify. It is therefore very important that a common terminology be used to facilitate cross-disciplinary communication. Over the years, many classification approaches have been taken based on different aspects of wetlands. Some systems have evolved to satisfy the specific needs of a scientific discipline, others to characterize the wetlands of a particular geographic area. Tthe Canadian system of wetland classification (National Wetlands Working Group, 1988) is used in this survey. The system works well to distinguish the different ecological conditions under which wetlands exist in the study area. This was selected over a similar system developed by the U.S. Fish and Wildlife Service (Cowarding, Carter and Golet, 1979) which has very broad application and was less effective in differentiating the variety of wetland conditions in the City. Correlations between the two systems can be developed if the need for comparisons with American landscapes is needed.

The goal of classification is to provide a framework that can be used by different disciplines as a basis for communication. Application of the classification is relatively simple to allow its use by persons whose primary specialties do not include wetland ecology.

The classification system contains three hierarchical levels: (1) class; (2) form and (3) type. Classes are recognized based on the overall origin and nature of wetland ecosystems. There are five wetland classes in the Canadian system: bog, fen, swamp, marsh and shallow open water. All except the bog were identified in the course of this study. Bogs are peat-covered wetlands, whose surface waters are strongly acidic and the upper peat layers are extremely deficient in nutrients. Due to reasons of semi-arid climate and calcareous local geology, bog wetlands do not form in the Whitehorse region. The other four classes of wetlands were identified and their characteristics are listed below:

***Fens*** are the most common wetland class in the study area. They are characterized by a permanent high water table (at or near the soil surface all year) but with enough internal drainage by seepage to allow some oxygen to be present in the fen waters. The slowly moving ground water is enriched by nutrients from surrounding upland mineral soils and are therefore considered minerotrophic. In most parts of Canada fens are composed of peat, however due to the relatively dry climate and high alkalinity of substrate materials, thick (>40 cm) deposits of peat are rare in Whitehorse.

***Swamps*** experience a wide fluctuation in water table levels through the year. Swamps are typically inundated by floods with may be brief or persist for long periods. They are usually associated with mineral-rich waters of creeks, streams or rivers. In southern Yukon, swamps are productive sites where tall willow shrubs show robust growth up to 3 m in height along stream and river banks and some lake shores.

***Marshes*** are wetlands that are periodically flooded by standing water and are usually underlain by mineral soils. They are characterized by emergent vegetation composed of reeds and sedges. The water table is usually associated with an adjacent water body like lakes or ponds. At certain times of the year marshes may be relatively dry.

Finally, ***shallow open waters***, often referred to as ponds or sloughs are relatively small bodies of standing water. Shallow open water bodies are common inclusions in all other wetland classes. In the study area they are often associated with depressions formed from melting permafrost (thermokarst). The depth of water is usually less than 2 m at maximum levels.

At the next level of classification, position on the landscape and proximity to various kinds of water bodies are used to differentiate the wetland <u>form</u>. Typical wetland forms include channels, basins, stream-sides and floodplains.

Finally, the wetland <u>type</u> is added. The type is based on the general structure (physiognomy) of the covering vegetation. In the study area, most wetlands are covered by shrub willow and birch and/or by sedge communities. Type classifications are best developed from on-site specie lists which allow a precise plant species name to be applied to the type classification. When using only air photographs for classification, broad vegetation groups may be used in the type classification such as graminoid, shrub or tall shrub categories. Representative plant specie list and site descriptions are given for wetland sites in Appendix 4.

A clear distinction should be drawn between wetland classification and mapping. Classification is a conceptual grouping of similar units, and mapping is the delineation of particular landforms as they occur on the natural landscape. In this study we used black and white 1:10,000 aerial photography to delineate wetland map units (also referred to as map polygons). Individual wetland map polygons usually consist of a mixture of various classes. Marshes are often associated with shallow open water and may even have swamps on their margins. Fens often have a swamp margin where mineralized stream water floods the wetland.

## 5.3 WETLAND CLASSES AND DISTRIBUTION

### 5.3.1 FENS

The most common class of wetland is the shrub-sedge channel fen. Most of these are less than 50 ha in size. These are elongated "buckbrush" covered wetlands common west of the Alaska Highway , many can be viewed from Copper Haul road. These wetlands usually occupy former glacial meltwater channels that were formed during the recession of the last glaciation. These channels may be 100 to 200 m wide and 2 km long. These often contain a creek flowing through the wetland. When these creeks are lined by tall willow shrubs, the riparian zone in the overall fen wetland is classified as a stream swamp. Almost all of these fens have a history of beaver activity with active dens or remnants of beaver dams and ponding within the wetland. Drier portions of these wetlands may have forested inclusions. The most common wetland type in the City of Whitehorse is the sedge-shrub channel fen. A typical sedge-shrub channel fen is illustrated in Plate 5-1. The fen is located within glacio-lacustrine sediments east of the Alaska Highway opposite from the Mary Lake subdivision.

The second most common fen type is the shrub basin fen. While this type is common throughout the study area, it is best represented east of the Yukon River. These fens occupy shallow depressions on the landscape, usually former shallow lakes that have filled with sediment and marl. The abundance of marl in the basin fens is a particularly notable feature of this form of wetland. The wetlands often have significant inclusions of forest on drier portions of the basins. Generally little peat has accumulated in the fens. Marl is a highly calcareous biogenic sediment associated with shallow lakes in the southern Yukon. It is found in most wetlands. Permafrost is found on the interface between the forested upland and the wetter portions of the fen where thick (>20 cm) growth of moss insulates the soil surface. Any portion of the fen is subject to moving water is usually without permafrost.

### 5.3.2 SWAMP

Swamps are a less common wetland class in the study area and are confined to the floodplains of streams, rivers and some lake shores. They usually exist as a complex adjacent to fens or marshes. They are best represented along several major creeks including parts of

McIntyre and Cowley Creeks and along much of the active floodplain of the Yukon River. Swamps differ from fens in that they are subject to wide flucuations in water table levels through the season. Flooding occurs regularly such that part of the season the water table may be above the soil surface, while at other times of the year, the water table may be a few meters below the surface. Vegetation is characterized by tall willows, often together with inclusions of white spruce. Plate 5-2 illustrates a tall shrub, stream swamp. Stream swamps usually have a history of flooding by beaver activity. Often along the floodplain of creeks, many of the tree species are killed because of flooding due to dams and snags become an important component of the vegetation cover. The soils are usually composed of peat or silty-sandy mineral soils such as the McIntyre soil association. The floodplain swamps along the Yukon River alternate from being relatively dry to being completely inundated each year. Floodplain swamps are underlain by mineral alluvial soils.

### 5.3.3 MARSH

Marshes are subject to the same degree of flooding periods as the swamp wetlands but are differentiated on the presence of non-woody vegetation, principally emergent species such as *Carex aquatilus*. Swamps and marshes are often found in proximity to each other and interspersed by open shallow water. The marshes tend to form where their is less active flow of flood water such as back channels and floodplain lakes. A floodplain marsh located within a large wetland complex is shown in Plate 5-3. The soils in marshes tend to be mineral as the result of deposition of silt and fine sand during the flooding period.

## 5.4 ECOLOGICAL IMPORTANCE OF WETLANDS

Wetlands provide unique biological habitat that is vastly different from the surrounding uplands. The number of plants and animals found in a wetland tends to be higher than in upland habitats. While the nature of the biology of fens, swamps and marshes differs, biodiversity is often high in each of these wetland classes. Hydrophillic plants are found in most wetlands as well as animals dependent on specific water habitats for their survival (i.e. waterfowl, muskrats, beaver, otters).

Wetlands provide a buffer and filter for run-off and ground waters. The soils act as storage and filter water, moderating the amplitude of downstream flow and removing particulate matter and some chemical constituents from the water.

Biological productivity is very high in wetlands. The total biomass (weight of plant and animal matter) produced per unit area may be many times greater in a wetland than in surrounding upland areas. As such, wetlands play an important role in the terrestrial carbon (orgainc material) cycle both storing carbon as plant biomass and exchanging carbon gases (carbon dioxide and methane) with the atmosphere.

Wetlands are usually suited for conventional human development and use, and have often been simply "filled-in" to provide industrial and residential building sites. An increased awareness of the ecological function of wetlands has led municipal planners to see these areas as important natural ecosystems which can also provide landscape variety, aesthetics and certain recreational (wildlife viewing, boating) opportunities within the municipal environment.

## 5.5 UNIQUE PROPERTIES OF WETLANDS WITHIN THE CITY OF WHITEHORSE

It is important to consider the wetlands within the City of Whitehorse within the context of wetlands found elsewhere in Canada. Whitehorse falls within the Boreal Cordilleran Ecozone of Canada (Ecostratification Working Group, 1995), one of three boreal ecozones in Canada (the others are the Boreal Shield and Boreal Plains). The boreal forests stretch from Newfoundland to Yukon. The southwestern Yukon is unique in that it is drier and more mountainous than most other boreal environments in the country. This semi-arid climate has led to the following characteristics that make the wetlands of Whitehorse unique within Canada:

i) abundant local limestone geology has resulted in alkaline soils and surficial parent materials in the study area. The wetlands are unusually base-rich and therefore without much acidity. The bog wetland class, one of the most common wetland classes in the boreal environment of Canada, is entirely absent in the study area.

ii) the ubiquitous presence of marl (mixture of lime-rich sediment and shells from small organisms formed in shallow lakes) acts as one of the major substrates found in most wetlands.

iii) the general lack of peat formation in most fens due to the alkalinity of the wetland substrates and the semi-arid climate. Most fens within the boreal environment in Canada are underlain by many meters of moss and sedge peat. Instead, unique marl-rich, mineral fen developments have developed locally.

iv) related to the above, is the complete replacement of black spruce in the wetlands by white spruce. In all other regions of the boreal environments, black spruce and tamarack are the usual conifers present. These are completely lacking from the wetlands within the City of Whitehorse. Instead, white spruce grows in a stunted form in poorly drained conditions as inclusions within the wetlands. This condition is unique even within the Yukon context.

## 5.6 REQUIREMENTS FOR FURTHER ASSESSMENT

There is a requirement to continue the inventory and monitoring of the wetlands of Whitehorse in order to:

i) assess the biological diversity of these ecosystems for all plants and selected groups of animals,

ii) better understand the relation between landforms, hydrologic regimes, vegetation cover and permafrost in these ecosystems,

iii) expand our understanding of the ecological function of the individual fens, swamps and marshes, and identify specific wetlands within the study area that are the best representatives of each class of wetland or have truly unique properties; and

iv) refine the descriptions and classification of these wetlands based on any new or additional information collected.

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# Appendix One Plates

Plate 2-1 Till composed of diamicton, unsorted clay to boulder sizematerial. Boulders present a hazard on this unstable slope. Terrain map unit M:TEA, Soil map unit WAS-3/9

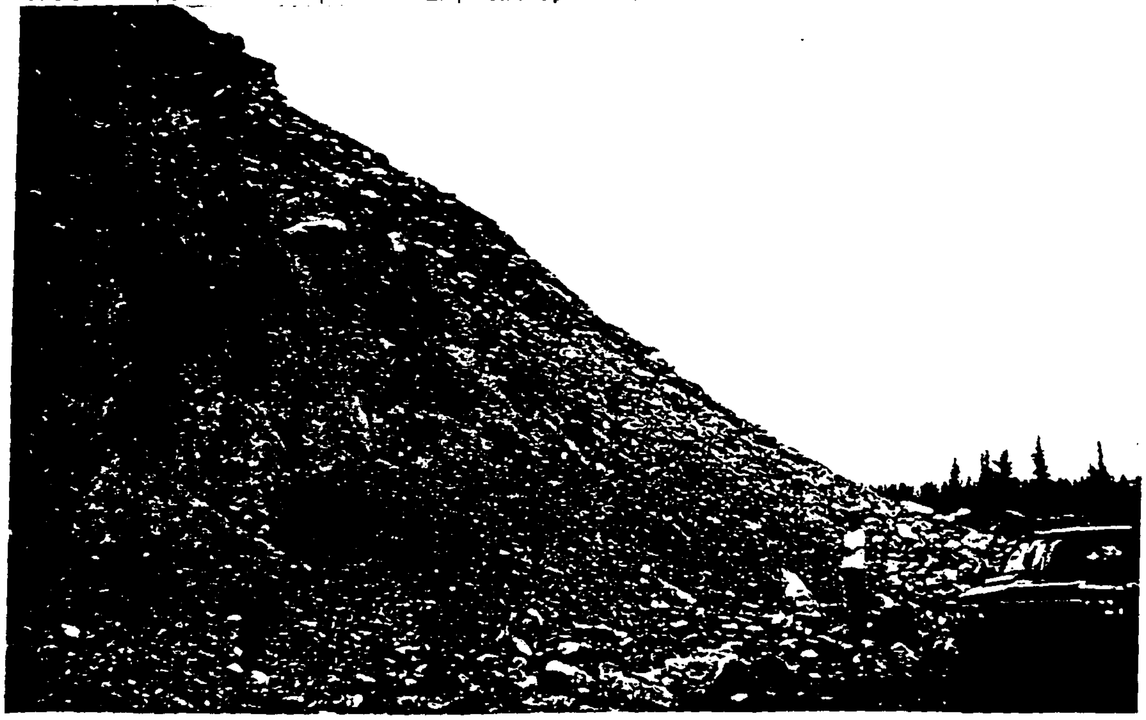


Plate 2-2 Steep slopes of stagnant ice , reverse topography, Terrain map unit sgFG/GL:T, Soil map unit CYO//ALK-2/6-9

Plate 2-3 Gently undulating to nearly level glaciofluvial outwash. Terrain map unit FG,
Soil map unit would be COW-12/2-3 if there is not fine sand veneer, and would be LOL2/23 if there is

Plate 2-4 This meltwater channel is a complex unit. The sides are composed dominantly of till, colluviated till, grus and other bedrock types. The floor used to be the bed of a short lived, high-volume meltwater stream. It is now occupied by wetland with a small Creek (McIntyre Creek). Beaver activity has modified both vegetation and drainage conditions many times during the life of this landforms. Permafrost is present on the margins of the wet portions of the wetland. Terrain map units are M/R:TE, O or F:BA. Soil Association for the floor of the channel is usually MCl-5-7/1, occasionally modified by O or Z or X.

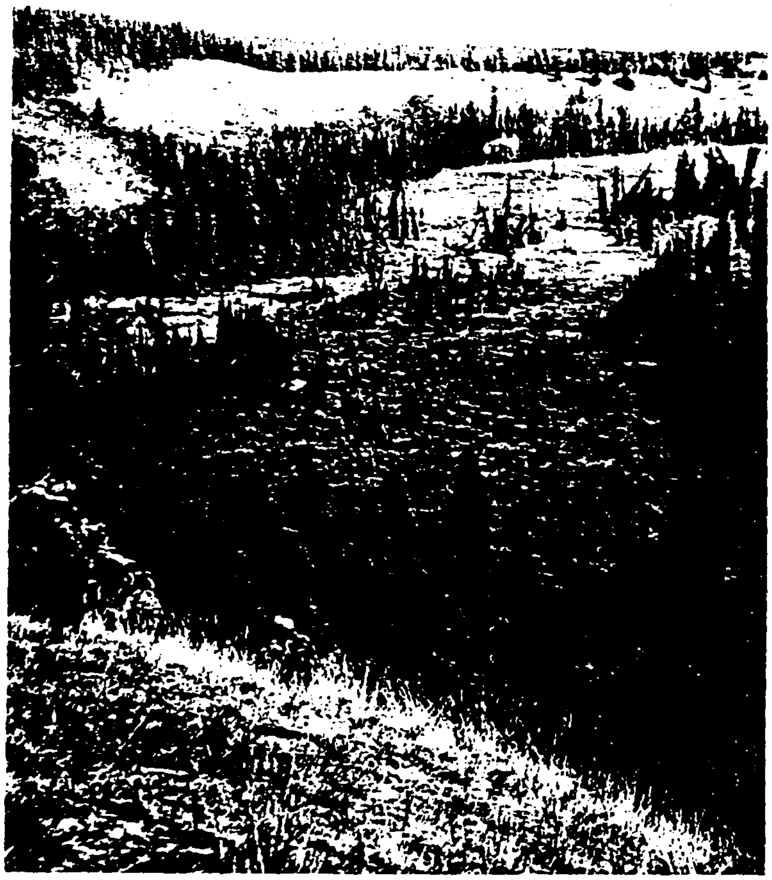


Plate 2-5 Steep gullied slopes of glaciolacustrine, well sorted, well stratified silt, fine sand and clay. Terrain map unit GL:TEA, or TEV. The surface of the cliff would be represented by GL.

Soil association for the surface could be KLW if there is sand at the surface (left side of plate) or CPG if not.

Plate 2-7 Fluvial terrace very close to water level and regularly flooded. This unit is poorly drained and composed of fine sand and silt. Terrain unit fF:FA, Soil map unit LBG-5-7/1

Plate 2-6 Inclusions of poorly sorted gravelly clay loam with faint laminae within beds of glaciolacustrine silt and clay, probably representing deposition from the ice frontal margin which was sitting in glacial lake Champagne

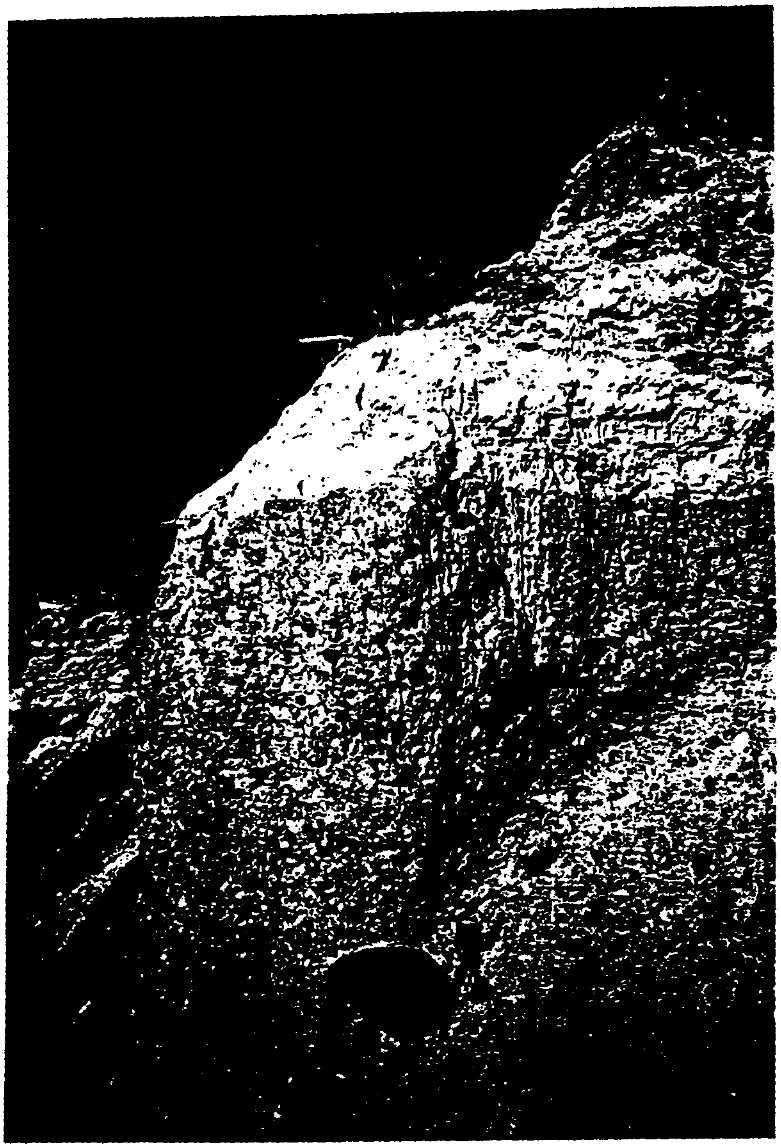


Plate 2-8 High relief gravelly glaciofluvial deposits. In the vicinity of Whitehorse, at low elevations, these deposits are often underlain by glaciolacustrine silt and clay. Terrain map unit sg FG;Te. Soil map unit CYO-1 2 / 7 9

Plate 2-9 Nearly level glaciofluvial sand . In the Yukon river Valley near Whitehorse, these deposits are almost always thinner than 6 m and unerlain by silt and clay. Terrain map unit sFG/GL. Soil map unit AHK-3/2

Plate 2-10 Moraine with thin loess veneer. Terrain map unit M. Soil map unit WAS 3/3

Plate 2-11 Thin moraine over bedrock . Terrain map unit M/R:R. Soil map unit HKL 1 2/ 5 7

Plate 2-12 Miles Canyon Basalt.

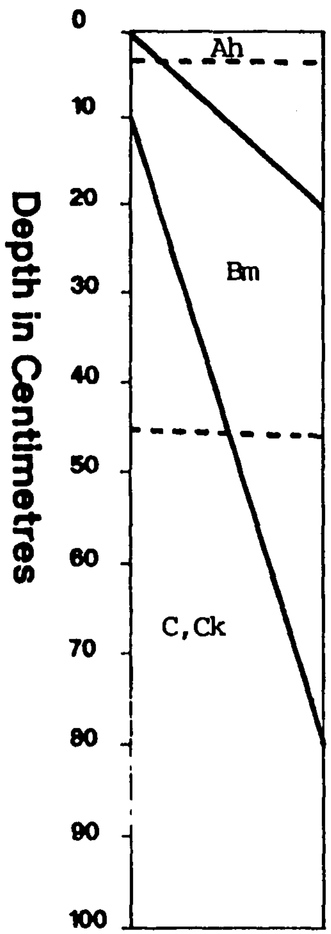
Figure 5-1. A sedge-shrub channel fen set within glacio-lacustrine sediments between Alaska Highway and the Yukon River east of Mary Lake subdivision. The far end of the fen shows evidence of an old beaver dam and past flooding. The wetland is presently not flooded. The soils were classified as belonging to the Buck soil association. These are mineral soils with only a very thin (10 cm) veneer of surface peat.

Figure 5-2. Typical tall shrub stream swamp found along McIntyre Creek west of the Copper Haul Road. White spruce stands are established on the better drained portions of the floodplain of the meandering creek. During periods of beaver activity, the spruce are drowned producing a typical cover of tall shrubs with abundant spruce snags. Soils belong to the McIntyre Creek soil association and are composed of peat over stratified silts and sands.

Figure 5-3. Wetland complex located between Takhini trailer park and Marwell area. In the foreground is a shrub-sedge basin fen. In the middle distance is the sedge floodplain marsh and shallow open water complex. In the distance is the tall shrub floodplain swamp interspersed with alluvial white spruce forest.

# 7. Appendix Two Soil Textural Data

The following information was collected in 1987 and 1992 during soil survey performed in the Takhini and Carcross Valleys. Data from soil associations common to these surveys and to the Whitehorse survey are presented here, as propertieds may be similar in the soils of the Whitehorse area. Not all soils are represented in this appendix.

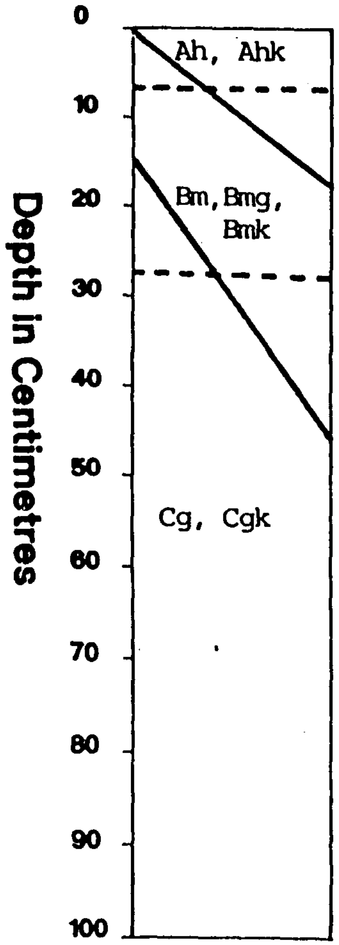



**Dominant Soil Subgroup**

Orthic Eutric Brunisol

SOIL ASSOCIATION: AISHIHIK

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 3 cm | 0-20 cm | 72 |
| Thickness of solum | 45 cm | 10-80 cm | 67 |
| Depth to lime | 41 cm | 30-71 cm | 77 |
| pH of Ah horizon | 6.9 | 6.1-7.8 | 48 |
| pH of C horizon | 7.1 | 6.0-7.8 | 48 |
| E.C. for 0-60 cm | 0.79 dS/m | 0.002-11.0 dS/m | 28 |
| Texture of 0-15 cm depth | LS | | 50 |
| Texture of 16-30 cm depth | S | | 50 |
| Texture of C horizon | S | | 50 |
| Stoniness class | 0 | 0-2 | 72 |
| Drainage class | 3 | 2-3 | 72 |
| Slope | 8 % | 0-47 % | 72 |

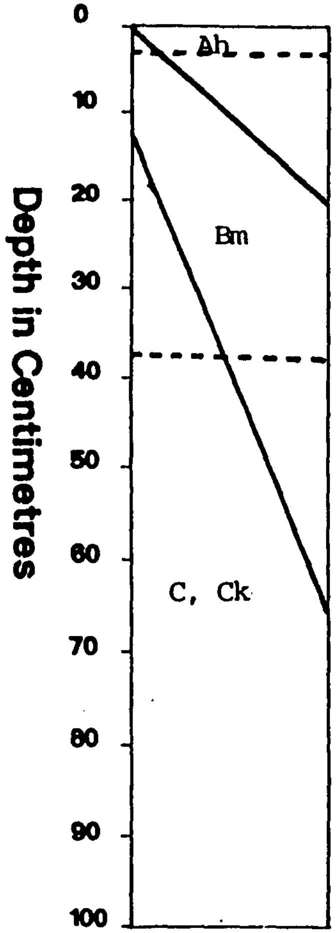



**Dominant Soil Subgroup**

Orthic Gleysol
Orthic Eutric Brunisol

SOIL ASSOCIATION: BUCK

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 7.5 cm | 0-18 cm | 18 |
| Thickness of solum | 28 cm | 15-46 cm | 15 |
| Depth to lime | 2 cm | 0-7 cm | 18 |
| Depth to mottles | 17 cm | 18-42 cm | 3 |
| pH of Ah horizon | 7.3 cm | 5.8-7.8 cm | 7 |
| pH of C horizon | 7.3 cm | 5.8-7.8 cm | 6 |
| E.C. for 0-60 cm | 0.48 dS/m | 0.48dS/m | 1 |
| Texture of 0-15 cm depth | L | | 8 |
| Texture of 16-30 cm depth | S | | 8 |
| Texture of C horizon | S | | 8 |
| Stoniness class | 0 | 0 | 8 |
| Drainage class | 5 | 5-7 | 15 |
| Slope | 2 % | 0-15 % | 12 |

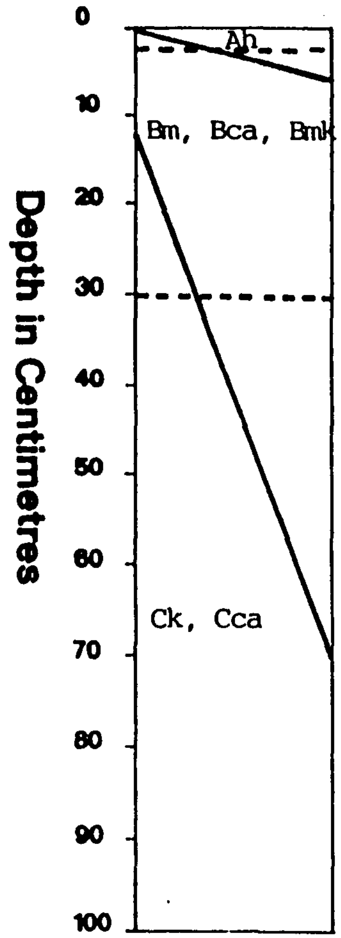



**Dominant Soil Subgroup**

Orthic Eutric Brunisol

SOIL ASSOCIATION: CANYON

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 3.0 cm | 0-20 cm | 32 |
| Thickness of solum | 38 cm | 13-66 cm | 23 |
| Depth to lime | 50 cm | 38-68 cm | 34 |
| pH of Ah horizon | 6.9 | 6.0-7.6 | 16 |
| pH of C horizon | 7.1 | 6.2-7.6 | 14 |
| E.C. for 0-60 cm | 0.1 dS/m | 0.04-0.19 dS/m | 3 |
| Texture of 0-15 cm depth | SL | | 20 |
| Texture of 16-30 cm depth | S-gS | | 20 |
| Texture of C horizon | gS | | 20 |
| Stoniness class | 5 | 1-6 | 20 |
| Drainage class | 2 | 1-2 | 20 |
| Slope | 12 % | 0-45 % | 33 |

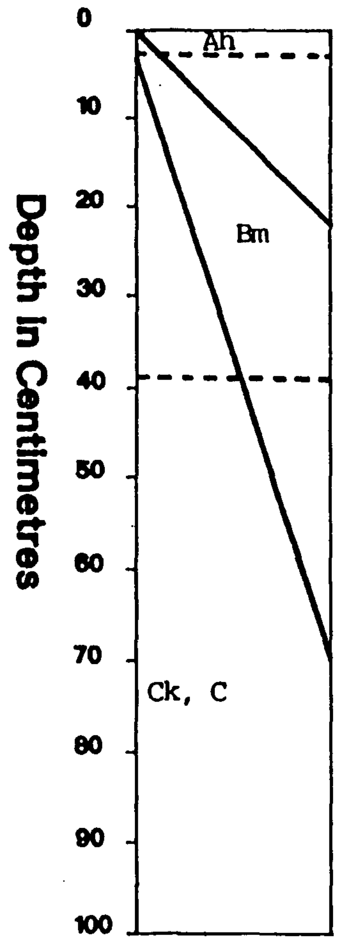



Dominant Soil Subgroup

Orthic Eutric Brunisol

SOIL ASSOCIATION: CHAMPAGNE

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 2 cm | 0-5 cm | 146 |
| Thickness of solum | 30 cm | 13-70 cm | 149 |
| Depth to lime | 31 cm | 8-51 cm | 146 |
| pH of Ah horizon | 7.1 | 6.0-7.8 | 77 |
| pH of C horizon | 7.4 | 6.6-8.1 | 76 |
| E.C. for 0-60 cm | 1.14 dS/m | 0.11-9.6 dS/m | 58 |
| Texture of 0-15 cm depth | L | | 84 |
| Texture of 16-30 cm depth | SiCL | | 84 |
| Texture of C horizon | SiC | | 84 |
| Stoniness class | 0 | 0 | 146 |
| Drainage class | 4 | 4 | 149 |
| Slope | 5 % | 0-31 % | 151 |

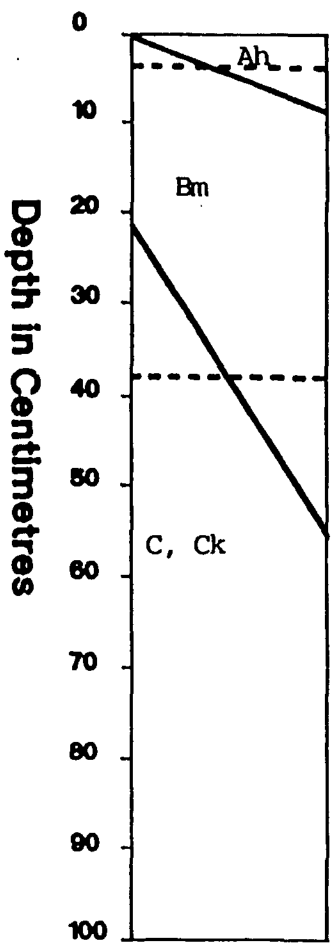



Dominant Soil Subgroup

Orthic Eutric Brunisol

SOIL ASSOCIATION: CROUCHER

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 2.5 cm | 0-22 cm | 76 |
| Thickness of solum | 39 cm | 4-70 cm | 74 |
| Depth to lime | 32 cm | 0-58 cm | 56 |
| pH of Ah horizon | 7.1 | 6.0-7.8 | 43 |
| pH of C horizon | 7.4 | 6.0-8.0 | 42 |
| E.C. for 0-60 cm | 0.35 dS/m | 0.07-1.32 dS/m | 45 |
| Texture of 0-15 cm depth | L | | 49 |
| Texture of 16-30 cm depth | LS | | 49 |
| Texture of C horizon | L-SL | | 49 |
| Stoniness class | 0 | 0 | 56 |
| Drainage class | 3 | 3-4 | 49 |
| Slope | 2 % | 0-11 % | 71 |

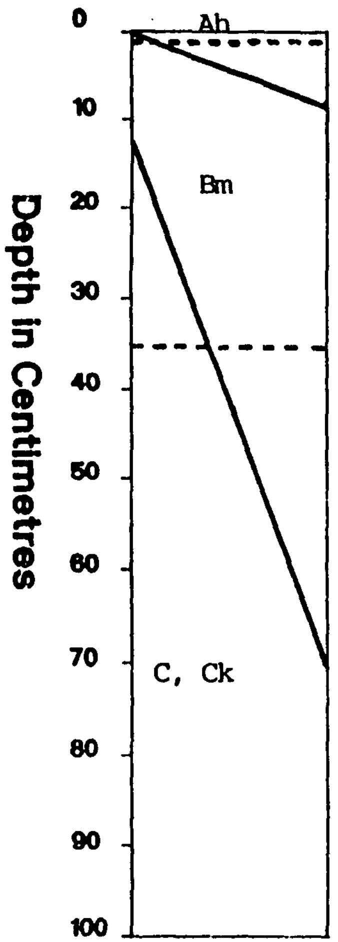



Dominant Soil Subgroup

Orthic Eutric Brunisol

SOIL ASSOCIATION: DISAPPOINTMENT

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 3.0 cm | 0-8 cm | 16 |
| Thickness of solum | 38 cm | 22-55 cm | 12 |
| Depth to lime | 33 cm | 8-48 cm | 4 |
| pH of Ah horizon | 7.2 | 6.8-7.8 | 7 |
| pH of C horizon | 7.2 | 6.4-7.6 | 7 |
| E.C. for 0-60 cm | 0.49 dS/m | 0.2-0.68 dS/m | 3 |
| Texture of 0-15 cm depth | L | | 9 |
| Texture of 16-30 cm depth | SL | | 9 |
| Texture of C horizon | GS | | 9 |
| Stoniness class | 2 | 0-4 | 17 |
| Drainage class | 3 | 2-3 | 16 |
| Slope | 12 % | 0-50 % | 16 |

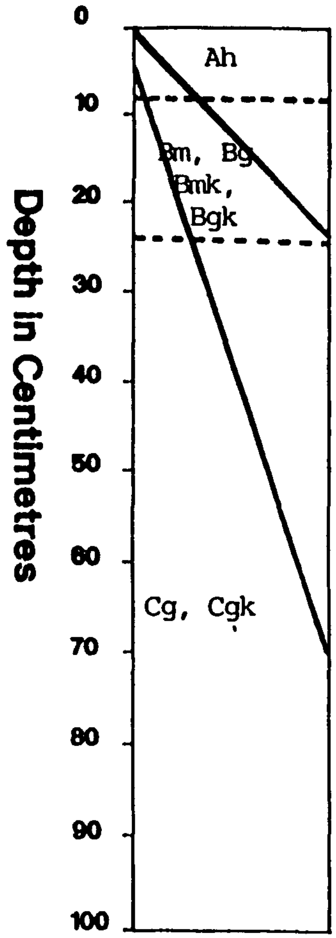



Dominant Soil Subgroup

Orthic Eutric Brunisol

SOIL ASSOCIATION: KLOWTATON

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 1.3 cm | 0-8 cm | 11 |
| Thickness of solum | 36 cm | 13-70 cm | 12 |
| Depth to lime | 42 cm | 13-66 cm | 10 |
| pH of Ah horizon | 7.3 | 6.8-7.8 | 7 |
| pH of C horizon | 7.2 | 6.4-7.6 | 7 |
| E.C. for 0-60 cm | 0.2 dS/m | 0.13-0.32 dS/m | 3 |
| Texture of 0-15 cm depth | SL | | 7 |
| Texture of 16-30 cm depth | SL | | 7 |
| Texture of C horizon | LS | | 7 |
| Stoniness class | 0 | 0 | 12 |
| Drainage class | 3 | 3-4 | 12 |
| Slope | 3 % | 2.7% | 10 |

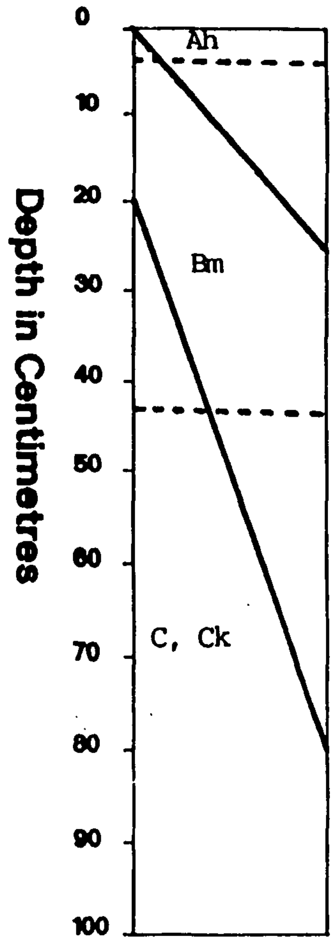



**Dominant Soil Subgroup**

Orthic Gleysol
Orthic Humic Gleysol

SOIL ASSOCIATION: LABERGE

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 8.5 cm | 0-23 cm | 24 |
| Thickness of solum | 24 cm | 5-70 cm | 33 |
| Depth to lime | 26 cm | 0-59 cm | 37 |
| Depth to mottles | 15 cm | 4-44 cm | 22 |
| pH of Ah horizon | 7.4 | 6.1-8.4 | 19 |
| pH of C horizon | 7.5 | 7.0-8.2 | 19 |
| E.C. for 0-60 cm | 1.07 dS/m | 0.13-4.8 dS/m | 10 |
| Texture of 0-15 cm depth | L | | 18 |
| Texture of 16-30 cm depth | SL-L | | 18 |
| Texture of C horizon | SL-LS | | 18 |
| Stoniness class | 0 | 0 | 37 |
| Drainage class | 6 | 4-7 | 19 |
| Slope | 3 % | 0-18 % | 36 |

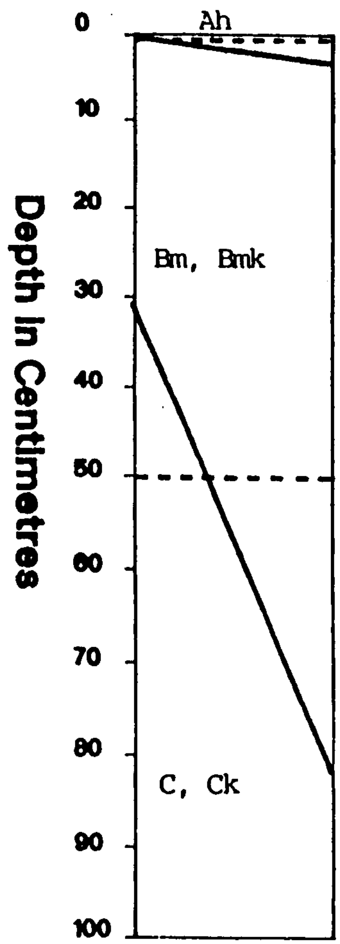



**Dominant Soil Subgroup**

Orthic Eutric Brunisol

SOIL ASSOCIATION: LEWES

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 3.5 cm | 0-25 cm | 106 |
| Thickness of solum | 43 cm | 20-80 cm | 104 |
| Depth to lime | 41 cm | 10-78 cm | 73 |
| pH of Ah horizon | 7.0 | 6.0-8.0 | 59 |
| pH of C horizon | 7.3 | 6.4-7.8 | 59 |
| E.C. for 0-60 cm | 0.65 dS/m | 0.08-9.8 dS/m | 38 |
| Texture of 0-15 cm depth | L | | 61 |
| Texture of 16-30 cm depth | L | | 61 |
| Texture of C horizon | SiCL-SL | | 61 |
| Stoniness class | 0 | | 61 |
| Drainage class | 4 | 3-4 | 59 |
| Slope | 4 % | 0-25 % | 107 |

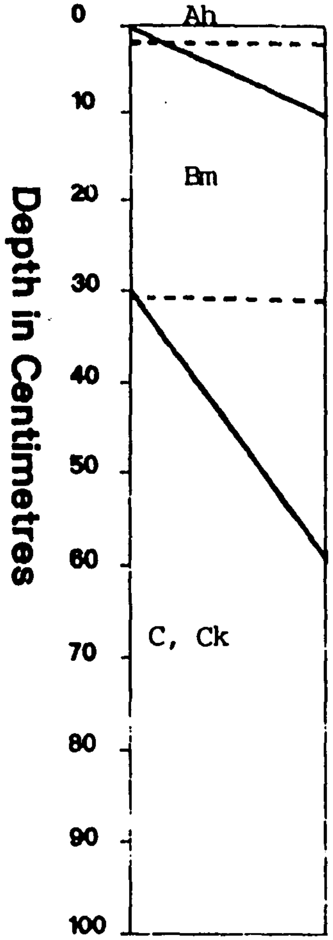



Dominant Soil Subgroup

Orthic Eutric Brunisol

SOIL ASSOCIATION: WHITEHORSE

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | .6 cm | 0-2 cm | 11 |
| Thickness of solum | 50 cm | 32-82 cm | 10 |
| Depth to lime | 63 cm | 39-100+cm | 12 |
| pH of Ah horizon | 7.1 | 6.0-7.8 | 7 |
| pH of C horizon | 7.2 | 7.0-7.6 | 7 |
| E.C. for 0-60 cm | 2.29 dS/m | 0.32-8.0 dS/m | 4 |
| Texture of 0-15 cm depth | L | | 7 |
| Texture of 16-30 cm depth | LS | | 7 |
| Texture of C horizon | SL | | 7 |
| Stoniness class | 0 | 0 | 7 |
| Drainage class | 3 | 2-3 | 12 |
| Slope | 12 % | 0-30 % | 12 |




**Dominant Soil Subgroup**

Orthic Eutric Brunisol

SOIL ASSOCIATION: WATSON RIVER

| | mean | range | total record |
|---|---|---|---|
| Thickness of Ah | 2.0 cm | 0-10 cm | 15 |
| Thickness of solum | 31 cm | 30-59 cm | 12 |
| Depth to lime | 51 cm | 15-99 cm | 9 |
| pH of Ah horizon | 7.0 | 6.1-7.4 | 10 |
| pH of C horizon | 7.2 | 6.6-7.6 | 11 |
| E.C. for 0-60 cm | 0.14 dS/m | 0.11-0.15 dS/m | 3 |
| Texture of 0-15 cm depth | SL | | 11 |
| Texture of 16-30 cm depth | LS | | 11 |
| Texture of C horizon | gLS | | 11 |
| Stoniness class | 3 | 1-4 | 10 |
| Drainage class | 3 | 3-4 | 10 |
| Slope | 12 % | 1-44 % | 16 |

# 8. Appendix Two Soil Capability for Cultivated Agriculture

The soil capability system for cultivated agriculture used in this survey was based on the Canada Land Inventory System and the Land Capability Classification for Agriculture System for British Columbia (Kenk 1982). It has two components: the capability class and the capability subclass. The capability class indicates a relative capability of the land for agriculture on a scale of one to seven. Class one has no restrictions, class seven has prohibitive restrictions. The subclass indicates the kind of limitations attached to that land. On capability maps, the most limiting class and up to two subclass limitations are represented.

The capability classes are defined by their potential and limitations for agricultural use. Lands with capability ratings of classes 1 to 4 are considered suitable for sustained production of common cultivated crops but because of climatic limitations none of the Whitehorse area soils were rated higher than class 5. Lands with a capability rating of class 5 are restricted to production of perennial forage crops or specially adapted crops. According to the Land Capability Classification for Agriculture in British Columbia, "Class 5 land can be cultivated and some can be used for cultivated crops provided unusually intensive management is employed and/or the crop is particularly adapted to the conditions peculiar to these lands. Cultivated field crops may be grown on some class 5 land where adverse climate is the main limitation but crop failure can be expected under average conditions."

Land with soil properties that do not restrict annual cultivation was rated as class 5. Land with soil properties which severely hamper cultivation was rated as class 6. These lands were considered as non arable in their unimproved condition. Land with prohibitive limitations to cultivation was rated as Class 7.

The capability class was determined both by climate and soil characteristics and was applied to both developed and undeveloped land. Agricultural ratings were based on the unimproved soil condition and the assumption that sound soil management was practised. Improvements possible on class 5 land include irrigation, intensive fertilisation, drainage, and stone removal. Land classified as class 6 was considered as either not improvable or improvable only at a great cost. Land classified as class 7 cannot be improved.

### Summary of soil subclasses

Subclasses provide information on the kind and severity of up to two most limiting factors. The subclasses or limitations present in the Takhini area included climate, inundation or flooding potential, presence of thermokarst, low moisture holding capacity, salt contamination of the soil, excessive stoniness, rockiness, steep topography, excess water and presence of permafrost. Limits for each subclass are presented in the legend of the agricultural capability maps.

**Climate (C) subclass** was based on the frost-free period and the number of degree-days above 5°C accumulated between May and September. The survey area was considered as having a limitation of Class 5 based on the average frost free period of 85 days and 900 growing degree days. Microclimatic variations such as southern exposure may affect this rating but the regional climate was used as the determining factor. Soils with the rating 5C were considered as the most suitable soils for cultivated agriculture in the Takhini Valley.

**Inundation subclass (I)** applied to soils where overflow by streams or lakes caused damage or restricted agricultural use. The class boundaries were based on the average number of days that a parcel of land could be flooded.

**Thermokarst subclass (K)** applied to land underlain by actively melting ground ice. It was applied most commonly to fine grained glaciolacustrine deposits and occasionally in fine grained fluvial deposits. When masses of segregated ground ice melt, the overlying material tends to subside and promote the development of ponds with collapsed banks. Change in the thermal condition of the soil, such as removal of the vegetation cover following a forest fire, can trigger thermokarst processes. The resultant landscape is pitted with numerous poorly drained steep-sided depressions. Cultivation of these areas is limited by the topography and the poor drainage but the land may provide some native grazing. Lands which exhibited thermokarst activity were rated as 6K.

**Moisture holding capacity subclass (M)** applied to well drained soils and was based on a modification of a capability system developed in Alberta (Pettapiece, 1987). This system evaluated the texture of a soil, and a moisture balance calculation based on precipitation and potential evapotranspiration. Climatic data used were from the Whitehorse airport weather station. The dominant soil texture of the first 50 centimetres was used to calculate the class ratings. Soils with medium to coarse sandy loam and fine loamy sand were assigned a rating of 5M. Soils with a texture finer than that do not present a limiting factor. Soils with texture ranging from medium to coarse loamy sand and sand were rated 6M. Soils composed of coarse sand to gravelly sand and gravel were rated 7M. Moisture holding capacity was the most common soil limitation in the survey area.

The **salinity subclass (N)** was defined from conditions observed in the Takhini and Yukon valleys and represents a slight modification to rating systems defined for B.C or Alberta. The most obvious indications of salt detectable in the field were white salt crusts at the surface salt crystals in soil profiles and the presence of salt tolerant native plants. In the survey area, grassy meadows without tree growth were often salt contaminated. In cultivated fields, stunted crop growth, barren patches, presence of abnormal leaf conditions and a blue green colour of the foliage were also indicators of higher salt concentration. In some situations the presence of anomalous concentrations of salt was difficult to assess in the field.

The electrical conductivity (E.C.) of a soil is directly related to the salt content: the higher the E.C. value, the higher the salt concentration. A rating of 5N was assigned to soil with E.C. values of 2 to 4 dS/m. It is intended as a warning for land managers that soils could degrade quickly if not managed properly. The rating 6N was assigned to soils with E.C. values of 4 to 8 dS/m. In this situation, the presence of salts usually affects the growth of the native and agronomic plants. The rating 7N was assigned to soils with E.C. reading greater than 8 dS/m and undergoing active salinization by groundwater discharge. Most of the delineations to which this rating was attached had soils with E.C. values greater than 12 dS/m and some had E.C. values of 20 dS/m and more. These soils were usually partially or completely covered by thick salt crust.

**Stoniness subclass (P)** was defined following the British Columbia System. It was applied to soils with sufficient coarse fragments (fragments 2.5 cm or larger) to significantly hinder tillage, planting, and/or harvesting operations. The ratings were determined based on the volume percentages of all coarse fragments as well as the percentage of stones and cobbles (fragments >7.5 cm diameter).

Class 5 P: Sufficient coarse fragments are present to prevent sustained cultivation until considerable picking has been done. Total coarse fragment content is 41 to 60% or cobbles and stones occupy 16 to 30% of the sieved soil.

Class 6 P: Coarse fragments are sufficiently numerous to make the application of improvement practices impractical. Total coarse fragment content is 61 to 80% or cobbles and stones occupy 31 to 90 % of the sieved soil. The land in its present condition provides sustained natural grazing.

Class 7 P: Coarse fragments prevent agricultural use. Total coarse fragment content is greater than 60% or cobbles and stones occupy more than 30 % of the sieved soil. The land in its present condition is not useable for either arable agriculture or sustained natural grazing for domestic livestock."

The **rockiness subclass (R)** or depth to solid bedrock was used for map units where the bedrock is near the surface or where outcrops might restrict plant growth and use of machinery. The class 5R was assigned to map polygons where the bedrock is mostly greater than 50 cm from the surface with occasional bedrock outcrops. The class 6R was assigned to map units where the bedrock depth is mostly 50 to 100 cm from the surface with numerous bedrock outcrops. The class 7R was assigned to map units where depth to bedrock was less than 50 cm or where outcrops form more than 80% of the surface.

**Topography subclass (T)** applied to land for which the topography limits the use of farm machinery, decreases the uniformity of growth and maturity of crops and increases the potential for water erosion. It is based on the B.C. system as defined by Kenk (1983). The

rating 5T was assigned to map units with slopes of 15% to 20% with a low percentage of slopes higher than 20%.

The rating 6T was assigned to map units with slopes varying form 21% to 60 % and the land in its present condition can sustain natural grazing.

The rating 7T was assigned to map units with slopes greater than 30 % and the land in its present condition was not suitable for either cultivated agriculture or sustained natural grazing.

**Excess water subclass (W)** was applied to soils for which excess free water, other than from inundation, limits their use for agriculture. The excess water occurs because of imperfect to very poor drainage due to high water tables, seepage, or runoff form surrounding areas. The subclass was based entirely on the dominant soil drainage class assigned to each polygon. Class limits are listed on the map legend.

**Permafrost subclass (Z)** was applied to soils where the presence of frozen soil was detected within 1.5 m from the surface. Permafrost was encountered in fine grained soils heavily insulated by a thick vegetation cover or organic matter, in north facing and poorly drained sites. The rating 6Z was assigned to map units where frost was still present in August within 1.5 meter of the surface. The rating assumes that persistent late season frost is indicative of a permafrost table within the control section. This limitation applied to all associations with the presence of Cryosolic soils and on individual polygons where field observations indicated persistent soil frost.

# 9. Appendix Three Soil Capability for Cultivated Agriculture

The soil capability system for cultivated agriculture used in this survey was based on the Canada Land Inventory System and the Land Capability Classification for Agriculture System for British Columbia (Kenk 1982). It has two components: the capability class and the capability subclass. The capability class indicates a relative capability of the land for agriculture on a scale of one to seven. Class one has no restrictions, class seven has prohibitive restrictions. The subclass indicates the kind of limitations attached to that land. On capability maps, the most limiting class and up to two subclass limitations are represented.

The capability classes are defined by their potential and limitations for agricultural use. Lands with capability ratings of classes 1 to 4 are considered suitable for sustained production of common cultivated crops but because of climatic limitations none of the Whitehorse area soils were rated higher than class 5. Lands with a capability rating of class 5 are restricted to production of perennial forage crops or specially adapted crops. According to the Land Capability Classification for Agriculture in British Columbia, "Class 5 land can be cultivated and some can be used for cultivated crops provided unusually intensive management is employed and/or the crop is particularly adapted to the conditions peculiar to these lands. Cultivated field crops may be grown on some class 5 land where adverse climate is the main limitation but crop failure can be expected under average conditions."

Land with soil properties that do not restrict annual cultivation was rated as class 5. Land with soil properties which severely hamper cultivation was rated as class 6. These lands were considered as non arable in their unimproved condition. Land with prohibitive limitations to cultivation was rated as Class 7.

The capability class was determined both by climate and soil characteristics and was applied to both developed and undeveloped land. Agricultural ratings were based on the unimproved soil condition and the assumption that sound soil management was practised. Improvements possible on class 5 land include irrigation, intensive fertilisation, drainage, and stone removal. Land classified as class 6 was considered as either not improvable or improvable only at a great cost. Land classified as class 7 cannot be improved.

**Summary of soil subclasses**

Subclasses provide information on the kind and severity of up to two most limiting factors. The subclasses or limitations present in the Takhini area included climate, inundation or flooding potential, presence of thermokarst, low moisture holding capacity, salt contamination of the soil, excessive stoniness, rockiness, steep topography, excess water and presence of permafrost. Limits for each subclass are presented in the legend of the agricultural capability maps.

**Climate (C) subclass** was based on the frost-free period and the number of degree-days above 5°C accumulated between May and September. The survey area was considered as having a limitation of Class 5 based on the average frost free period of 85 days and 900 growing degree days. Microclimatic variations such as southern exposure may affect this rating but the regional climate was used as the determining factor. Soils with the rating 5C were considered as the most suitable soils for cultivated agriculture in the Takhini Valley.

**Inundation subclass (I)** applied to soils where overflow by streams or lakes caused damage or restricted agricultural use. The class boundaries were based on the average number of days that a parcel of land could be flooded.

**Thermokarst subclass (K)** applied to land underlain by actively melting ground ice. It was applied most commonly to fine grained glaciolacustrine deposits and occasionally in fine grained fluvial deposits. When masses of segregated ground ice melt, the overlying material tends to subside and promote the development of ponds with collapsed banks. Change in the thermal condition of the soil, such as removal of the vegetation cover following a forest fire, can trigger thermokarst processes. The resultant landscape is pitted with numerous poorly drained steep-sided depressions. Cultivation of these areas is limited by the topography and the poor drainage but the land may provide some native grazing. Lands which exhibited thermokarst activity were rated as 6K.

**Moisture holding capacity subclass (M)** applied to well drained soils and was based on a modification of a capability system developed in Alberta (Pettapiece, 1987). This system evaluated the texture of a soil, and a moisture balance calculation based on precipitation and potential evapotranspiration. Climatic data used were from the Whitehorse airport weather station. The dominant soil texture of the first 50 centimetres was used to calculate the class ratings. Soils with medium to coarse sandy loam and fine loamy sand were assigned a rating of 5M. Soils with a texture finer than that do not present a limiting factor. Soils with texture ranging from medium to coarse loamy sand and sand were rated 6M. Soils composed of coarse sand to gravelly sand and gravel were rated 7M. Moisture holding capacity was the most common soil limitation in the survey area.

The **salinity subclass (N)** was defined from conditions observed in the Takhini and Yukon valleys and represents a slight modification to rating systems defined for B.C or Alberta. The most obvious indications of salt detectable in the field were white salt crusts at the surface salt crystals in soil profiles and the presence of salt tolerant native plants. In the survey area, grassy meadows without tree growth were often salt contaminated. In cultivated fields, stunted crop growth, barren patches, presence of abnormal leaf conditions and a blue green colour of the foliage were also indicators of higher salt concentration. In some situations the presence of anomalous concentrations of salt was difficult to assess in the field.

The electrical conductivity (E.C.) of a soil is directly related to the salt content: the higher the E.C. value, the higher the salt concentration. A rating of 5N was assigned to soil with E.C. values of 2 to 4 dS/m. It is intended as a warning for land managers that soils could degrade quickly if not managed properly. The rating 6N was assigned to soils with E.C. values of 4 to 8 dS/m. In this situation, the presence of salts usually affects the growth of the native and agronomic plants. The rating 7N was assigned to soils with E.C. reading greater than 8 dS/m and undergoing active salinization by groundwater discharge. Most of the delineations to which this rating was attached had soils with E.C. values greater than 12 dS/m and some had E.C. values of 20 dS/m and more. These soils were usually partially or completely covered by thick salt crust.

**Stoniness subclass (P)** was defined following the British Columbia System. It was applied to soils with sufficient coarse fragments (fragments 2.5 cm or larger) to significantly hinder tillage, planting, and/or harvesting operations. The ratings were determined based on the volume percentages of all coarse fragments as well as the percentage of stones and cobbles (fragments >7.5 cm diameter).

Class 5 P: Sufficient coarse fragments are present to prevent sustained cultivation until considerable picking has been done. Total coarse fragment content is 41 to 60% or cobbles and stones occupy 16 to 30% of the sieved soil.

Class 6 P: Coarse fragments are sufficiently numerous to make the application of improvement practices impractical. Total coarse fragment content is 61 to 80% or cobbles and stones occupy 31 to 90 % of the sieved soil. The land in its present condition provides sustained natural grazing.

Class 7 P: Coarse fragments prevent agricultural use. Total coarse fragment content is greater than 60% or cobbles and stones occupy more than 30 % of the sieved soil. The land in its present condition is not useable for either arable agriculture or sustained natural grazing for domestic livestock."

The **rockiness subclass (R)** or depth to solid bedrock was used for map units where the bedrock is near the surface or where outcrops might restrict plant growth and use of machinery. The class 5R was assigned to map polygons where the bedrock is mostly greater than 50 cm from the surface with occasional bedrock outcrops. The class 6R was assigned to map units where the bedrock depth is mostly 50 to 100 cm from the surface with numerous bedrock outcrops. The class 7R was assigned to map units where depth to bedrock was less than 50 cm or where outcrops form more than 80% of the surface.

**Topography subclass (T)** applied to land for which the topography limits the use of farm machinery, decreases the uniformity of growth and maturity of crops and increases the potential for water erosion. It is based on the B.C. system as defined by Kenk (1983). The

rating 5T was assigned to map units with slopes of 15% to 20% with a low percentage of slopes higher than 20%.

The rating 6T was assigned to map units with slopes varying form 21% to 60 % and the land in its present condition can sustain natural grazing.

The rating 7T was assigned to map units with slopes greater than 30 % and the land in its present condition was not suitable for either cultivated agriculture or sustained natural grazing.

**Excess water subclass (W)** was applied to soils for which excess free water, other than from inundation, limits their use for agriculture. The excess water occurs because of imperfect to very poor drainage due to high water tables, seepage, or runoff form surrounding areas. The subclass was based entirely on the dominant soil drainage class assigned to each polygon. Class limits are listed on the map legend.

**Permafrost subclass (Z)** was applied to soils where the presence of frozen soil was detected within 1.5 m from the surface. Permafrost was encountered in fine grained soils heavily insulated by a thick vegetation cover or organic matter, in north facing and poorly drained sites. The rating 6Z was assigned to map units where frost was still present in August within 1.5 meter of the surface. The rating assumes that persistent late season frost is indicative of a permafrost table within the control section. This limitation applied to all associations with the presence of Cryosolic soils and on individual polygons where field observations indicated persistent soil frost.

# 8. Appendix Three Soil Capability for Cultivated Agriculture

The soil capability system for cultivated agriculture used in this survey was based on the Canada Land Inventory System and the Land Capability Classification for Agriculture System for British Columbia (Kenk 1982). It has two components: the capability class and the capability subclass. The capability class indicates a relative capability of the land for agriculture on a scale of one to seven. Class one has no restrictions, class seven has prohibitive restrictions. The subclass indicates the kind of limitations attached to that land. On capability maps, the most limiting class and up to two subclass limitations are represented.

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**Summary of soil subclasses**

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rating 5T was assigned to map units with slopes of 15% to 20% with a low percentage of slopes higher than 20%.

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**Excess water subclass (W)** was applied to soils for which excess free water, other than from inundation, limits their use for agriculture. The excess water occurs because of imperfect to very poor drainage due to high water tables, seepage, or runoff form surrounding areas. The subclass was based entirely on the dominant soil drainage class assigned to each polygon. Class limits are listed on the map legend.

**Permafrost subclass (Z)** was applied to soils where the presence of frozen soil was detected within 1.5 m from the surface. Permafrost was encountered in fine grained soils heavily insulated by a thick vegetation cover or organic matter, in north facing and poorly drained sites. The rating 6Z was assigned to map units where frost was still present in August within 1.5 meter of the surface. The rating assumes that persistent late season frost is indicative of a permafrost table within the control section. This limitation applied to all associations with the presence of Cryosolic soils and on individual polygons where field observations indicated persistent soil frost.

# 10. Appendix four Wetland Vegetation and Site Description

-vegetation lists available for several of these sites.

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 62 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 72 | Microtopography | Strongly Mounded |
| Wetland Polygon Classification | sedge-shrub channel fen/ forest/ beaver +permafrost | Soil Drainage | Poor |
| Site Classification | stream swamp | Flood Hazard | Moderate |
| Latitude | 60°43' | | |
| Longitude | 35°10' | | |
| Elevation | 2600 ft. | | |
| Location | Junction of Fish Lake Road + Haul Road, SW of junction | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Snag* | 1 | FB | *Epilobium aliatum* | 1 |
| LT | *Snag* | 15 | | *Rorippa palustris* | 5 |
| TT | *Picea glauca* | 1 | | *Veronica americanum* | 1 |
| LT | *Picea glauca* | 5 | GR | *Carex rostrata* | 15 |
| TS | *Salix athabascensis* | 5 | | *Carex aquatilis* | 45 |
| | *Picea glauca* | 1 | BR | *Bryophytes Total* | 10 |
| MS | *Salix arbusculoides* | 10 | | | |
| LS | *Salix arbusculoides* | 1 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 90 |
| | > 2 cm | |
| Water | | 15 |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | CM 65 | Site Position (Macro) | Lower slope |
| Wetland Polygon Number | 72 | Microtopography | Strongly mounded |
| Wetland Polygon Classification | sedge-shrub channel, fen, beaver+permfrost | Soil Drainage | Poor |
| Site Classification | forest | Flood Hazard | Moderate |
| Latitude | 60°43' | | |
| Longitude | 135°10' | | |
| Elevation | 2600 ft. | | |
| Location | Junction of Fish Lake Rd and Haul Rd - SW of junction | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Picea glauca* | 10 | *GS* | *Rubus acaulis* | 1 |
| LT | *Picea glauca* | 15 | | *Linnaca borealis* | 1 |
| TT | *Snag* | 1 | | *Salix myrtillifolia* | 20 |
| TS | *Picea glauca* | 1 | *FB* | *Astragalus americanus* | 1 |
| | *Salix athabasce* | 10 | | *Equisetum scirpoides* | 5 |
| MS | *Salix arbusculoides* | 15 | *GR* | *Carex aquatilis* | 10 |
| | *Potentilla fruticosa* | 5 | | *Arctagro latifolia* | 5 |
| LS | *Salix myrtillifolia* | 15 | *BR* | *Bryophytes Total* | 80 |
| | *Potentilla fruticosa* | 1 | | | |
| Litter | < 2 cm | 5 | | | |
| | > 2 cm | | | | |
| Water | | 15 | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 210 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | | Microtopography | Severely Mounded |
| Wetland Polygon Classification | not a wetland | Soil Drainage | Very Poorly |
| Site Classification | | Flood Hazard | Frequent & Regular |
| Latitude | 60°41' | | |
| Longitude | 135°05' | | |
| Elevation | 2500 ft. | | |
| Location | West of Lobird Trailer Court | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix glauca* | 1 | GR | *Carex aquatilis* | 30 |
| MS | *Salix sp.* | 10 | | *Carex utriculata* | 1 |
| | *Betula glandulosa* | 20 | | *Calamagrostis stricta* | 1 |
| LS | *Salix sp.* | 1 | BR | *Bryophytes Total* | 35 |
| | *Betula glandulosa* | 1 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 35 |
| | > 2 cm | |
| Water | | 15 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 180A | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 80 | Microtopography | Micromounded |
| Wetland Polygon Classification | shrub-sedge stream fen/ shallow water/beaver | Soil Drainage | Very Poorly, high water table |
| Site Classification | shrub floodplain swamp | Flood Hazard | Frequent & irregular (Beaver) |
| Latitude | 60°45' | | |
| Longitude | 135°07' | | |
| Elevation | 2400 ft. | | |
| Location | Yukon College McIntyre Pond | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix glauca* | 10 | GR | *Juncus balticus* | 5 |
| MS | *Salix glauca* | 10 | | *Carex aquatilis* | 20 |
| LS | *Salix glauca* | 1 | BR | *Bryophytes Total* | 50 |
| GS | *Rubus acaulis* | 1 | | | |
| FB | *Equisetum hyemale* | 1 | | | |
| | *Equisetum scirpoiides* | 15 | | | |

| | | | |
|---|---|---|---|
| Litter | < 2 cm | 15 | |
| | > 2 cm | | |
| Water | | 50 | (Flooding) |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 180B | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 80 | Microtopography | Smooth |
| Wetland Polygon Classification | shrub-sedge stream, fen/ shallow water/ beaver | Soil Drainage | Very Poor |
| Site Classification | sedge stream fen | Flood Hazard | Frequent & Irregular (Beaver) |
| Latitude | 60°45' | | |
| Longitude | 135°07' | | |
| Elevation | 2400 ft. | | |
| Location | Yukon College - McIntyre Pond | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| GR | *Carex aquatilis* | 50 | BR | *Bryophytes Total* | 40 |
| | *Carex rostrata* | 10 | | | |
| | *Carex utriculata* | 1 | | | |
| FB | *Rumex sp.* | 1 | | | |
| | *Petasites frigidus* | 5 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 10 |
| | > 2 cm | |
| Water | | 75 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 184A | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 81 | Microtopography | Micromounded |
| Wetland Polygon Classification | shrub willow graminoid stream swamp/ beaver | Soil Drainage | Very Poorly |
| Site Classification | sedge stream fen | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°08' | | |
| Elevation | 2300 ft. | | |
| Location | McIntyre Creek East of the KK | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp.* | 5 | GR | *Carex rostrata* | 70 |
| MS | *Salix sp.* | 5 | | *Calamagrostis canadensis* | 5 |
| FB | *Rumex arcticus* | 10 | BR | *Bryophytes Total* | 10 |

| | | |
|---|---|---|
| Litter | < 2 cm | 50 |
| | > 2 cm | |
| Water | | 10 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 184B | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 81 | Microtopography | Moderately Mounded |
| Wetland Polygon Classification | shrub willow graminoid stream swamp/ beaver | Soil Drainage | Very Poorly |
| Site Classification | shrub willow graminoid stream swamp/ beaver | Flood Hazard | Frequent & Irregular |
| Latitude | 60°45' | | |
| Longitude | 135°08' | | |
| Elevation | 2300 ft. | | |
| Location | McIntyre Creek east of the Kopper King | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp.* | 10 | GR | *Carex aquatilis* | 5 |
| MS | *Salix sp.* | 5 | | *Calamagrostis canadensis* | 50 |
| LS | *Salix* | 1 | | | |
| FB | *Rumex* | 10 | BR | *Bryophytes Total* | 30 |
| | *Epilobium angustifolium* | 5 | | | |
| | *Epilobium lactiforum* | 15 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 70 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 186 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 7 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge-willow, stream, fen sedge, stream, march | Soil Drainage | Poorly |
| Site Classification | | Flood Hazard | Frequent & Irregular |
| Latitude | 60°36' | | |
| Longitude | 135°00' | | |
| Elevation | 2300 ft. | | |
| Location | Cowley Creek west of Alaska Highway | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix glauca* | | GR | *Carex aquatilis* | |
| MS | *Salix glauca* | | | *Carex rostrata* | |
| LS | *Salix glauca* | | | *Calamagrostis canadensis* | |
| | | | | *Bryophytes Total* | |
| FB | *Epilobium angustifolium* | | | | |
| | *Epilobium lactiforum* | | | | |
| | *Ranunculus gmelinii* | | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | |
| | > 2 cm | |
| Water | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | CM 199A | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 63 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge basin fen/ shallow water/ anthropogenic | Soil Drainage | Very Poorly |
| Site Classification | sedge basin fen/ shallow water/ anthropogenic | Flood Hazard | Frequent & Regular |
| Latitude | 60°43' | | |
| Longitude | 135°05' | | |
| Elevation | 2400 ft. | | |
| Location | Paddy,s Pond Hillcrest | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| | | | GR | *Carex arostrata* | 35 |
| | | | | *Carex podocarpa* | 5 |
| | | | | *Carex aquatilis* | 5 |

| | | |
|---|---|---|
| Litter | < 2 cm | 90 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 199B | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 63 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge basin fen/ shallow water anthropogenic | Soil Drainage | Very Poorly |
| Site Classification | shrub basin swamp | Flood Hazard | Frequent & Regular |
| Latitude | 60°43' | | |
| Longitude | 135°05' | | |
| Elevation | 2400 ft. | | |
| Location | Paddy,s Pond Hillcrest | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix glauca* | 10 | GR | *Carex aguatilis* | 25 |
| MS | *Salix glauca* | 10 | | *Calamagrostis stricta* | 5 |
| LS | *Salix sp.* | 5 | BR | *Bryophytes Total* | 25 |

| | | |
|---|---|---|
| Litter | < 2 cm | 85 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | CM 203 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 62 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | shrub-sedge channel fen/ permafrost | Soil Drainage | Very Poorly |
| Site Classification | shrub basin swamp | Flood Hazard | Frequent & Regular |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | Paddy's Pond (Undisturbed south end of pond) | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp.* | 15 | GR | *Carex aguatilis* | 1 |
| | *Picea glauca* | 1 | | *Carex rostrata* | 5 |
| MS | *Salix sp.* | 15 | | *Calamagrostis stricta* | 5 |
| | *Picea glauca* | 5 | | *Carepodocarpa* | 20 |
| LS | *Salix sp.* | 1 | BR | *Bryophytes Total* | 40 |
| | *Picea glauca* | 1 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 50 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | MK 18A | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 67 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | shallow water/ sedge-shrub channel fen/ beaver permafrost | Soil Drainage | Poor |
| Site Classification | shrub stream swamp | Flood Hazard | Frequent & Regular |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | Wetland East of Copper Haul Road near Junction Of Fish Lake Road | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Picea glauca* | 1 | GR | *Carex aguatilis* | 1 |
| | | 1 | | | |
| MS | *Picea glauca* | 5 | | | |
| | *Betula glandulosa* | 25 | | | |
| | *Salix sp.* | 25 | BR | *Bryophytes Total* | 40 |
| LS | *Potentilla fruticosa* | 1 | | *Minuartia sp.* | 5 |
| GS | *Rubus acaulis* | 5 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 35 |
| | > 2 cm | |
| Water | | 5 |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | MK 18 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 67 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | shallow water/sedge-shrub channel fen/ beaver permafrost | Soil Drainage | Very Poorly |
| Site Classification | fen | Flood Hazard | Frequent & Irregular |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | Wetland East of Copper Haul Road near Junction Of Fish Lake Road | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| MS | *Salix athabascensis* | 40 | GR | *Carex aquatilis* | 20 |
| | *Betula glandulosa* | 10 | | | |
| LS | *Salix myrtillifolia* | 10 | | | |
| | *Betula glandulosa* | 1 | | | |
| GS | *Rubus acaulis* | 10 | BR | *Minuartia sp.* | 25 |
| | | | | *Drepanocladus sp.* | |
| | *Potentilla pulchella* | 1 | | *Pohlia sp.* | |
| Litter | < 2 cm | 35 | | | |
| | > 2 cm | | | | |
| Water | | 15 | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | MK 19 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 67 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | shallow water/ sedge-shrub channel fen/ beaver permafrost | Soil Drainage | Very Poorly |
| Site Classification | shrub stream swamp | Flood Hazard | Frequent & Irregular |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | Wetland East of Copper Haul Road near Junction Of Fish Lake Road | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| LT | *Picea glauca* | 10 | GR | *Carex aquatilis* | 20 |
| TS | *Picea glauca* | 1 | | *Carex diandra* | 1 |
| MS | *Salix sp.* | 1 | BR | *Tome sp.* | 35 |
| | *Picea glauca* | 25 | | *Drep sp.* | 20 |
| | *Betula glandulosa* | 25 | | *Minuartia sp.* | 1 |
| LS | *Salix sp.* | 5 | | | |
| | *Potentilla fruticosa* | 1 | | | |
| | *Betula glandulosa* | 15 | | | |
| | | | | | |
| Litter | < 2 cm | 35 | | | |
| | > 2 cm | | | | |
| Water | | | | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | CM 67 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 56 | Microtopography | Micro Mounded |
| Wetland Polygon Classification | marl sedge-shrub, channel fen/ marl, shallow water | Soil Drainage | Very Poorly |
| Site Classification | marl-sedge-shrub, channel fen | Flood Hazard | Frequent & Irregular |
| Latitude | 60°43' | | |
| Longitude | 135°07' | | |
| Elevation | 2400 ft. | | |
| Location | West of Copper Ridge Subdivision | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| LT | *Picea glauca* | 1 | FB | *Tofieldia glutinosa* | 1 |
| MS | *Salix alexensis* | 1 | | *Habenaria dilatata* | 1 |
| | *Salix athabascensis* | 1 | | *Triglochin maritimum* | 1 |
| | *Betula glandulosa* | 5 | GR | *Carex aquatilis* | 15 |
| LS | *Salix arbusculoides* | 10 | | *Eriophorum viridicarinatum* | 1 |
| | *Salix myrtillifolia* | 1 | | *Carex sp.* | 5 |
| | *Betula glandulosa* | 20 | BR | *Bryophytes Total* | 70 |

| | | |
|---|---|---|
| Litter | < 2 cm | 15 |
| | > 2 cm | |
| Water | | 15 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | MK 20 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 67 | Microtopography | Micromounded |
| Wetland Polygon Classification | shallow water/ sedge-shrub channel fen/ beaver permafrost | Soil Drainage | Poor |
| Site Classification | sedge channel fen | Flood Hazard | Frequent & Regular |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | East of Copper Haul Road (Marl Fen Transect) | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| MS | *Salix sp.* | 1 | GR | *Carex aquatilis* | 25 |
| | *Betula glandulosa* | 5 | | *Carex diandra* | 10 |
| | *Potentilla fruticosa* | 1 | | *Carex gynocrates* | 1 |
| LS | *Salix sp.* | 1 | | | |
| | *Potentilla fruticosa* | 1 | | | |
| | *Betula glandulosa* | 5 | BR | *Drepanocladus* | 80 |
| FB | *Menyanthes trifoliata* | 20 | | *Scorpidium* | 5 |

| | | |
|---|---|---|
| Litter | < 2 cm | 25 |
| | > 2 cm | |
| Water | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | MK 21 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 67 | Microtopography | Strongly Mounded |
| Wetland Polygon Classification | shallow water/ sedge-shrub channel fen/ beaver permafrost | Soil Drainage | Poor |
| Site Classification | forest transition | Flood Hazard | No Hazard |
| Latitude | 60°43' | | |
| Longitude | 135°09' | | |
| Elevation | 2400 ft. | | |
| Location | East of Copper Haul Road (Marl Fen Transect) | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Picea glauca* | 10 | | *Picea glauca* | 1 |
| | | | GS | *Arctostaphylos rubra* | 15 |
| LT | *Picea glauca* | 10 | | *Salix myrtillifolia* | 10 |
| TS | *Picea glauca* | 5 | | | |
| MS | *Picea glauca* | 5 | GR | *Carex aquatilis* | 10 |
| | *Betula glandulosa* | 10 | BR | *Tome sp.* | 70 |
| LS | *Betula glandulosa* | 10 | | | |
| | *Potentilla fruticosa* | 5 | | | |
| Litter | < 2 cm | 20 | | | |
| | > 2 cm | | | | |
| Water | | | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | MK 67 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 101 | Microtopography | Slightly Mounded |
| Wetland Polygon Classification | graminoid-willow stream marsh/ shallow water/ beaver | Soil Drainage | Moderately Well |
| Site Classification | shrub-sedge stream fen | Flood Hazard | Moderate |
| Latitude | 60°48' | | |
| Longitude | 135°11' | | |
| Elevation | 2200 ft. | | |
| Location | North Cousins Airstrip | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Betula glandulosa* | 5 | GR | *Poa pratensis* | 5 |
| MS | *Betula glandulosa* | 10 | | *Carex aquatilis* | 15 |
| | *Salix sp.* | 1 | | *Calamagrostis stricta* | 5 |
| LS | *Betula glandulosa* | 5 | | *Gramineae* | 1 |
| | *Salix myrtillifolia* | 10 | | | |
| | *Potentilla fruticosa* | 1 | BR | *Bryophytes Total* | 65 |
| FB | *Geum aleppicum* | 1 | | | |
| | *Deschampsia sp.* | 1 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 25 |
| | > 2 cm | 1 |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | MK 71 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 88 | Microtopography | Strongly Mounded |
| Wetland Polygon Classification | willow-sedge channel marsh permafrost | Soil Drainage | Very Poorly |
| Site Classification | shrub-sedge channel fen | Flood Hazard | Frequent & Irregular |
| Latitude | 60°46' | | |
| Longitude | 135°10' | | |
| Elevation | 2400 ft. | | |
| Location | North of Kulan Subdivision | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Snag* | 1 | GS | *Arctostaphylos rubella* | 10 |
| LT | *Snag* | 1 | | *Rubus acaulis* | 1 |
| TS | *Salix myrtillifolia* | 15 | | | |
| MS | *Salix sp.* | 5 | | | |
| | *Salix myrtillifolia* | 15 | GR | *Carex aquatilis* | 30 |
| LS | *Salix sp.* | 5 | BR | *Bryophytes Total* | 65 |
| | *Potentilla fruticosa* | 1 | | | |
| | *Ledum groenlandicum* | 1 | | | |

| | | |
|---|---|---|
| Litter | < 2 cm | 20 |
| | > 2 cm | 5 |
| Water | | 5 |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | SS15 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 76 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Very Poorly |
| Site Classification | sedge-shrub stream fen | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Qwanlin Dun Old Village Marwell | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| MS | *Salix athabascensis* | 1 | GS | *Calamagrostis stricta* | 5 |
| | *Betula glandulosa* | 1 | | *Carex aquatilis* | 25 |
| LS | *Salix sp.* | 20 | | *Carex podocarpa* | 1 |
| | *Betula glandulosa* | 1 | | *Carex sp.* | 1 |
| | *Salix alaxensis* | 1 | GR | *Carex sp.* | 1 |
| | | | BR | *Bryophytes Total* | 95 |

| | | |
|---|---|---|
| Litter | < 2 cm | 35 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS16 | Site Position (Macro) | Lower Slope |
| Wetland Polygon Number | 76 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Very Poorly |
| Site Classification | sedge-shrub basin fen | Flood Hazard | Rare |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Qwanlin Dun Old Village Marwell | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Snag* | 1 | LS | *Betula glandulosa* | 1 |
| LT | *Picea glauca* | 1 | | *Salix sp. 1* | 1 |
| | *Snag* | 1 | | *Potentilla fruticosa* | 1 |
| TS | *Betula glandulosa* | 5 | | *Picea glandulosa* | 1 |
| | *Picea glauca* | 1 | | *Salix sp. 2* | 10 |
| | *Salix sp.* | 15 | GR | *Carex aquatilis* | 15 |
| MS | *Betula glandulosa* | 1 | | *Carex sp. 1* | 1 |
| | *Salix sp. 1* | 5 | | *Carex sp. 2* | 5 |
| | *Salix sp. 2* | 10 | BR | *Bryophytes Total* | 90 |
| Litter | < 2 cm | 35 | | | |
| | > 2 cm | | | | |
| Water | | | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS17 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 76 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Very Poorly |
| Site Classification | | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Qwanlin Dun Old Village Marwell | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp. 1* | 1 | GR | *Carex aquatilis* | 35 |
| | *Salix sp. 2* | 1 | | *Carex diandra* | 0.5 |
| MS | *Salix sp. 1* | 1 | | | |
| | *Salix sp. 2* | 10 | | | |
| LS | *Salix sp. 1* | 1 | | | |
| | *Salix sp. 2* | 10 | | | |
| | | | BR | *Bryophytes Total* | 10 |
| Litter | < 2 cm | 25 | | | |
| | > 2 cm | | | | |
| Water | | 15 | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS18 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 76 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Poor |
| Site Classification | forest transition | Flood Hazard | Moderate |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Qwanlin Dun Old Village Marwell | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Picea glauca* | 1 | | *Picea glauca* | 1 |
| | *Snag* | 1 | | *Ledum groenlandicum* | 20 |
| LT | *Picea glauca* | 10 | | *Potentilla fruticosa* | 1 |
| TS | *Salix sp. 1* | 10 | | *Vaccinium vitis-idaea* | 5 |
| | *Betula glandulosa* | 1 | GS | *Empetrum nigrum* | 1 |
| MS | *Salix sp. 2* | 20 | GR | *Carex aquatilis* | 5 |
| | *Betula glandulosa* | 1 | | *Carex gynocrates* | 1 |
| | *Picea glauca* | 1 | | *Eriophorum brachyantherum* | 1 |
| LS | *Salix Myrtillifolia* | 20 | BR | *Bryophytes Total* | 80 |
| Litter | < 2 cm | 25 | | | |
| | > 2 cm | | | | |
| Water | | 15 | | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | SS20 | Site Position (Macro) | Plain |
| Wetland Polygon Number | 76 | Microtopography | Severely Micromounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Poor |
| Site Classification | forest transition | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Wetland South of Takhini Trailer Court | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Picea glauca* | 20 | | *Picea glauca* | 1 |
| LT | *Picea glauca* | 5 | | *Ledum groenlandicum* | 20 |
| TS | *Salix athabascensis* | 10 | | *Vaccinium uliginosum* | 1 |
| | *Betula glandulosa* | 1 | GS | *Empetrum nigrum* | 10 |
| | *Picea glauca* | 1 | | *Vaccinium vistis-idaea* | 1 |
| MS | *Salix sp. 1* | 1 | FB | *Equisetum scirpoides* | 5 |
| | *Ribe hudsonianum* | 1 | GR | *Carex aquatilis* | 5 |
| | *Potentilla fruticosa* | 5 | | *Calamagrostis canadensis* | 5 |
| LS | *Salix myrtillifolia* | 1 | BR | *Bryophytes Total* | 80 |
| Litter | < 2 cm | 15 | | | |
| | > 2 cm | | | | |
| Water | | 5 | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS21 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 76 | Microtopography | Severely Micromounded |
| Wetland Polygon Classification | sedge-shrub/ basin fen/ collapse scar/ fen | Soil Drainage | Poor |
| Site Classification | sedge collapse scar fen | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Wetland South of Takhini Trailer Court | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp.* | 15 | | | |
| MS | *Salix sp. 1* | 10 | | | |
| LS | *Salix* | 5 | | | |
| GS | *Rubus Acaulis* | 1 | GR | *Carex aquatilis* | 20 |
| | | | | *Calamagrostis* | 5 |
| | | | BR | *Bryophytes Total* | 50 |
| Litter | < 2 cm | 35 | | | |
| | > 2 cm | 5 | | | |
| Water | | 5 | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS22 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 76 | Microtopography | Strongly Mounded |
| Wetland Polygon Classification | sedge-shrub,/ basin fen/ collapse scar/ fen | Soil Drainage | Poor |
| Site Classification | sedge-shrub basin fen | Flood Hazard | Frequent & Regular |
| Latitude | 60°45' | | |
| Longitude | 135°05' | | |
| Elevation | 2000 ft. | | |
| Location | Wetland South of Takhini Trailer Court | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| LT | *Salix sp. 1* | 10 | GR | *Calamagrostis* | 20 |
| | | | | *Carex aquatilis* | 5 |
| TS | *Salix sp. 1* | 15 | | | |
| | *Salix sp. 2* | 1 | | | |
| MS | *Salix* | 5 | | | |
| LS | *Salix sp. 1* | 1 | | | |
| FB | *Epilobium angustifolium* | 5 | | | |
| | | | BR | *Bryophytes Total* | 20 |
| Litter | < 2 cm | 25 | | | |
| | > 2 cm | 5 | | | |
| Water | | | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS34 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 113 | Microtopography | Severely Mounded |
| Wetland Polygon Classification | shrub stream fen/ collapse scar/ forest/ beaver | Soil Drainage | Poor |
| Site Classification | shrub-sedge stream fen | Flood Hazard | No Hazard |
| Latitude | 60°46' | | |
| Longitude | 135°00' | | |
| Elevation | 2300 ft. | | |
| Location | East of Long Lake Road | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TT | *Picea glauca* | 1 | GS | *Arctagrostis rubra* | 10 |
| LT | *Picea glauca* | 10 | | *Salix memb* | 1 |
| TS | *Picea glauca* | 1 | | | |
| | *Salix glauca* | 1 | FB | *Tofieldia pusilla* | 1 |
| MS | *Betula glandulosa* | 5 | GR | *Carex sp. 1* | 30 |
| | *Salix glauca* | 5 | | *Gramineae sp. 1* | 5 |
| LS | *Ledum groenlandicum* | 5 | LN | *Cladonia* | 1 |
| | *Potentilla fruticosa* | 5 | | | |
| | *Salix memb* | 15 | BR | *Bryophytes Total* | 70 |
| Frost Boils | | 15 | | | |
| Litter | < 2 cm | | | | |
| | > 2 cm | | | | |
| Water | | | | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | SS35 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 113 | Microtopography | Extremely Mounded |
| Wetland Polygon Classification | shrub stream fen/ collapse scar/ forest/ beaver | Soil Drainage | Imperfectly |
| Site Classification | collapse scar fen | Flood Hazard | Rare |
| Latitude | 60°46' | | |
| Longitude | 135°00' | | |
| Elevation | 2300 ft. | | |
| Location | East of Long Lake Road | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| FB | *Petasites sagittatus* | 35 | | | |
| TS | *Salix sp.* | 1 | | | |
| | | | BR | *Bryophytes Total* | 90 |

| | | |
|---|---|---|
| Frost Boils | | |
| Litter | < 2 cm | 05 |
| | > 2 cm | 10 |
| Water | | |

**SITE PROPERTIES**

| | | | |
|---|---|---|---|
| Site Number | SS62 | Site Position (Macro) | Plain |
| Wetland Polygon Number | 8 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge-willow channel fen/ beaver | Soil Drainage | Poor |
| Site Classification | sedge-willow channel fen/ beaver | Flood Hazard | Frequent & Irregular |
| Latitude | 60°37 | | |
| Longitude | 134°95 | | |
| Elevation | 2200 ft. | | |
| Location | East of Model Aircraft Site, South of Cowely Creek, East side of Hwy. | | |

**VEGETATIVE COVER**

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix glauca* | 5 | GR | *Carex aquatilis* | 10 |
| MS | *Salix glauca* | 5 | | | |
| LS | *Salix glauca* | 1 | | | |
| | | | BR | *Bryophytes Total* | 10 |

| | | |
|---|---|---|
| Frost Boils | | |
| Litter | < 2 cm | 80 |
| | > 2 cm | |
| Water | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS63 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 8 | Microtopography | Micromounded |
| Wetland Polygon Classification | sedge-willow channel fen/ beaver | Soil Drainage | Poor |
| Site Classification | sedge-willow channel fen/ beaver | Flood Hazard | Frequent & Irregular |
| Latitude | 60°37' | | |
| Longitude | 134°90' | | |
| Elevation | 2200 ft. | | |
| Location | East of Model Aircraft Site, South of Cowely Creek, East side of Hwy. | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| TS | *Salix sp.* | 1 | GR | *Carex aquatilis* | 5 |
| | | | | *Carex podocarp* | 30 |
| MS | *Salix sp* | 1 | | | |
| | | | BR | *Bryophytes Total* | 10 |
| Frost Boils | | | | | |
| Litter | < 2 cm | 90 | | | |
| | > 2 cm | | | | |
| Water | | | | | |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS65A | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 11 | Microtopography | Micromounded |
| Wetland Polygon Classification | graminoides, flloodplain/ marsh | Soil Drainage | Very Poorly |
| Site Classification | graminoides, flloodplain/ marsh | Flood Hazard | Frequent & Regular |
| Latitude | 60°38' | | |
| Longitude | 134°95' | | |
| Elevation | 2200 ft. | | |
| Location | Yukon River, East Bank opposite confluence with Wolf Creek | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| FB | *Epilobium sp.* | 1 | GR | *Alpoecurus aequalis* | 15 |
| | *Caryophyllaceae* | 50 | | *Poa pratensis* | 5 |
| | | | | *Gramineae* | 5 |
| | | | | *Carex podocarp* | 5 |
| | | | AL | *Algae sp.* | 5 |
| | | | BR | *Bryophytes Total* | 15 |

| | | |
|---|---|---|
| Frost Boils | | |
| Litter | < 2 cm | 10 |
| | > 2 cm | 10 |
| Water | | 1 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS65B | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 11 | Microtopography | Micromounded (frost boils) |
| Wetland Polygon Classification | graminoides flloodplain marsh | Soil Drainage | Very Poorly |
| Site Classification | graminoides flloodplain marsh | Flood Hazard | Frequent & Regular |
| Latitude | 60°38' | | |
| Longitude | 134°95' | | |
| Elevation | 2200 ft. | | |
| Location | Yukon River, East Bank opposite confluence with Wolf Creek | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| FB | *Potentilla sp.* | 5 | GR | *Alpoecurus aequalis* | 1 |
| | *Caryophyllaceae sp.* | 20 | | *Deschampsia caespitosa* | 1 |
| | *Ranunculaceae sp.* | 15 | | | |
| | *Aqua tufts sp.* | 1 | | | |
| | | | | *Carex podocarp* | 5 |
| | | | AL | *Algae sp.* | 5 |
| | | | BR | *Bryophytes Total* | 15 |

| | | |
|---|---|---|
| Litter | < 2 cm | 5 |
| | > 2 cm | 20 |
| Water | | 15 |

## SITE PROPERTIES

| | | | |
|---|---|---|---|
| Site Number | SS68 | Site Position (Macro) | Valley Floor |
| Wetland Polygon Number | 9 | Microtopography | Micromounded |
| Wetland Polygon Classification | shrub flloodplain swamp | Soil Drainage | Poor |
| Site Classification | shrub flloodplain swamp | Flood Hazard | Frequent & Regular |
| Latitude | 60°38' | | |
| Longitude | 134°95' | | |
| Elevation | 2200 ft. | | |
| Location | Yukon River, East Bank opposite confluence with Wolf Creek | | |

## VEGETATIVE COVER

| Strata | Species | Percent | Strata | Species | Percent |
|---|---|---|---|---|---|
| LT | Snag picea | 1 | FB | Stellaria crassifolias | 25 |
| TS | Snag picea | 1 | | | |
| | Salix glauca | 10 | GR | Carex rostrata | 1 |
| MS | Salix glauca | 5 | | Calamagrostis canadensis | 5 |
| LS | Salix glauca | 1 | | Deschampsia caespitosa | 1 |
| FB | Rumex arcticus | 1 | | | |
| | Epilobium ciliatum | 5 | | | |
| | Equisetum arvense | 1 | | | |
| | Chrysosplenium tetrandrum | 1 | BR | Bryophytes Total | 60 |

| | | |
|---|---|---|
| Litter | < 2 cm | 40 |
| | > 2 cm | 10 |
| Water | | |

# 11. Appendix Five Ceramic Clay Potential Data

## CHARACTERISTICS OF UNFIRED SAMPLES

| SAMPLE | DESCRIPTION | TEMPERING WATER (%) | PLASTICITY | WORK-ABILITY | DRYING PROPERTIES ROOM TEMP. | DRYING PROPERTIES 105 C | DRYING SHRINKAGE (%) 150 C |
|---|---|---|---|---|---|---|---|
| CC1 | Light olive gray (5 Y 6/1) | 23.36 | good | good | initially good - linear cracking appeared several days later | initially good - linear cracking appeared several days later | 05.80 |
| CC2 | Light olive gray (5 Y 6/1) | 20.50 | good | good | good | good | 04.90 |
| CC3 | Light olive gray (5 Y 6/1) | 20.33 | good | good | good | good - slight surface cracking along edges | 04.60 |
| CC6 | Light olive gray (5 Y 6/1) | 19.50 | good | good | good | good | 06.00 |

XRD SEMI-QUANTITATIVE CLAY MINERAL RESULTS

| SAMPLE | ILLITE | MONTMORILLONITE | CHLORITE | KAOLINITE | % SAND-SILT (>2u) | % CLAY (<2u) |
|---|---|---|---|---|---|---|
| CC1 | 40% | 0% | 10% | 50% | 33.6% | 66.4% |
| CC2 | 45% | 0% | 10% | 45% | 58.5% | 41.5% |
| CC3 | 45% | 5% | 10% | 40% | 54.9% | 45.1% |
| CC6 | 40% | 20% | 15% | 25% | 68.5% | 31.5% |

OTHER MINERALS PRESENT IN ALL FOUR SAMPLES:

Quartz
Plagioclase Feldspar
Calcite

## CHARACTERISTICS OF FIRED SAMPLES

| STEEL HARD COLOR | STEEL HARD TEMP. (C) | STEEL HARD ABSORPTION (%) | MAXIMUM FIRE COLOR | MAXIMUM FIRE TEMP. (C) | MAXIMUM FIRE ABSORPTION (%) | MAXIMUM FIRE SHRINKAGE (%) | REMARKS |
|---|---|---|---|---|---|---|---|
| Pale brown (5 YR 5/2) | 1080 | - | - | 1128+ | - | - | Maximum fire temp not reached. Severe cracks and curving upward in fired bars, white specks (lime) throughout. Calcite active flux material. Doubtful value. |
| Pale brown (5 YR 5/2) | 1102 | 0.20 | Pale brown (5 YR 5/2) | 1122 | 0.23 | 10.92 | Extremely short firing range (<25 C). White specks (lime) at hot end of bars. Calcite active flux material. Possible structural clay products if firing is accurate. |
| Light brown (5 YR 6/4) | 1101 | 2.55 | Pale brown (5 YR 5/2) | 1125 | 0.13 | 10.75 | Extremely short firing range (<25 C). White specks (lime) at hot end of bars. Calcite active flux material. Possible structural clay products if firing is accurate. |
| Pale brown (5 YR 5/2) | 1150 | 0.19 | Pale brown (5 YR 5/2) | 1125 | 0.63 | 8.16 | Maximum fire temp below steel hard. White specks (lime) throughout bars. Calcite active flux material. Doubtful value. |

Table 2 Criteria Used in Evaluating Selected Clay Products, from Scafe 1991

| | Face brick | Sewer pipe | Stoneware | Artware |
|---|---|---|---|---|
| Unfired Properties | | | | |
| Workability | good | good | good | good |
| % water of plasticity | 15-40 | 0-35 | not critical | not critic |
| Drying characteristics | no warping or cracking | no warping or cracking | no warping or cracking | no warpi or crackii |
| % drying shrinkage | 0-12 | 0-8 | 3-8 | 0-15 |
| Fired Properties | | | | |
| Maturing temperature (°C) | 980-1200 | 980-1150 | 1210-1330 | 980-1150 |
| Hardness | steel hard | steel hard | steel hard | steel harc |
| % Absorption (unglazed) | 0-15 | 0-8 | 0-2 | not critica |
| Color | reds, buffs, creams, etc. | reds, buffs | buffs, grays | variety |

*Maximum fire temperature:* temperature beyond which a body overfires (e.g. at which bloating or fusion will take place).

*Firing range:* is the temperature range between steel hard temperature and the maximum firing temperature. A range of $5^{o}$ C to $25^{o}$ C is considered an extremely short firing range, $30^{o}$ C to $50^{o}$ C is a short firing range and $55^{o}$ C to $100^{o}$ C is a moderate firing range.

*Maximum Fire Shrinkage:* during firing, porosity as measured by absorption gradually decreases and shrinkage increases. Firing is terminated when acceptable shrinking is attained.

*Comments or concerns:* any additional observations relevant to the clay behaviour (e.g. presence of lime specks) are included in these analytical tests.

### 3.2 Laboratory Results

The summary of the analyses for the samples which were shipped are shown on Tables 3 and 4 and the laboratory data are in Appendix 1. All the samples which were shipped for this study had a sufficient clay content, good plasticity and good workability. The main clay minerals which are present in the submitted samples include kaolinite, illite, chlorite and in one case, montmorillonite in a significant percentage. Other minerals such as quartz, plagioclase feldspar and calcite are also present in all samples (Table 3).

**Table 3 XRD SEMI QUANTITATIVE CLAY MINERAL RESULTS**

| SAMPLE | ILLITE % | MONTMOR. % | CHLORITE% | KAOLINITE% | SAND-SILT% | CLAY(<2U)% |
|---|---|---|---|---|---|---|
| CC1 | 40 | 0 | 10 | 50 | 33.6 | 66.4 |
| CC2 | 45 | 0 | 10 | 45 | 58.5 | 41.5 |
| CC3 | 45 | 5 | 10 | 40 | 54.9 | 45.1 |
| CC6 | 40 | 20 | 15 | 25 | 68.5 | 31.5 |

Table 4 CHARACTERISTICS OF UNFIRED SAMPLES

| Sample | Descrip. | Tempering Water % | Plasticity | Workability | Drying Prop. room T | Drying prop. 105C | Drying shrinkage %, 150C |
|---|---|---|---|---|---|---|---|
| CC1 | light olive gray 5Y6/1 | 23.36 | good | good | initially good, linear cracking appeared several days later | initially good, linear cracking appeared several days later | 05.80 |
| CC2 | light olive gray 5Y6/1 | 20.50 | good | good | good | good | 04.90 |
| CC3 | light olive gray 5Y6/1 | 20.33 | good | good | good | | 4.60 |
| CC6 | light olive gray 5Y6/1 | 19.50 | good | good | good | good | 6.00 |

Table 5 CHARACTERISTICS OF FIRED SAMPLES

| Sample | Steel Hard Color | Steel Hard Absorp .% | Steel Hard Temp. % | Max. Fire Color | Max. Fire Temp. | Max. Fire Absorp. % | Max. Fire Shrink. % | REMARKS |
|---|---|---|---|---|---|---|---|---|
| CC1 | Pale Brown, 5YR5/2 | 1080 | - | - | 1128+ | - | - | Max. fire Temp. not reached. Severe cracks and curving upwards in fired bars, white specks(lime) throughout. Calcite active flux material. Doubtful value |
| CC2 | Pale Brown, 5YR5/2 | 1102 | 0.20 | Pale Brown, 5YR5/2 | 1122 | 0.23 | 10.92 | Extremely short firing range (<25C).Calcite active flux material. White specks (lime) at hot end of bars. Possible structural clay products if firng is accurate. |
| CC3 | Light Brown, 5YR6/4 | 1101 | 2.55 | Pale Brown, 5YR5/2 | 1125 | .13 | 10.75 | Extremely short firing range (<25C).Calcite active flux material. White specks (lime) at hot end of bars. Possible structural clay products if firing is accurate. |
| CC6 | Pale Brown, 5YR5/2 | 1150 | 0.19 | Pale Brown, 5YR5/2 | 1125 | 0.63 | 8.16 | Max. fire temp. below steel hard. White specks (lime) in bars. Calcite active flux material. Doubtful value |