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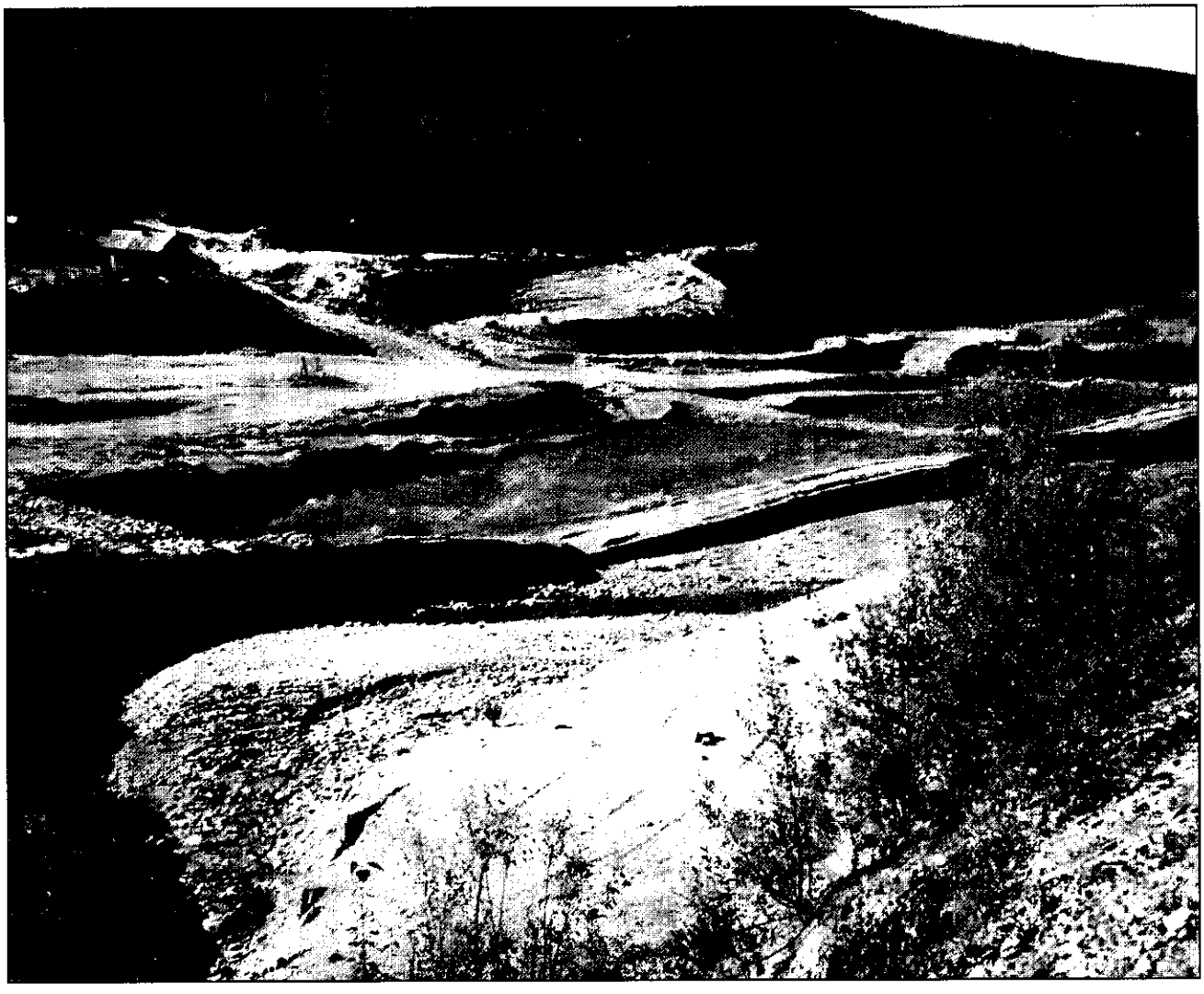
NATURAL LAND RECLAMATION

FOR MINERAL EXPLORATION PROPERTIES AND PLACER MINES IN YUKON



by
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Mougeot GeoAnalysis

for
Exploration & Geological Services Division
Mineral Resources Directorate

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Canada

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SUMMARY

The Canadian Environmental Assessment Act legislates that development activities requiring federal permits be assessed through environmental screening, and environmental impacts mitigated with existing technology. The implementation of Mining Land Use Regulations on mineral claims in Yukon will require routine environmental impact assessment within a permitting system. A database of known environmental impacts related to mineral exploration and placer mining will thus make the screening process more efficient. This particular project focuses on three different mining districts of Yukon, and provides information on soil, overburden, vegetation, slope stability and permafrost conditions on disturbed and undisturbed surfaces related to mineral exploration and placer mining.

Disturbances included in this study consist of trenches (dating from 1912 to 1993), drill pads (dating from 1967 to 1993), ripped and compacted surfaces associated with roads and camps, and placer mine highwalls and tailings piles (dating from 1911 to 1993). Observations include detailed vegetation description (tree, tall shrubs, low shrub, dwarf shrub, herb, graminoid, and mosses and lichens layers), soil texture and basic chemistry, slope, height, width and age of the trenches, elevation, aspect and latitude of the site, and description of any active processes such as slope erosion, permafrost degradation, failure, sheet erosion and gullying.

The preferred sites and rates of natural revegetation by pioneer species were related to disturbance characteristics, such as trench orientation, surface compaction, and presence or absence of permafrost. Recommendations on site abandonment and treatment were formulated using analysis of the above data. Factors most important to the natural revegetation of sites were identified as elevation (alpine versus subalpine), at least 20 centimetres of soil with at least 20% fine-grained matrix, and stable slopes with angles of 45 degrees or less. Trench design, mixture of organic matter with the surface material, aspect and slope position of the disturbance are significant factors, but of lesser importance. Placer mined sites located in fine-grained, organic- and ice-rich sites were found to reclaim both cuts and tailings successfully within five to ten years.

The least intrusive approach to site reclamation is to abandon disturbances in a state such that natural colonization could take place within a few years, and the site re-integrated to its ecosystem within a reasonable period of time. However, in some cases, slopes will not reach stable profile without the help of surface vegetation. More aggressive revegetation procedures may then be required (contouring and/or seeding), especially when dealing with high alpine sites. A revegetation strategy should take into consideration the local ecosystem and plant succession. Species imported to the area should facilitate, not eliminate, the re-entry of local pioneer forb, grass and shrubs species. A program designed to test the optimum conditions for site abandonment could provide further information on physical requirement for physical design of abandoned features and possible seed/fertilizer mixtures in alpine and subalpine areas.

RÉSUMÉ

La Loi canadienne sur l'évaluation environnementale prescrit que les activités d'exploitation exigeant un permis fédéral fassent l'objet d'une évaluation environnementale préalable et que les effets environnementaux soient atténués à l'aide de la technologie existante. La mise en oeuvre du Projet de *Règlement sur l'utilisation des terres minières* pour les claims miniers au Yukon exigera une évaluation environnementale normale dans le cadre d'un système d'attribution de permis. Une base de données sur les effets environnementaux connus liés à l'exploration minérale et à l'exploitation des placers rendra donc le processus d'évaluation préalable plus efficace. Le présent projet porte sur trois différents districts miniers du Yukon et fournit des données sur le sol, le mort-terrain, la végétation, la stabilité des pentes et les conditions du pergélisol sur les surfaces perturbées et non perturbées en rapport avec l'exploration minérale et l'exploitation des placers.

Les perturbations considérées dans la présente étude sont des tranchées (datant de 1912 à 1993), des aires de forage (datant de 1967 à 1993), des surfaces défoncées et compactées associées à des routes et des campements, ainsi que des murs d'appui et des tas de résidus liés à l'exploitation des placers (datant de 1911 à 1993). Les observations comprennent une description détaillée de la végétation (arbres, arbrisseaux, arbustes, arbustes nains, plantes herbacées, graminoïdes, ainsi que couches de mousses et de lichens), de la texture et des principales propriétés chimiques du sol, de la pente, de la hauteur, de la largeur et de l'âge des tranchées, de l'altitude, de l'orientation et de la latitude du site, et une description de tout processus actif comme l'érosion des pentes, la régression du pergélisol, les ruptures, l'érosion en nappes et le ravinement.

Le taux de reverdissement naturel par les espèces pionnières et les endroits où ce reverdissement est susceptible de s'effectuer de préférence ont été liés aux caractéristiques des perturbations subies, telle l'orientation des tranchées, le degré de compaction des surfaces et la présence ou l'absence de pergélisol. Les recommandations concernant l'abandon et le traitement des sites ont été formulées après analyse des données susmentionnées. Les facteurs les plus importants pour le reverdissement naturel étaient l'altitude (zone alpine ou subalpine), la présence d'au moins 20 centimètres de sol dont au moins 20 % doit être constitué de matériaux fins, ainsi que des pentes stables de 45 degrés ou moins. La manière dont les tranchées ont été creusées, la présence de matières organiques dans les matériaux de surface, l'orientation et la position de la pente de la zone perturbée sont des facteurs dont il faut tenir compte, mais dont l'importance est moindre. On a observé que les zones de déblais et de résidus des placers, où le sol est de texture fine, riche en matières organiques et en glace, se recouvraient de végétation en moins de cinq à dix ans.

L'approche de remise en état des sites la moins interventionniste consiste à abandonner les zones perturbées dans un état tel que la colonisation naturelle puisse se faire en quelques années et que le site réintègre l'écosystème dans un délai raisonnable. Dans certains cas, toutefois, les pentes ne recouvreront pas leur stabilité sans le concours d'une végétation de surface. Il faudra peut-être avoir recours à des approches plus énergiques de reverdissement (terrassement et/ou ensemencement), surtout dans les zones alpines élevées. Une telle stratégie devrait prendre en compte l'écosystème local et la succession végétale. Les espèces importées devraient faciliter, et non éliminer, la réimplantation des espèces locales de plantes herbacées dicotylédones, de graminées et d'arbustes. Un programme conçu pour mettre à l'épreuve les conditions optimales d'abandon des sites devrait fournir de plus amples données sur les exigences physiques des sites abandonnés et sur l'utilisation éventuelle de semences ou d'engrais dans les zones alpines et subalpines.

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CHAPTER ONE

INTRODUCTION

The Canadian Environmental Assessment Act (CEAA) legislates that development activities requiring federal permits be assessed through environmental screening, and environmental impacts mitigated with existing technology. The implementation of Mining Land Use Regulations (MLUR) on mineral claims will require routine environmental assessment within a permitting system. A database of known environmental impacts related to mining exploration should make the screening process more efficient. This particular project focuses on hard rock mineral exploration and placer mining in three different areas of the Yukon Territory and will provide useful baseline information on both disturbed and undisturbed sites. This is meant to assist government in formulating reclamation objectives.

Mine site reclamation requirements have been developed in most Canadian jurisdictions and are presently being formulated in Yukon. Most hard rock mining operations include large pits, waste dumps, tailings impoundments, and associated buildings such as camps, equipment maintenance shops, storage facilities for fuel and other chemical substances. Reclamation regulations of such operations must therefore plan for disposal of mine waste and stored chemical substances, with possible impact on local drainage and ground water, as well as disturbance of the land, slope and original vegetation communities, and impact on wildlife due to increased access. Mineral exploration activities are usually less intense than production activities in terms of environmental impact. Examples of these activities include limited road development, semi-permanent to temporary camps, trenches, drill pads, backhoe pits and stripped areas.

Terrestrial reclamation associated with mineral exploration activities has not yet been studied in a consistent manner in Yukon. A brief study done in the Mt. Nansen area in 1993 was carried out by EBA Engineering Consultants, Mougeot GeoAnalysis and Steffen, Roberston and Kirsten (Canada) Inc. Their recommendations included a list of factors which should be described in the field before developing reclamation techniques, these factors are included in this study. The most comprehensive reclamation study in placer mined areas was done by Brady (1984) which demonstrated that rehabilitation objectives can be clearly defined with an understanding of the natural recovery processes. Furthermore, Brady's work shows that optimum reclamation of placer mined sites is possible under a set of specific conditions (e.g. slope, moisture holding capacity, grain-size of substrate, natural seed sources and micro-climate) such that preparation work on disturbed sites (e.g. contouring, fertilizing programs and re-seeding) is kept to a minimum.

Geotechnical information on slope stability, soil erosion and revegetation for hard rock mineral exploration in Yukon is limited. The removal of surface vegetation in sub-alpine and alpine terrain can result in surface run-off, accelerated soil erosion, degradation of permafrost, and reactivation of slope processes, such as creep, solifluction and detachment failures. All of these anthropogenic disturbances could be reduced through the revegetation of disturbed areas. Reclamation guidelines in British Columbia deal with three basic aspects which include slope stability, revegetation to slow down or stop soil erosion, and the re-establishment of drainage systems. These major components are considered crucial for reclamation in Yukon. The northern environment requires that in addition permafrost, natural vegetation, natural seed sources, etc. be addressed. This project presents data on the geotechnical and pedologic properties of natural and disturbed surfaces, natural vegetation communities and local drainage conditions, such as seepage areas, areas of run-off and other site drainage conditions.

OBJECTIVES

The original objectives of the study were to "provide insight into the geotechnical and geological characteristics of surficial deposits which have been impacted by exploration and mining activities." The scientific authority and the Mougeot GeoAnalysis team redefined the objectives in the field to include a broader data collection, in order to provide a basis for future studies dealing with the rehabilitation of disturbed sites under a variety of ecological conditions in Yukon. The redefined objectives are:

1. collect data relevant to natural revegetation, slope stabilization and processes in abandoned, unreclaimed exploration and placer disturbances;

2. summarize these data as they relate to definite parameters, such as disturbance type, slope position, overburden matrix,

climatic zone, aspect, elevation, and age of disturbances;

3. formulate general relationships between rates of revegetation success, slope stability and physical characteristics of the disturbances;

4. formulate general guidelines or suggest abandonment techniques using the above observations in order to create optimum conditions to facilitate natural vegetation for reclamation of placer and hard rock exploration.

PRODUCTS

This report includes chapters with descriptions of all trenches, drill pads and other disturbances visited during the field season. The interpretation of this data is the basis for recommendations of reclamation strategies presented in the last two chapters which also include an outline of reclamation trial plots to test the recommendations. A collection of photographs taken in the field is included in Appendix One. Two maps were drafted on 1:30,000 scale base maps for each of the three areas: 1. a map of anthropogenic features, such as roads, camp sites, trenches, stripped or excavated areas, as available from air photos and assessment reports, with field observation sites; and, 2. a surficial geology map of the properties visited. Appendix Four contains vegetation descriptions of all field sites. Natural vegetation and colonizing vegetation communities are described in terms of ground coverage and species, and trees are subdivided into shrubs, saplings, small trees and mature trees (to characterize the site's regeneration).

METHODOLOGY & BACKGROUND MATERIAL

RESEARCH

The terms of reference identified three general areas and several possible properties for study. The site selection was narrowed down after inspection of air photos at the 1:60,000 and 1:80,000 scale. This preliminary air photo interpretation provided general information about the kinds of features and the surficial deposits in these areas. Assessment reports were provided by Mineral Resources, Indian and Northern Affairs Canada. These reports and appropriate Yukon Minfile sections provided the research team with an exploration history for each of these properties, and hence a range of dated features and field targets.

SITE SELECTION

The original site selection was done by D. Emond and was refined in the field by a team comprising D. Emond, C. Mougeot, N. Steffen and R. Mueller. Properties from three historic mining regions were selected, to provide data from different climatic zones, bedrock types and vegetation community types (Figure 1). The Klondike area was represented by the Lone Star property located on Bonanza Creek between O'Neil and Victoria Gulches, as well as placer mines on the Eldorado and Bonanza drainage basins. Data collected in the Klondike area spans a period from 1912 to 1993. The Dawson Range in central Yukon was represented by the Nucleus and Revenue properties. These properties are located on Big Creek, by Mechanic and Revenue Creeks, and are roughly 80 km west of Carmacks. A placer mine located on Revenue Creek was also examined. Data collected in this area dated from 1968 to 1992. The Wheaton River area in southern Yukon was represented by the Red Ridge and Idaho Hill properties. These properties are located west of Annie Lake, roughly 40 km south of Whitehorse, with disturbances dating only from 1988 in the case of the Red Ridge property. There are no active placer operations in this area, thus the data only relates to hard rock exploration.

FIELD WORK

The field crew was in the Klondike area from August 30 to September 6, 1994, the Carmacks area on September 8 and from September 11 to 17, and the Annie lake area from September 19 to 23. Field work was completed prior to the first heavy snowfall at high elevation. The crew was composed of C. Mougeot (project manager, geologist and geomorphologist), N. Steffen (soil surveyor), R. Mueller (plant taxonomist) and M. King (geotechnical technician, J.R. Paine and Associates Ltd.). H. Jeong (soil surveyor) joined the team at the Carmacks and Annie Lake locations. D. Emond was present during all site selection visits as well as during the entire duration of field work in the Klondike area, to guide discussions and to familiarize herself with field procedures. Most features were assigned to a particular exploration program and dated with the help of assessment reports and a company geologist. Sampling strategy aimed at collecting data covering a variety of ages, overburden and bedrock types, slopes, exposures, elevations and exploration disturbances. Hard rock exploration features varied according to the target; in most cases, several trenches and drill pads were investigated, as well as stripped areas. Abandoned cuts and tailing piles were investigated at placer mines and in some cases, one to three year old settling pond surfaces were included.

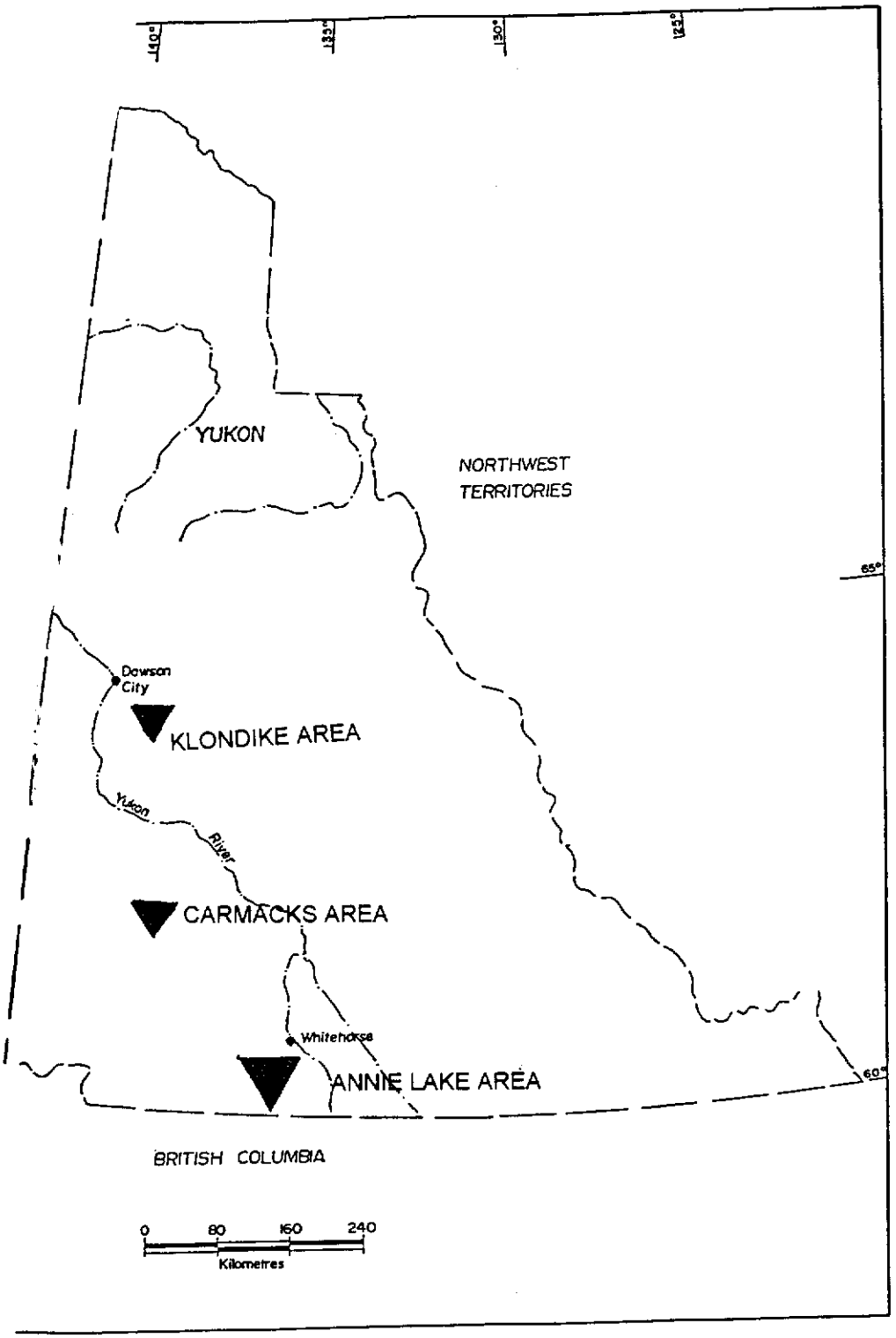

Figure One Location Map

Klondike Area:	Lone Star property and placer mines.
Carmacks area:	Nucleus and Revenue properties, and placer mine.
Annie Lake area:	Red Ridge and Idaho Hill properties.

Site data is presented in the following format. A general description of each property is given as well as information on the exploration history, tectonic terrane, general geology of the area, general description of glacial history and landforms and expected terrain hazards. General climatic data for each area is provied, using the closest weather collecting base is Atmospheric Services, Environment Canada.

The following observations were collected.

Site Description

Undisturbed sites were selected in close proximity to the trench or cut.

Disturbed site description include:

1. disturbance morphology, such as wall height and slope, general orientation and orientation relevant to the natural slope,
2. signs of slope instability such as slumping, overhang of organic material, separation crack, or other erosion processes such as slope wash, gullying, permafrost degradation, etc.

Soil/Surficial Geology

1. Soil association/classification, presence and thickness of organic material, moisture holding capacity, site drainage, soil and subsoil texture; all properties are described according to Agriculture Canada guidelines.

2. Presence/absence of permafrost, depth, etc.

3. Parent material properties such as texture, stoniness, rockiness.

4. Active/inactive processes (in addition to permafrost related processes) such as slope erosion, gullying, slope wash, flooding, etc.

5. Soil samples were collected at all sites.

Site Hydrology

1. Surface and subsurface drainage conditions, seepage, proximity to stream, etc.

Vegetation

1. Total vegetation cover for the various trenches is qualified as very sparse (less than 5% of vegetation coverage), sparse (less than 10%), moderately revegetated (between 10 and 50%), densely (50 to 70%), very densely (70 to 90%), or completely revegetated (90 to 100%). A representative area (approximately 10 by 10 metres square) was selected for each site and a vegetation survey conducted within the area's perimeter. Vegetation data is recorded in seven layers. Each layer is considered separately, each with a potential for 100% coverage. It is therefore possible to have a total of 700% coverage for all seven layers combined. This method of surveying vegetation is used in most cases when plant survey information other than productive forest information is required. It allows the plant ecologist to visualize the various types of vegetation making up the canopy, as well as the understory, and of particular interest to this study, the ground cover species and shrubs, as well as trees regeneration. Plant species percentages mentioned in this report refers to the percentage of a particular layer occupied by that species within the selected representative area. All vegetation survey data for each site is presented in Appendix 3.

2. Vegetation plots are usually done within a 10 m^2 area. Due to the odd shape of some of our sites, this was rarely possible and areas of similar surfaces were estimated in the field. R. Mueller did all the vegetation survey and therefore, the percentage estimates and surface coverage were consistently evaluated by the same person. R. Mueller has rated his possible margin of error to less than 5% when dealing within total ground cover. Some small young mosses and grass species could not be identified.

3. Layers are as follows.
   Tree Layer: tree species are considered trees if they reach a height of five metres or more, and have a DBH (diameter at breast height) of seven centimetres or more.
   Tall Shrub Layer: consists of any plant species which does not fit into the tree classification, and is taller than two metres.
   Low Shrub Layer: includes plants other than graminoids, lichens and mosses which are shorter than 2 m and taller than 0.5 m.
   Dwarf shrub layer: consists of plants, other than graminoids, mosses and lichens which are shorter than 0.5 m.
   Herb or forb layer: describes all plants which are not tree species, shrubs, graminoids, lichens or mosses.
   Graminoid layer: includes all grasses and sedges.
   Mosses and lichen layer is the closest to the ground.

POST FIELD WORK

Soil samples were collected at all sites. Selected samples were analysed for soil fertility and plant nutrients. PH values and grain-size determination were done on 80% of samples collected. This information is presented in Appendix 4. The location of all sites was drafted on updated anthropogenic and surficial geology maps.

Geotechnical, geological and vegetation data are integrated, and the observations are categorized per disturbance type. Hard rock exploration sites are described in Chapter 2, 3 and 4 and placer mine observations presented in Chapter 5. Bedrock and surface geology, and climate is provided for each general area, and mining and exploration history is outlined for each hard rock property. Soil, slope and vegetation parameters are summarized for trenches, drill pads and other disturbances of similar age, starting with the most recent to the oldest. An example of a site description for a disturbance dating from 1988 is included for each area to facilitate comparison between revegetation and slope processes that have taken place during the last 6 years in the three mining districts. Comments on undisturbed and disturbed conditions include a general description of the features, active slope or other erosion processes, soil properties, vegetation cover and species present at the site. All plates are presented in Appendix 1. Complete site descriptions can be found in Appendix 2 under the coded site name (always typed in bold in the text) and site locations are marked on the anthropogenic feature maps. Detailed vegetation species and coverage percentages are in Appendix 3 and soil analysis results are listed in Appendix 4. A summary of observations for each disturbance type is presented at the end of each chapter.

Recommendations for the abandonment of disturbance types derived from these observations are presented in Chapter 6. An overview of a study designed to test these recommendations is given in Chapter 7. Research into compatible agronomic and native seed stock was conducted by M. E. Jarvis (reclamation technician).

CHAPTER TWO

HARD ROCK EXPLORATION DISTURBANCES KLONDIKE AREA

INTRODUCTION

The Klondike area has been a mining target for the last 120 years. Gold placer mining, as well as hard rock exploration have been an integral part of the area's development. The Lone Star property and placer mines along the Eldorado and Bonanza Creeks were selected as part of this project. The Lone Star Property is approximately 22 km southeast of Dawson City and is accessible by a road forking off the Bonanza Ceek Road. A 4 wheel drive vehicle was used to access the property, as well as foot traverses. The elevation ranges between 450 m and 1775 m. Kennecott Canada Inc. has been exploring the property for several years. A Kennecott geologist spent a few hours on the ground with the team, helping determine the dates of numerous trenches and roads.

The Lone Star property has long history of mining and exploration: several surface features date from the early 1910's and ongoing exploration programs provide recently disturbed surfaces. A small building dating from at least 1911 is still being used as temporary camp. The two adits are still visible, although heavily slumped over (Plate 2-1). Several trenches, dating from 1911 to 1990, and drill pads from 1987 to 1993 were examined, and one large stripped shallow pit. A total of 44 sites were investigated at the Lone Star property (Figure 2).

CLIMATE

The climate is sub-arctic continental, relatively dry with major temperature variability on both a daily and seasonal basis. Mean annual precipitation is about 325 mm, slightly more at higher elevations. Temperatures are extreme, with January means near -30^0 C and July means near 16 C. Mean annual temperature is about -5^0 C. Mean temperatures during growth season (May to June) are approximately 11^0 C and average precipitation for the same period is 140 mm. This data is from the Dawson City airport weather station, located at an elevation of 324 m (Oswald and Senyk, 1977). Weather conditions at the Lone Star property can be expected to be different, the precipitation being slightly higher and daily temperature range to be slightly greater.

GEOLOGY

The Lone Star Property is located in the heart of the Klondike placer mining area. It is within the allochothonous and geologically complex crystalline belt known as the Yukon-Tanana Terrane, and is south and west of the major structural break, the Tintina Fault.

The rocks of the region are primarily quartz and feldspar schists with varying amounts of muscovite and hornblende. Minor lenses of carbonaceous quartzites and marbles, and chlorite, actinolite and amphibole schists occur within the assemblage. Some foliated intrusive rocks also occur in the area. The schists and the igneous rocks are all thought to be Triassic and/or older. Younger (Late Cretaceous to Early Tertiary) dykes and volcanic rocks which are predominantly felsic porphyries and tuffs crosscut the older rocks in narrow, north-trending bodies.

Mineralization occurs within Klondike augen schist which is mylonitized and foliated. Shearing is though to have occurred in the Permo-Triassic. There has been significant later thrust and crosscutting normal faulting, some of which is related to movement along the Tintina Fault. Rocks are also strongly deformed into northwest-trending, tight to isoclinal folds which are overturned to the northeast.

SURFICIAL GEOLOGY

The properties visited in the Klondike area are located in the unglaciated portion of the Western Yukon Plateau. Smooth rounded summits (such as the one on which the Lone Star property sits) and valleys formed during late Tertiary time as a mature landscape with a well developed system of streams which drained in a southerly direction. After a period of tectonic stability (e.g. inactive faults), uplift occurred (e.g. upward movement in the crust) which continued into the Quaternary time period (Templeman-Kluit, 1980). Drainage systems became entrenched, and with the onset of Quaternary glaciations, drainage reversals in a northerly direction occurred throughout central Yukon (Templeman-Kluit, 1980).

At elevations above stream deposits, such as the Lone Star property (Figure 3), the surficial geology consists mainly of colluvial blankets and residual bedrock. The colluvial material is a very angular,

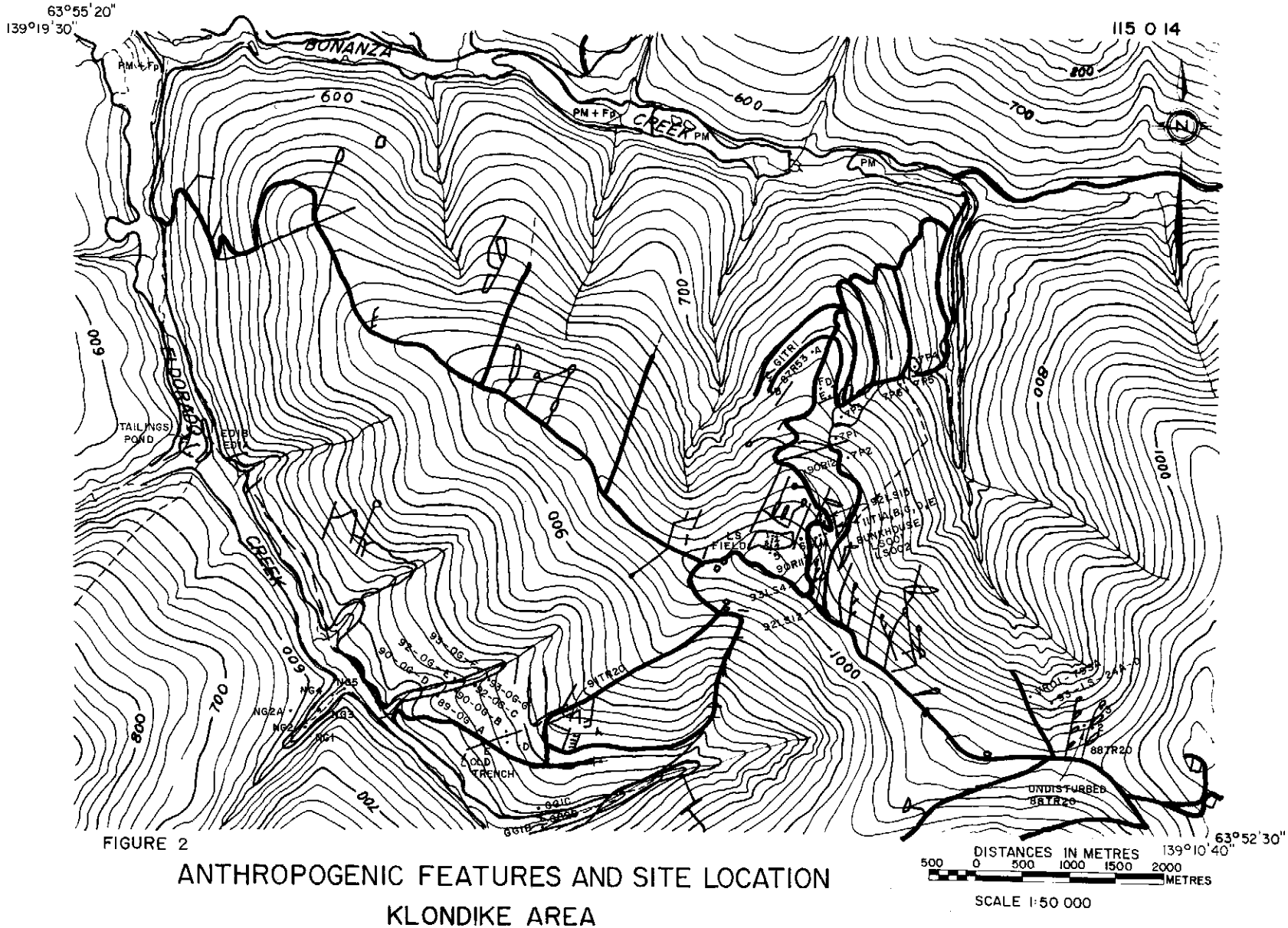

FIGURE 2

ANTHROPOGENIC FEATURES AND SITE LOCATION
KLONDIKE AREA

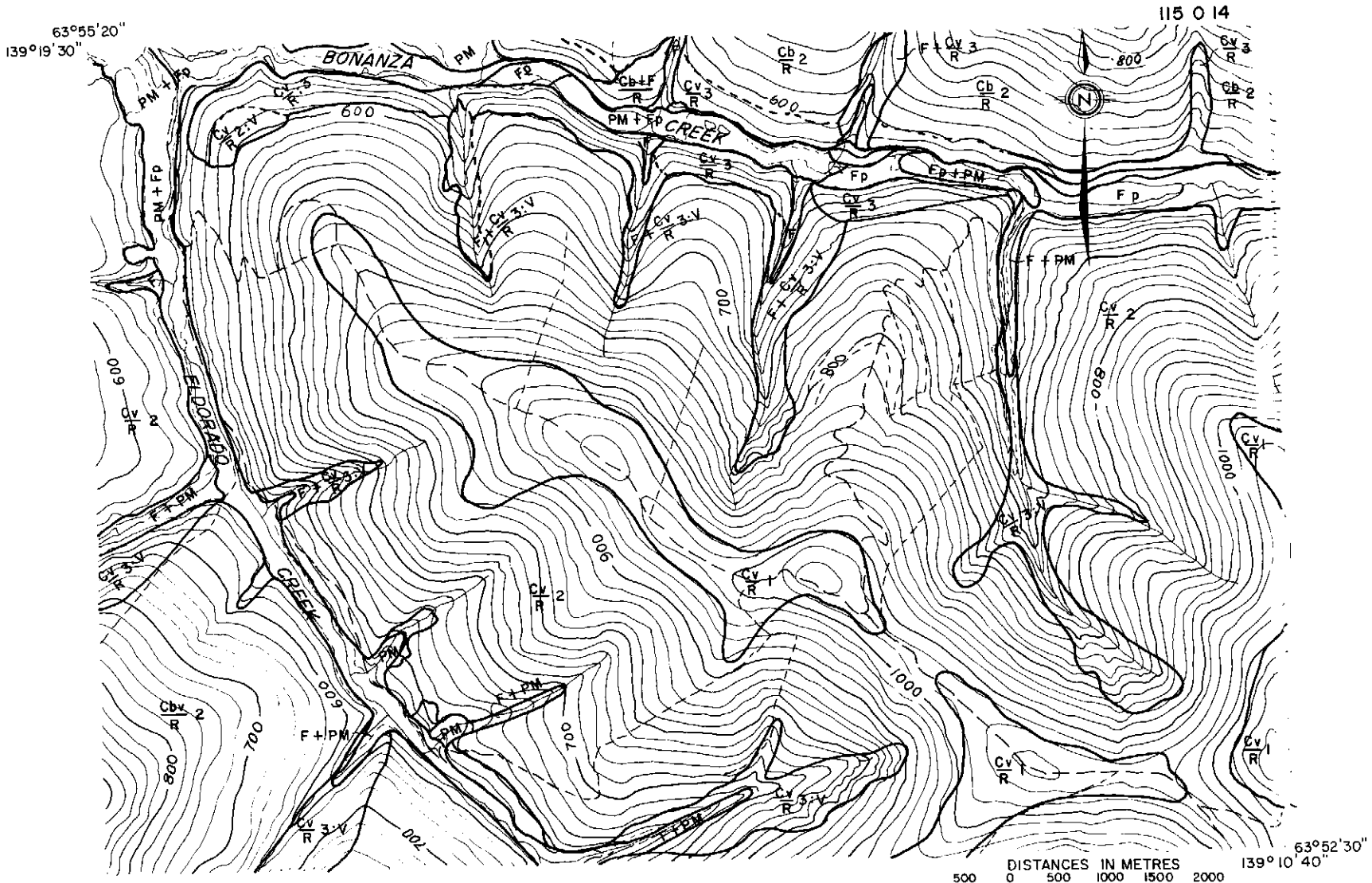

FIGURE 3

SURFICIAL GEOLOGY – KLONDIKE

coarse gravel composed of fragments of the local schist, and quartz cobbles. The matrix is a micaceous silt loam to loamy sand, and coarse fragment content varies from 40 to 80% in undisturbed sites.

Alluvial environments include:

1. glaciofluvial sand and gravel termed the "Klondike Gravel" which is pre-Reid in age;

2. White Channel sediments which stratigraphically underlie the Klondike Gravel, and are thought to be late Pliocene to early Pleistocene in age;

3. mid to lower slope terrace features which contain fluvial gravel, sand, and black muck; and,

4. valley bottom fluvial deposits (Morison, 1987). All of these alluvial settings contain placer gold with the exception of the Klondike Gravel. Several placer mines visited during this program (Oro Grande and Nugget Gulches) are excavated in ice-rich, organic rich, silty alluvial deposits. One placer site (Discovery Claim) is located on a bedrock bench which probably supported White Channel Gravel. The 7Pup mining operation is partially reworking old tailings and partially working alluvial terraces. Due to time constraints and restricted geographical targets, no other placer settings were visited.

Permafrost conditions in the area represent the most widespread geological process. Apart from the large serpentinite rock slide off the Dome, behind Dawson City, no other references to large rock slides have been found in that general area. Permafrost, present at mid to high elevations, can be associated with processes such as solifluction, soil creep, nivation and cryoturbation. Fine-grained sediments in the valley bottoms are likely to be underlain by permafrost with a high ice content which may thermokarst if disturbed.

MINERAL EXPLORATION HISTORY

Claims were first staked on the Lone Star property in 1897, at the height of the Klondike Gold Rush. By 1903 both an adit and a shaft had been dug on the property. In 1909, construction of a tramway to transport ore and a stamp mill were started. Mining by open cut methods was initiated. In the period from 1912 to 1914, 7650 tonnes with an average grade of just under 5 g/t gold were mined.

Exploration activity on the property has been undertaken every few years, by a variety of different owners. This has included several projects of excavating shafts, adits and raises; diamond drilling; churn drilling; trenching; geochemical surveys; geological mapping; and VLF, EM, magnetometer, IP, and airborne mag and EM surveys. Most recently, Kennecott Canada Inc. optioned the property and undertook a reverse circulation drilling program which yielded interesting results. An airborne magnetometer survey and ground geophysics (E-Scan survey) added to the knowledge of the local geology and outlined drill targets.

The Boulder Lode which was mined in the early 1900's is one of a series of discordant quartz-pyrite veins and stringers in the hanging wall of a thrust fault. Visible gold generally occurs along the vein margins and in narrow pyrite veinlets, however, the gold is erratically distributed. Gold values have also been encountered in sulphide pockets which were not mined during the earlier activities. A Permian lead isotopic age obtained from a sample from Lone Star property, implies that mineralization is probably syngenetic, or of the same age and origin as the enclosing schists.

Drilling of the Buckland Zone intersected 4.7 m grading 4.6 g/t gold. Recent reverse circulation drilling encountered grades of better than 1.5 g/t over 1.5 m in 12 of 20 drill holes. High grade sections up to 10.76 g/t over 4.6 m were also found. Diamond drilling has intersected abundant hydrothermal alteration, but low gold values.

Recent exploration has outlined an oxidized zone beneath the old workings which may be mineable by bulk tonnage methods and with the use of modern heap leach technologies.

LONE STAR PROPERTY

UNDISTURBED SOIL AND VEGETATION CONDITIONS

(Sites LSU, 93LS24-D (Plate 2-2), 61TR1-F, 88TR20-U (Plate 2-3), LSD7, LSFIELD-5, LS4)

The natural conditions on the Lone Star property vary slightly with elevation and aspect. The two dominant environments are described here. Additional undisturbed sites were selected at the suggestion of the plant taxonomist and are described in Appendix 2.

Both the morphology and vegetation of undisturbed site **LS3 U** are considered representative for a large portion of the property, and consist of open forest growing on thin colluvium, or residual bedrock. The black spruce, willow and feather moss forest has a stable surface, a soil showing development of an eluviated horizon, and a thin organic mat covered by well-structured and well-developed vegetation typical of alpine boreal environment.

Located approximately 75 m downhill from the old bunk house (Figure 2), LS3U is on an east facing slope of 15 degrees, at an elevation of 970 m. The soil is a well- to moderately well-drained Eluviated Eutric Brunisol (a mildly weathered forest soil showing signs of clay displacement downwards) developing in weathered/altered bedrock. The organic mat is 14 cm thick, and the mineral soil (pH 4.6) is a loamy sand to sandy loam with 60% coarse fragments (gravel to stones). The bedrock at this site is a muscovite quartz schist, friable and highly fractured. The top surface (30 to 50 cm) of the schist is weathered with coarse, very angular to channery gravel in a loamy matrix.

Vegetation entirely covers the surface and no large outcrops are visible. The black spruce (*Picea mariana*) trees are small. Typical tree trunk diameter at breast height (DBH) range from 9 to 14 cm, and tree heights average 10 m. Black spruce is found minimally in the dense tall shrub layer which is dominated by willow (*Salix spp*). The low shrub layer is well (50%) developed and evenly represented by four species: Alder (*Alnus crispa*, 15%), Labrador tea (*Ledum groenlandicum*, 20%), blueberry (*Vaccinium uliginosum*, 15%), and spirea (*Spiraea* spp, 5%). Two dwarf shrubs, low bush cranberry (*Vaccinium vitis idaea*, 25%), and crowberry (*Empetrum nigrum*, 15%) complete the shrub component. Forb coverage is low (less than 15%) and is composed of three species: Bunchberry (*Cornus canadensis*, 10%), bastard toadflax (*Geocaulon lividum*, 2%) and horsetail (*Equisitum sp*, 2%). The forest floor is dominated (more than 80%) by a common moss (*Hylocomnium splendens*). Three more mosses combine for another 8% coverage, including a tiny showing of brown sphagnum. Three lichens, have a small showing at 15%, with the dominating species being *Cladina mitis* (10%).

The next dominant environment is well represented by site **93LS24D** (Plate 2-2). This site is a typical black spruce/moss/shrub subalpine forest developed on a colluviated hillside underlain by permafrost. The trees are leaning in several directions which suggests slow soil creep. Located on a west facing hillside, this site is at an elevation of 950m and on a slope of 12 degrees. The soil consists of an imperfectly drained Static Orthic Cryosol (frozen soil) with significant seepage. The hummocky, frost heaved surface shows fractures partially filled with water. The organic mat is 30 cm thick and the mineral soil is a gravelly sandy loam with 40% coarse fragments and pH values around 5.4. Permafrost was encountered at a depth of 34 cm with 80 to 90% ice crystals by volume. Few, micro to fine roots reached up to 47 cm deep, where the permafrost is a root restricting layer.

This plot is very densely vegetated. Although black spruce covers 50% of the tall shrub layer, very few individual specimens can be considered trees (>5 m tall, DBH >7 cm) by height alone. The majority of this species is between 0.3 m and 5 m tall, and some have a DBH of 9 cm. The dense shrub layer is represented by four species: Dwarf birch (*Betula glandulosa*) and labrador tea each cover 25%; blueberry covers 15%; and willow adds 2%. The dwarf shrub layer is represented by low-bush cranberry and crowberry each at 20%, as well as cloudberry (*Rubus chamaemorus*) at 15%. The forb layer is very sparsely represented by coltsfoot (*Petasites frigidus*, 5%). The very sparse graminoid layer is made up of one grass (*Calamagrostis* sp), and a sedge (*Carex* sp). The dense moss layer is well represented by four species, including spagnum (20%), and dominated by *Hylocomnium splendens* (30%). Five lichen species, combine for 50% coverage of that layer.

Aspect and elevations differences result in variation in the natural vegetation cover. For example, the area surrounding trench 88TR20 (Plate 2-3), with a NNE aspect and approximate elevation of 1020 m is an open subalpine black spruce forest with substantial shrub birch and blueberry components. The other side of the ridge, with a SW aspect, is characterized by a much denser black spruce cover augmented by Labrador tea and low bush cranberry. However, this side of the hill displayed a greater variety of vegetation communities with patches of open aspen forest found at all elevations.

TRENCHES

General Trench Description

Trenches of various ages were observed on the Lone Star property, as recent as 1993, and as old as 1911 (Plate 2-4). Most trenches were excavated into a friable muscovite schist which is locally altered and weathers rapidly. The schist is commonly covered by 1 to 2 m of colluvium, mainly a micaceous sandy to loamy sandy gravel, with 40% coarse fragments. The trenches vary in width, depth and orientation. The material in the trenches is a mixture of excavated and slumped material, and generally consists of a gravel with loamy sand to sandy loam matrix, with a higher coarse fragments contents, ranging from 60 to 90 %. The angular gravel is composed of local bedrock fragments. The matrix and moisture content is critical to this study, as the matrix forms the seed bed for most sites; textural analysis was performed on samples collected at shallow depth (0 to 15 cm). Moisture content ranged significantly, depending on the site position along the slope, and the matrix content and texture.

Soil development was nil to negligible on all disturbed surfaces, since there has been insufficient exposure time for significant alteration of the surface

material. In most cases, the soils were classified as Regosols, implying that surfaces are either young or actively eroding. In a few locations, thin litters or thin organic horizons are present over the mineral soil surface, but basically there is no significant formation of organic-rich or humic horizons. The pH of disturbed surfaces ranged from 4.8 to 6.6. All trenches are below treeline.

Recent Trenches: 1991 to 1993

(Trenches LS3 (Plate 2-5), V01793A, LS7, 91TR20)

The more recent trenches generally have segments of steep, near vertical bedrock walls with colluvium burying the lower third or half of the cut, and segments of collapsed bedrock and overburden with slopes of 35 to 50 degrees. Steep bedrock surfaces show no revegetation. The upper portion of the walls commonly show signs of failure, such as organic mats from the original surface overhanging or slumping down the colluvium. Actively eroding surfaces, regardless of slope show very little revegetation, and most of the growth is concentrated on lower portion of the colluvium, on the trench floor, or on and around slumped fragments of organic mat. Slumping of vegetated organic-rich clumps onto the upper trench wall encourages regrowth on this otherwise inhospitable surface. However, active slopes will deter the establishment of firmly rooted plant communities (Plate 2-5). Trees located close to the wall edge often slump in the trench as it widens itself through this failing and slumping process.

Fine-grained sediments wash down from the trench walls and commonly accumulate on the trench floor, forming colluvial fans or aprons. These piles of colluviated material generally have a matrix content of 15 to 30%, and a slope of up to 50%. Revegetation of the colluviated portion varies greatly; coverage increases as the slope is more stable, and as matrix content increases. Site LS7, a 1991 trench, shows significant regrowth on the stable portions of colluviated bedrock and overburden: a shrub layer with 35%, composed of labrador tea, black spruce and alder; a dwarf shrub layer of 5% composed of low bush cranberry; a sparse forb and grass layer; with lichens and mosses covering 11% and 25% of the ground, respectively.

Highly compacted trench floors show low revegetation rates, in spite of higher content of fine grained material and moisture. Gullying and slope wash hinder revegetation on trench floors that are parallel to the hillside, with slopes higher than 20 degrees, as is the case on the sloping trench bottom of LS3 (Plate 2-5). These gullies become more and more entrenched as run off and local drainage adopt them as their main path. In the case of LS3, parallel gullies only a few years old were 0.4 m wide and 0.5 m deep.

These gullies become pathways for a significant volume of fine-grained sediments which accumulate either in depressions on the trench floor, or at lower elevations below the trenches as fans or sheets overlying the surrounding ground vegetation. Trench floors often have a higher moisture content, for example at site LS3, trench wall moisture content is 5.5%, floor moisture content is 29%. In cases where the trench is oriented perpendicular to the natural surface slope, or where depressions act as catchment basins for both moisture and fine textured soil, the vegetation re-establishes itself fairly easily. At this particular site, up to a metre of silt and fine sand has accumulated and forms a nearly flat, very soft and moist surface. That part of LS3 was the only site showing significant vegetation coverage, with up to 55% of the ground covered by grasses in the survey plot. However the continuous deposition of layers of silt and sand may prevent the development of a more mature community.

Piles of overburden associated with these trenches are more hospitable to plant regrowth. Soils are basically very similar to the trench wall material; they have nil or very low organic matter content and low nutrients, a matrix content averaging 20%, and slopes ranging between 35 and 45 degrees. The main difference between the colluviated trench material and these overburden piles seem to be their more stable slopes. For example, in the 1991 trench LS7, the overburden pile with a matrix content close to 20% shows 50% regrowth: with a low shrubs layer coverage of 50% (alder, black spruce, balsam poplar); a dwarf shrub layer coverage of 20% (cranberry and crowberry); a sparse forbs, grass and moss layer; and a dense lichen layer with 60% coverage. The overburden pile, composed of similar material to the trench wall, but with a loose, stable surface, shows significantly better regrowth.

Detailed Trench Description - 1988

(Trench 88TR20 (Plates 2-6, 2-7, 2-8 and 2-9))

This trench is situated at the crest of a ridge, south and east of the main Lone Star camp. Its elevation is 1040 m at its point of origin (the access road), and 1000 m at its lowest point. The trench cuts through 3 to 4 m of weathered and altered bedrock and is parallel to the hill slope. It is approximately 3 m wide at the base and on average 5.5 m wide at the top, trending northeast. Approximately 250 m long, the trench runs down the slope of a hill with the upper portion sloping gently, and the middle and lower portions having slopes to a maximum of 50 degrees, before levelling off towards the end of the excavation. The trench was subdivided into three: 88TR1 (plate 2-7) at the top portion, 88TR2 in the central portion (Plate 2-8), and 88TR3 in the lower portion. Three different sample locations (a, b, and c) were chosen

to represent the various conditions in the trench: trench walls, toes of slopes, and the trench bottom.

The first segment of the trench was excavated at the crest of the hill into bedrock. It has unstable, near vertical sidewalls composed of weathered friable altered schist (Plate 2-7), with a blanket of colluvium (**88TR 1a**) classified as a sandy gravel with some silt (12.9%) and a high content of fractured and angular bedrock clasts. The trench wall surface is soft and friable, with a moisture content of 6.2%. There is no vegetation growing on this steep slope.

The foot of the trench wall is covered by colluviated schist blocks and cobbles, with a fringe of finer textured sediment at its lower portion. Sample **88TR 1b** taken at this site shows a higher content in fines (24.4% silt and traces of clay), as well as a higher moisture content (13.9%). The surface is soft and slope washed; also remobilization of colluvial material is an active process on this part of the wall. A very sparse vegetation cover (less than 15%) is concentrated at the toe of the east facing wall because the fine-grained material accumulated there acts as a moisture and seed trap. Vegetation is mainly composed of willow, fireweed, two grasses and a moss. The colluviated weathered bedrock at the bottom of the west facing wall supports more vegetation which still occurs in a patchy manner and covers less than 50% of the surface. The fireweed and arctic lupine combine for a sparse forbs layer whereas four grasses achieve a cover of 45%, and a moss adds 1%.

The very bottom of this part of the trench (**88TR 1c**) is a flat, gently dipping, moderately well- to well-compacted surface approximately 3 m wide. The texture is dominantly silt with a trace of clay, and an in situ moisture of 42%. Several segments of the trench floor are composed of scraped bedrock. There is no gullying or erosion taking place in this part of the trench floor. Ponds are forming in small depressions and vegetation patches cover 10 to 30% of the ground. This sparse incoming vegetation consists of the shrubs willow and labrador tea, and grasses, dominantly *Agrostis scabra.*

The second segment of trench 88TR (**88TR 2a and b**) is located approximately 115 m downwards from site 88TR1. The steep altered bedrock surface is highly friable, and the localized clay rich zones contribute to the active erosion and material transport taking place on the excavated walls. The walls have sloughed inwards (Plate 2-8). The top part of the east facing wall has a discontinuous, sparse vegetation cover consisting of the following species: willow, fireweed, two grasses and a moss, originating mostly from the surface vegetation mat that is slumping down.

The colluviated material at the base of the wall is classified as a silty sandy gravel, with as much as 27% silt and a moisture content of 14%. The surface is loose and has a 30 to 35 degree slope. The colluviated material again shows the most revegetation, due to the loose surface, and availability of fine-grained material acting as a seed and moisture trap. Still, the discontinuous vegetation covers less than 10% of the ground at that particular site. Within the vegetation plot, fireweed and arctic lupine combine for 2%, whereas four grasses achieve a cover of 45%, with a trace of moss.

Slopes along the trench floor range from 20 to 25 degrees and along the trench walls they range from 30 to 35 degrees to vertical. Erosion and/or gullying at the base of the trench walls and along the floor of the trench has exposed large fragments of bedrock up to 20 cm in diameter. The trench floor is composed mainly of a densely compacted sandy gravel with an 8% moisture content. There are small patches of loosely compacted gravelly colluviated bedrock, and in several areas, scraped bedrock is exposed. The vegetation coverage is sparse and patchy, varying from 0 to 30%. The shrubs, willow and labrador tea, combine to cover 2%. The other four plant species on site are all grasses, dominated by *Agrostis scabra,* combining for 45%.

The last 25 m of trench (**88TR3**) has a steep floor sloping up to 50 degrees, parallel to the hillside. This is the most eroded and gullied part of the trench. The upper portion of the trench wall consists primarily of dry decomposing bedrock fragments protected by an overhanging organic layer. Larger pieces of bedrock to 20 cm in size are present at the toe of the sloped trench walls. These pieces of bedrock are trapping fine sediment which supports localized vegetation.

This site has a greater vegetation coverage (10 to 12 %) than the rest of the trench due to the import of slumping organic matter and vegetation. The moss and lichen still clinging to these clumps are not included in the regeneration description. Within the vegetation plot, traces of willow and fireweed represent the shrub and forb layers. Three species of grasses dominate (65%), especially *Agrostis scabra* (40%). A liverwort (15%) and two other mosses (35%) complete the vegetation occurrences at this site. However, none of this vegetation is rooted in the wall or colluviated material and is likely to be displaced as slumping and erosion continue. A very large and deep gully is actively cutting the edge of the drilling platform built at this site (Plate 2-9).

Vegetation on the compact and steep trench floor is negligible. Most of the trench floor is composed of either exposed scraped bedrock, or compact residual bedrock with gullies as deep as 0.5 metres.

Older Trenches
(61TR (Plate 2-10, 2-11), 11TR1 (Plate 2-12 & 2-13))

61tr 1961 - Contour Trenches

Trench 61TR is located at an elevation of approximately 820 m and intersects the access road from Eldorado Creek. It is one of a series of trenches excavated in 1961, more than 30 years ago, more or less parallel to elevation contours and easily identifiable from the air (Plate 2-10). Today this trench resembles an access road, originally it must have been a shallow feature. It is approximately 4 m wide at the base with a 1.3 m berm on the north side, and several hundreds of metres long. The north facing trench wall has a slope between 10 to 15 degrees and shows signs of past movement. This movement now seems to be halted possibly due to the ground temperature being stable and the presence of fairly dense vegetation. The south facing berm consists of three levels of stable compacted material, all of which are highly vegetated. There is noticeably less vegetation in the bottom or base of the trench; this is possibly due to its higher density (i.e, machine compacted).

The northwest facing trench has a floor sloping 11 degrees and trench wall sloping 20 to 40 degrees. Soil has a loamy sand matrix (27%) with a coarse fragment content of 72% and in situ moisture of 7.7%. The bottom of the trench has a slightly to moderately compacted surface. A discontinuous organic soil is developing, with thicknesses up to 11 cm in places on both walls of the trench, and the surface there is friable to slightly compacted. This shallow trench is densely revegetated predominantly by alder, with shrubs as tall as 2 m covering 70% of the layer, and with black spruce blueberry, willow and paper birch filling the rest of it. Dwarf shrubs like crowberry and low-bush cranberry are also part of this community as are horsetail, fireweed, grasses, lichens and moss. This site successfully hosts healthy growth in most layers.

The east facing arm of the trench has a similar surface, morphology and soils to above. Even though the indigenous vegetation is re-establishing itself on the cut slope, the site is dominated (50%) by the pioneer shrub alder which reaches two metres in height. The other six vascular plant species on the slope are all common shrubs covering another 45%. The site has a strong lichen component (35%), but very little moss. The vegetation (Plate 2-11) has stabilized the trench surface, but the trench bottom receives fresh sediments from a more recent trench (possibly dating from 1988) located upslope. The sediments wash through an undisturbed forest floor and settle principally at the bottom of this trench. This washed out silt deposit found at the base of the old trench slope is sparsely vegetated and hosts two pioneering grasses, *Agrostis scabra* and grass species and fireweed.

11TR - 1911 Trench

Trench **11TR1** was excavated in 1911 and is the oldest trench of the entire program. Excavated material consists dominantly of altered and weathered schist, with a blanket (1 to 2 m) of gravelly colluvial material, with a high content of bedrock fragments. It is approximately 10 m wide at the surface, 8 m deep, 150 m long, facing an easterly direction, and runs into a gently sloping hill. It is assumed that the trench was abandoned with near vertical walls and a fairly level floor. A gully measuring up to 1m wide and 0.6 m deep runs the full length of the trench. No water was present at the time of observation, but water likely runs through it during snow melt. This deep trench provides a micro-environment isolated from wind, and run off provides moisture at the bottom. Slumping has been important in creating the present slopes, most of the wall faces have slopes ranging from 35 to 85 degrees, and parts of the trench walls are still actively slumping. Soil samples and vegetation surveys were collected at 5 locations on disturbed surfaces, i.e. trench walls and slumps.

The end wall of the trench is formed by a near vertical rock face with a rough, irregular surface, facing east. This face seems quite stable, but still shows very little growth with mainly sparse moss and lichen cover. Part of this wall has a gentler slope (47 degrees) composed mainly of rock fragments of cobble size and although vegetation is still sparse, it shows a healthy variety of species. The vegetation plot has a vegetation cover of 40% with a shrub layers composed of paper birch, willow, alder, blueberry, Labrador tea and very sparse black spruce and white spruce. The very sparse forb layer is composed of arctic lupine, Labrador lousewort (*Pedicularis labradoria)*, bunchberry, fireweed, yarrow (*Achillea millefolium*,1%), and black-tipped groundsel (*Senecio lugens*, 1%). Six lichens combine for 50% of the ground coverage, and three mosses contribute another 20%.

The southwest facing trench wall has a 35 to 40 degree slope on the lower portion and up to a 65 degree slope on the upper portion. This wall shows signs of active erosion and deposition in the form of large fragments of bedrock up to 70 cm in diameter, scattered on the lower and bottom portions of the trench wall. These fragments still carry their organic cover, surface vegetation, and even shrubs and trees down the slope. Exposed patches of steeply sloping bedrock are visible where slumping has recently occurred. The friable quartz muscovite schist bedrock weathers easily which contributes to the erosion of the original steep cut, creating a gentler slope and

the formation of the fine-grained matrix necessary for revegetation. The soil is composed of up to 80% coarse channery cobbles and 20% loam to sandy loam matrix. The organic mat varied between 1 and 5 cm and in general the surface is loose. This trench wall shows a dense vegetation (Plate 2-12); small shrubs and trees can make walking difficult. Several of the larger trees appear to have travelled down the slope on a slumped block, or as the overhanging organic mat fell into the trench.

The opposite trench wall (**11TR 1E**) has a very steep slope (75 to 85 degrees), and at least 3 m has recently failed (Plate 2-13). The lower portion of this wall is composed of smaller bedrock fragments mixed with less than 10% of fine sand and silt size particles. Boulders as large as 90cm were noted. The recent movement of debris and failure has erased traces of past revegetation. The original surface's organic mat will most likely slump onto the debris pile and re-initiate revegetation of the talus scree; very little vegetation is present in this part of the trench.

The rest of this wall (**11TR 1F**) is densely vegetated with a slope of 42 degrees, and a micro-mounded surface. The wall shows some stability even though small local slumps are visible. Runoff has caused some gullying towards the centre of the trench wall and loosened cobbles up to 30 cm in diameter. The soil profile here shows a loose, micaceous to loamy matrix with more than 80 to 85% of coarse channery cobbles. The soil horizons are poorly developed and immature as in other soil profiles in this trench. Very little rock is showing and no newly disturbed rock is visible. There are no trees or tall shrubs on this site, but the low shrub layer is very dense. The three species of forbs on this site are arctic lupines (15%), black-tipped groundsel (5%), and fireweed (5%). Grasses cover approximately 15% of the site. The moss community includes a strong component (30%) of a liverwort species. Three more common species combine for another 70%. Nine lichens combine for 45% coverage and are dominated by *Cladonia borealis* (20%).

White spruce with DBH's of 4 to 5 cm is found in the bottom of the trench, as well as paper birch measuring 20 cm and 14 cm DBH. These trees have probably moved down from the original surface, possibly as saplings on slumped blocks, and matured into trees with little evidence of displacement.

DRILL PADS

(87R53, 90R11 (Plate 2-14), 90R12, 92LS12, 92LS15, 93LS24 (Plate 2-15))

General Description

A number of drill sites dating from 1987 to 1993 were investigated. Drilling equipment usually operated on a pad constructed with pushed and compacted overburden from neighboring trenches or pits. These pads and their immediate perimeter were observed to document the effect of compaction on the revegetation of flat surfaces similar to roads, camp sites, equipment maintenance yards, etc.

These drill pads have similar physical characteristics; they are all fairly flat, stable, compact surfaces, approximately 10 by 10 metres square, built with gravel with a sandy loam matrix with up to 80% coarse fragment content. The pH values range from 4.8 to 7.2, with the more recent surfaces having the lowest pH values. Soil and vegetation surveys were conducted in the compacted portion of the drilling pads and at the rim or perimeter where conditions are the same except for being a rougher, looser surface. No signs of severe erosion, runoff or gullying were observed at any of these sites.

Recent Drill Pads (1990-1993)

The most recent drilling site (**93LS24**) showed sparse revegetation, with less than 10% of the ground covered by Colt's foot, fireweed and grass (*Agrostis scabra*, Plate 2-15). The periphery of this drill pad showed much greater revegetation, dominated by a moss cover of 80%, with 30% of the ground covered by horsetail, and another 15% covered by grasses, and a few willow shrubs.

Physical characteristics of the 1992 sites are very similar to those of 93LS24. One of the sites (**92LS12**) had a moderately compacted surface with some organic matter mixed in, within the first 25 cm from the surface. The grass layer at this site is dense with as much as 85% of the ground covered by three grass species; and a significantly enlarged forb layer, with 30% coverage dominated by fireweed and wild rhubarb. The perimeter of this drill pad was entirely revegetated mainly by grasses.

Pad 92LS15 has a well compacted surface and might have been part of an old road surface. More than 50% of the surface is bare. Vegetation is dominated by grasses (30%), a few shrubs like willow, blueberry and raspberry; a sparse forb layer composed of fireweed, wild rhubarb and arctic lupine. The looser, softer perimeter of this site show up to 80% revegetation, with a dense grass layer, and significant shrub (willow, raspberry and dwarf birch), and forb (fireweed and wild rhubarb) layers, approximately 30 to 35% each.

Drill pads dating from the 1990 exploration program (**90R11** and **90R12,** Plate 2-14) show the same pattern. Vegetation is greater on the looser, rougher surfaces of the drilling pad perimeters (as opposed to the highly compacted centre), and is dominated by a dense grass layer.

1987 Drill Pad

The 1987 site (**87R53**) is located at a lower

elevation, at the west end of the 1961 trench, and shows the same association of greater vegetation at the rim, on the hummocky loose surface as well as on the surrounding slope, and a near bare surface where the drilling equipment has compacted the surface.

STRIPPED SURFACES

(LSFIELD (Plates 2-4, 2-15))

Site LSFIELD was probably stripped in 1988, and covers several hundred square metres. It is located west of the bunk house at elevations ranging from 1015 to 1040 m. This shallow pit is like a stripped surface, facing north with slopes ranging from 1 to 12 degrees. The surface exposed is approximately 150 m wide by 250 m long and can be subdivided into zones of bare rock, ripped rock, rock with blanket of fine-grained sediment, overburden, and broken rock piles. Each of these zones were examined as they exhibit different vegetation and surface conditions.

The northernmost zone of the field (**LSFIELD 4**) consists of a 20 m wide band of smooth, scraped bedrock, consisting of schist with quartz veins; it faces north to northeast, and has a slope of 12 to 14 degrees. The site is very rapidly draining, and signs of surface run off are visible. Ninety percent of the surface is bare rock. Two forbs are found in this northern zone at extremely low density: fireweed (2%), and arctic lupine (<1%). Two grasses, *Calamagrostis sp* and *Agrostis scabra*, grow here at 1% and 5% density, respectively. The moss *Polytricum juniperinum* (5%) completes the vegetation occurrence at this site.

Below this zone of smooth rock is a band of ripped bedrock and boulders (**LSFIELD3**). The surface is very rough and the average slope of the field is 12 degrees. Several parallel ripped sections measuring 1 m wide at 2.5 to 3 m spacing are perpendicular to the contour of the slope. There is no organic matter or fine mineral soil on the surface, and no revegetation taking place at this site .

The lower part of this field (**LSFIELD1**) is a fairly flat, very well revegetated, 20 m wide area at the base of the exploration field slope. There is 20 to 35 cm of fine sandy loam overlying the bedrock surface and up to 80% of the surface is revegetated. The low shrub layer is well represented (60%) by willow which grows up to 2 m tall. The forb layer is well represented (55%) by three species, dominated by fireweed, Arctic lupine 5%, and black-tipped groundsel <1%. There are two regularly occurring grasses at this site: *Calamagrostis sp.* (20%) and *Agrostis scabra* (10%).

The overburden pile located at the southern edge of the field was included to complete our data collection. **LSFIELD2** (Plate 2-15) is a pile of pushed and broken rock less than 1m high and approximately 4 m wide. The surface expression is marked by cat blade tracks and is moderately compacted to loose. The mineral soil is a well drained, loamy sandy gravel. Approximately 30% of the surface is vegetated mainly by forbs (fireweed 25%) and grasses (*Calamagrostis sp* 25%, and *Agrostis scabra* 10%). There is a small (<1%) showing of the moss *Polytricum juniperinum.*

OTHER DISTURBANCES

Cat Trails

(DC1, LSFIELD6)

A few sites under this unorthodox category were investigated. They consist of areas where heavy equipment "walked over" or drove, blade up, so that the surface vegetation cover was ripped, and discontinuous, but still left on site, with portions of the original surface still intact. For example, site DC1 is associated with a 1990 drill pad and the disturbance is assumed to date from 1990. The soil is shallow (22 cm deep) without signs of soil erosion. The blade and track imprints are still easily seen on the ground. The soil consists of a mixture of exposed sandy loam and gravel (70% coarse material), and original soil with a organic mat over the parent material. The pH values average 5.8. Vegetation is dense, with an irregular pattern of exposed soil bearing new pioneer species of shrubs, grasses and forbs. The original surface is either undisturbed, or at least preserved enough for the natural vegetation to recover rapidly. Such sites show very successful recovery due to less bare surfaces within the scraped surfaces. The disturbed surface still contains mixed organic matter with the soil, and in addition to an abundant seed source in close proximity, it also benefits from the root propagation of surrounding shrubs and grasses.

Camp Building (Bunk House)

(Site LS 01 (Plate 2-17)).

This site is located on the north side of the bunk house and it is assumed that this surface is as old as the structure immediately beside it. The bunk house was built on a fairly flat, stable pad probably in 1912 or earlier (there are newspapers used as wallpaper in the bunkhouse which are dated January, 1912). The soil is very hard and compact at a depth greater than 20 cm. It consists of well drained silty loam, and sandy loam with 40% coarse fragments, with pH value of 5.0. There is an organic mat as thick as 12 cm, and a humic A horizon as thick as 9 cm.

The entire area around the building itself is densely revegetated, with at least 90% of the surface covered (Plate 2-17). Most layers, except the tree layer show a robust growth both in coverage and in species variety; even the white and black spruce are reintegrating into this site. The plot is visually

dominated by the tall shrub layer (45%) which consists of alder, two willow species, and white spruce. The low shrub layer (25 to 30%) is composed of willow, black spruce, dwarf birch paper birch, wild raspberry, blueberry and labrador tea. Dwarf shrubs are sparse: crowberry and low-bush cranberry together cover 10%. The forb layer (35%) is made up of fireweed, bunchberry, twin-flower, a groundsel, coltsfoot, and horsetail. The graminoid layer consists of a rush and three grasses combining for 15% total coverage. Two mosses combine for 50% coverage, and two lichens add 7%. A clubmoss is also present at 2%.

SUMMARY

TRENCHES

Most trench walls consist of friable bedrock with pH and chemistry tolerated by pioneer plant species, and overall, low nutrients available to plants. Most trenches had unstable wall portions even after 80 years, with slumping, gullying and surface erosion still modifying the morphology and surface of the trench wall and floor. Trenches parallel to the hillside were noticeably less stable and showed more gullying than trenches excavated perpendicular to the hillside. Soil development is negligible within the time frame studied here, but the formation of thin organic mat on the 1911 trench slumps show the beginning of more nutrient rich soil.

Revegetation is nil to sparse on steep bedrock walls, bouldery slopes, very recent (1993 trenches), and very active or very compact surfaces (some trench floors). Revegetation was more successful on trench walls and associated debris piles when the fine-grained matrix content was at least 20%, slopes were gentler than 45 degrees and surfaces were friable. Revegetation also benefits from the mixture of organic matter into the surface material, and from the import of organic rich, vegetated patches of forest floor slumping onto the trench colluvium. Overburden piles and slumped deposits with stable slopes are also very successfully revegetated. Overburden piles as recent as 1991 showed 50% revegetation by either shrubs, grasses or forbs (or a combination).

After six years, revegetation in trench 88TR20 is still sparse and is concentrated on loose surfaces, with fairly stable, moderately steep slopes, and where the loamy matrix content is approximately 20%. Areas where organic mat is slumping benefits from the import of nutrient and rooted vegetation, but this may be a short term benefit due to the active nature of the slopes. Steep bedrock wall and bouldery scree slopes are basically unvegetated, as are the compacted and/or gullied sections of the trench floor. Most successful regrowth is dominated by grass and moss species.

The 1961 trench was very successfully revegetated by shrubs, probably because of the stable surface and the abundance of fines in its matrix. Earlier slope movement may have incorporated organic matter and nutrients from the overlying surface. The original trench was shallow and wide, and run off accumulated in ponds in low lying areas, but this has not caused severe gullying. Aspect does not seem to significantly influence revegetation of this site.

The 80 year old trench, 11TR, is still partially unstable. The stable portion of the trench walls have immature soil development, but accumulation of organic matter at the surface is initiating the development of an organic-rich layer. Areas with stable slopes show dense revegetation, especially by shrubs, grasses and mosses. However, after eighty years, many areas show sparse to no revegetation, and these include steep bedrock faces, coarse bouldery slopes, and active surfaces with active slope wash or large recent slump.

DRILL PADS

Drill pads consist of nearly flat surfaces and commonly have sufficient matrix content. Soil nutrients are low, as in most other sites. Revegetation was more successful in areas where the surface was not compact (rim and periphery of the pads). Sites showed moderate to dense regrowth usually by grasses and forbs, after only a few years, a more rapid colonization than the trenches.

STRIPPED SURFACE

Gently sloping exposed bedrock and highly fractured bedrock did not show significant re-vegetation. However, areas with at least 20 cm of fine textured soil showed a moderately dense shrub (60%) and forb (55%) layer, and a grass layer with at least 30% coverage.

OTHER DISTURBANCES

The cat trails, where a significant amount of the original surface was either undisturbed or mixed with the ripped surfaces, have greater vegetation coverage, as the remaining original vegetation is complemented by the incoming pioneer plants.

The surfaces around the 1912 bunkhouse have probably been subject to some disturbance between now and 1912, at least in parts, but most of it appeared untouched by heavy equipment since the construction of the bunk house platform. Revegetation is very dense for most layers and surface soil horizons show the beginning of organic rich layers.

CHAPTER 3

HARD ROCK EXPLORATION DISTURBANCES CARMACKS AREA

INTRODUCTION

The area west of Carmacks has been an exploration and mining target for several decades. The Revenue and Nucleus properties were selected as representative exploration sites for this region. Access to these properties can be obtained via a mining road in fair condition, and driving on the properties themselves is possible with a 4 wheel drive vehicle. Placer mines located in the same valley are also accessible by the main mining road. A total of 26 sites are described on the Nucleus property and 18 on the Revenue Property ranging in ages from 1968 to 1990 (Figure 4).

CLIMATIC DATA

The climate is sub-arctic continental, relatively dry with major temperature variability on both a daily and seasonal basis. Precipitation is relatively light, ranging from 250 to 300 mm, two thirds of which falls during the summer months as rain, primarily showers. Snow cover is in place generally from mid October and lasts to mid April in the lowest valley floors and a month longer over the higher terrain. Mean annual temperatures are near -4° C. Mean January temperatures range from -30° in the lowest valleys to a more moderate -20° over the higher terrain due to the inversion effect. Mean July temperatures range from near 15° in the lowest valleys to 10° over the higher terrain. The most extreme daily temperatures will occur in the lowest valley floors and these can range from extreme minimums of -60° to -65° to extreme maximums near 35°. The period with mean daily temperatures above zero range from late April to mid October although it should be noted that frost has occurred in all months of the year. Mean temperature from May to September is 10° C. Climatoloical information is available from the Carmacks weather station located at an elevation of 521 metres a.s.l. (Walh, in prep.).

GEOLOGY

The Revenue and Nucleus mineral occurrences, along with numerous other showings, are located in the Dawson Range. The region occurs within the allochthonous and geologically complex crystalline belt known as the Yukon-Tanana Terrane. The geology of this part of the central Yukon is poorly known as the area was never glaciated, and outcrop is therefore scarce. Recent regional airborne geophysical surveys carried out by the Geological Survey of Canada have led to reinterpretation of previous mapping.

The oldest rocks in the region are Palaeozoic gneisses and schists of metasedimentary and metaigneous origins. These were intruded by Early Jurassic granitic rocks of varying composition which have also been metamorphosed and exhibit foliated textures. These have been intruded by Early to Mid-Cretaceous quartz diorites and granodiorites of the Dawson Range Batholith which form sheet or sill-like bodies concordant with the foliation in the adjacent metamorphic rocks. A late, high level phase of this intrusive event is represented by potassium-rich leuco-granites which form discordant plutons. All these rock units are crosscut by dykes of the Mid-Cretaceous Mount Nansen Group, as well as the coeval Prospector Mountain Plutonic Suite (Figure 4). The youngest rocks in the area are volcanic and subvolcanic rocks of the Carmacks Group.

Copper mineralization is associated with both the potassium-rich granites of the Dawson Range Batholith and with the Prospector Mountain instrusions.

QUATERNARY GEOLOGY

During the Quaternary time period, at least four major Cordilleran glaciations have affected southern and central Yukon Territory: the Nansen (oldest) and Klaza Glaciations which are collectively referred to as pre-Reid glaciations; the Reid (Illinoian) Glaciation; and the most recent McConnell (Wisconsinan) Glaciation (Bostock 1966, Hughes et al. 1968).

The Nucleus and Revenue properties are believed to be located beyond the area covered by pre-Reid glaciation, but pre-Reid glaciofluvial sand and gravel may be present in creek and valley bottoms. On the surface geology map accompanying this report (Figure 5), colluvial blankets or veneers (map units Cv, Cb and C) can be interpreted as including residual bedrock.

The Reid and McConnell glaciers did not cover the area although the same climatic conditions prevailed there as in the glaciated portions of Yukon. The limit for the Reid glacial advance, however is located a few kilometres east of Victoria Creek, and

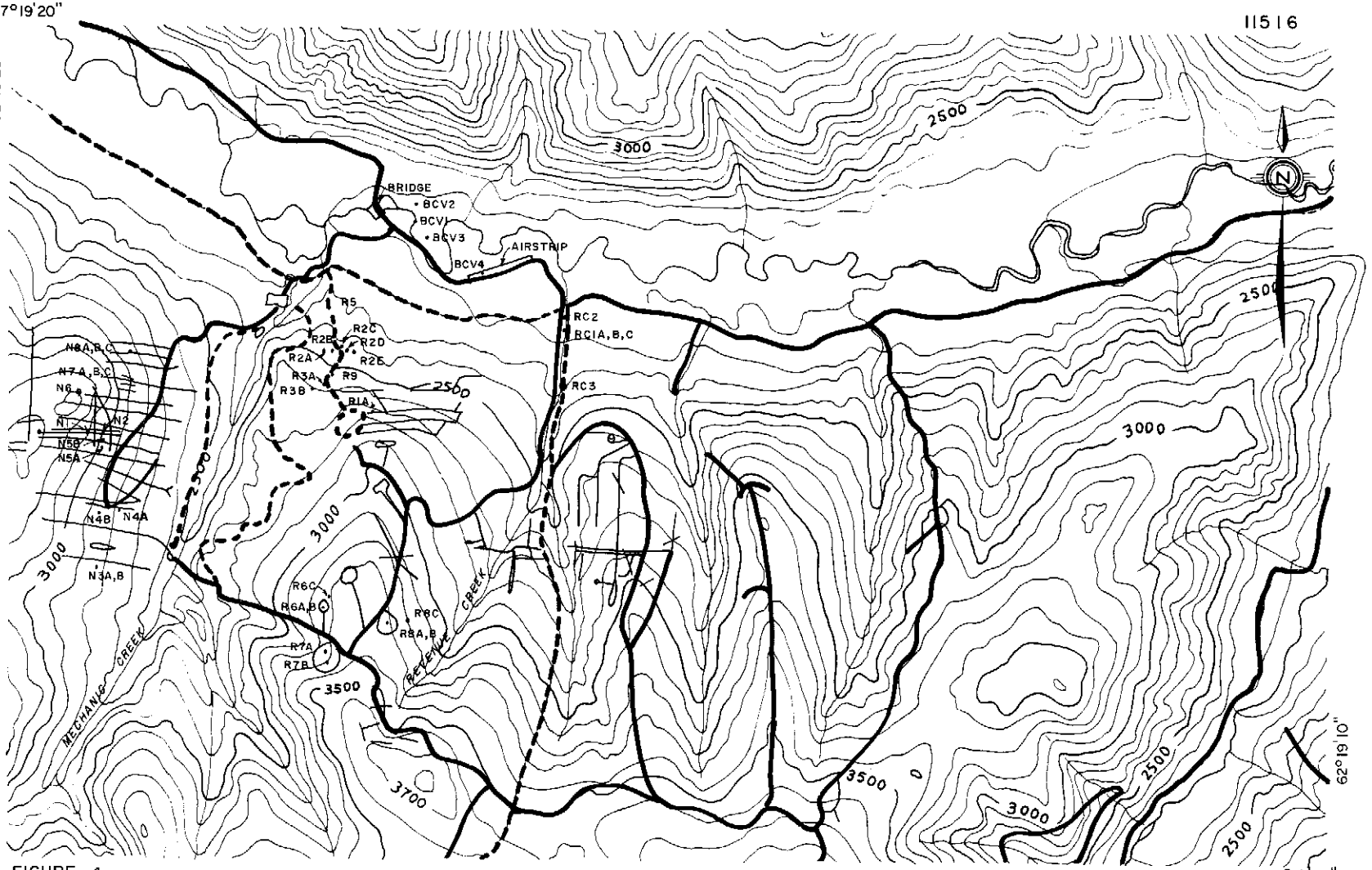

FIGURE 4

ANTHROPOGENIC FEATURES AND SITE LOCATION
CARMACKS AREA

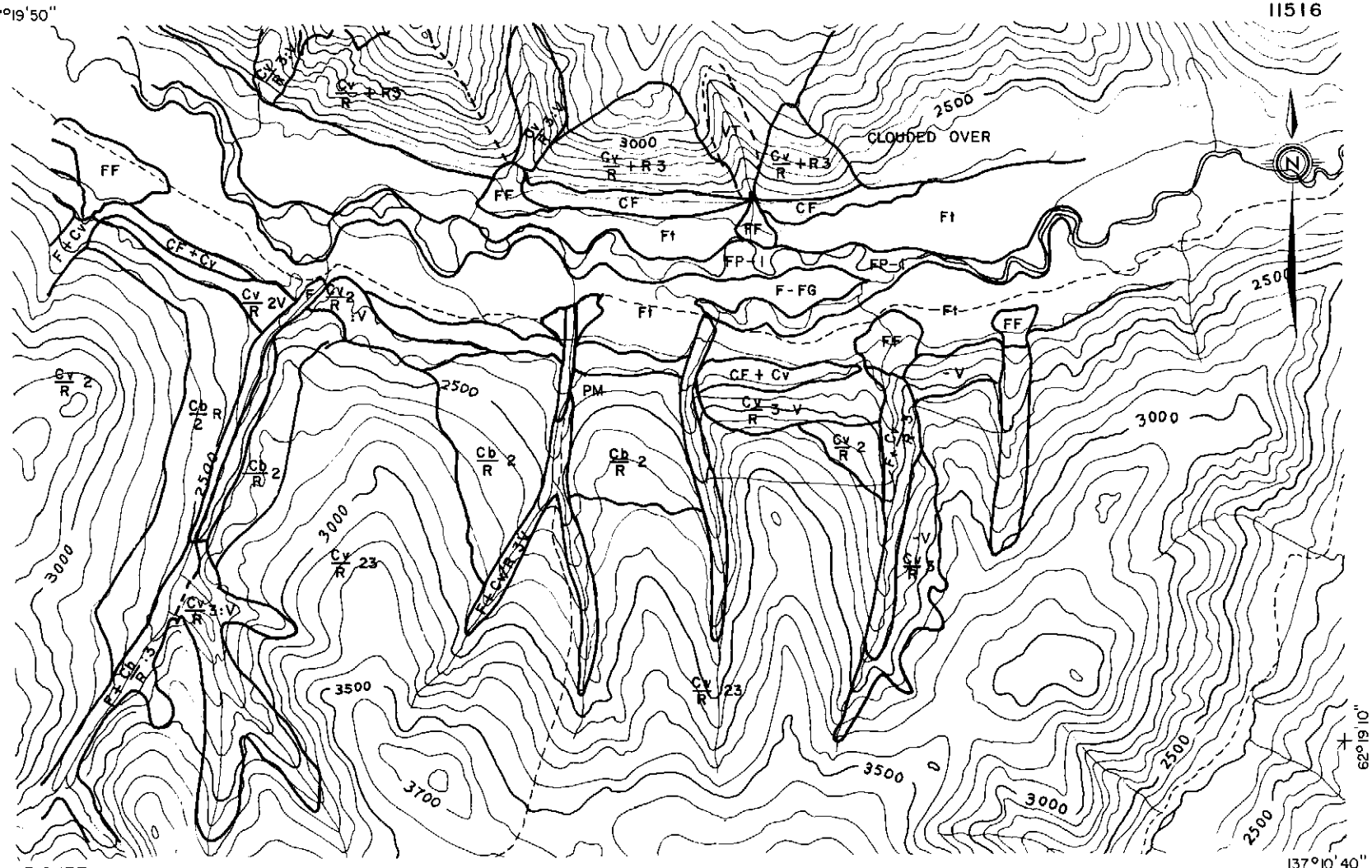

FIGURE 5

SURFICIAL GEOLOGY - REVENUE and NUCLEUS PROPERTIES
CARMACKS AREA

DISTANCES IN METRES
500 0 500 1000 1500 METRES

SCALE 1:30 000

proglacial deposits related to advancing and retreating glacial ice are found at lower elevations in the major valley floors of the study area. Some gravel deposits at higher elevations could also be linked to the Reid glaciations (Jackson, in prep.), as well as some of the main terraces along the main valley. The Mt. Nansen area, located south of the study area, was subjected to changes in stream base level during glaciation, where rising base levels caused considerable aggradation of gravelly deposits in gulches and creeks (LeBarge 1993). In contrast, during deglaciation, base levels were lowered which resulted in the degradation, downcutting and dissection of pre-existing alluvial landforms, such as fans and terraces. These base level cycles may have occurred several times during either, or both of the Reid and McConnell glaciations, impacting both valley bottom alluvial fill deposits and higher level colluvial slope deposits. The Big Creek valley was likely affected in the same way.

Colluvial or slope processes are active within the study area, and permafrost is widespread in valley bottoms, on north facing slopes and at higher elevations in subalpine to alpine areas. At lower elevations, permafrost with a high ice content (i.e. large ice lenses or pods) can be expected in fine-grained sediments with a thick organic cover. Disruption of the organic cover will breach the insulation which preserves the frozen soil, and initiates or enhances soil creep, solifuction and slope failure. The disruption of fine grained sediments containing large ice lenses may trigger thermokarst collapse activity, as well as very poor drainage conditions for several years. These conditions were observed in trenches on the Revenue property (Trench **R2A**, map 4), and considerable slumping is still taking place where permafrost was exposed during excavation.

MINERAL EXPLORATION HISTORY

Placer claims were first staked in vicinity of the Revenue property in 1934. Hardrock or quartz claims were only staked there in 1950. Claims were first staked on the Nucleus property in 1968.

Records indicate that a variety of diamond drilling, percussion drilling, trenching, soil geochemical surveys, and VLF-EM, IP, magnetometer and other EM surveys have been carried out on the Revenue property between 1950 and the early 1990's. Soil geochemistry has outlined several anomalous zones, some of which have been followed up by drilling.

The Nucleus property has been subjected to extensive trenching, percussion and diamond drilling, and geochemical sampling since it was first staked (Plate 3-1). A 1988 drilling program indicated a high grade zone with reserves of 211,900 tonnes grading 3.16 g/t gold. One drill hole intersected values of 34.9 g/t over 13.7 m.

The Revenue property contains gold and copper, with minor tungsten, and some molybdenum. The mineralization occurs in breccia and stockwork in fractured and sheared quartz monzonite and associated rhyolite which cut Late Cretaceous lapilli tuffs. Exploration programs including trenching were run in 1966 to 1969 (during which most roads were built), in 1974, 1978 and 1979, and an extensive bulldozer trenching program was completed in 1987 and 1988.

The Discovery Zone occurs along the south-dipping contact between a breccia zone and quartz monzonite. There is associated propylitic, argillic and phyllic alteration, typical of porphyry-type deposits. Early exploration adits reportedly cut 5 m which assayed 15% copper and 15.6 g/t gold. Other zones have been identified in brecciated rhyolite and areas of intense argillic alteration.

Recent drilling tested zones of supergene enrichment beneath the leached, but gold-bearing cap. Two holes of 4 hole program, intersected significant mineralization, with the best reported grades being 15.2 m of 0.66% copper and 1.00 g/t gold in a zone of supergene sulphide mineralization. Lower grade sulphide mineralization was encountered at greater depths.

Gold mineralization on the Nucleus property occurs in highly fractured and altered porphyry, as well in associated microgranite and schist. The highest gold grades are associated with gouge zones and quartz stockworks adjacent to porphyry dykes. Drilling has outlined a gold-bearing leached cap to the deposit which is 60 to 100 m thick. At least two leached gold zones had been identified by the early 1990's which remained open to the north and east. The leached cap is underlain by a supergene sulphide zone with both gold and copper values. Copper mineralization occurs in the zone of supergene enrichment mainly as chalcocite in dark quartz veinlets in fractured porphyry and altered schist. There is some associated molybdenite. One recent drill hole intersected 38 m of sulphide mineralization which averaged 0.87 g/t gold and 0.52% copper. Reserves of at least 4.3 million tonnes grading 1 g/t gold have been outlined.

NUCLEUS PROPERTY

UNDISTURBED SOIL AND VEGETATION CONDITIONS

(Site N7C, N4B (Plate 3-2))

Site N7C is representative of most undisturbed forest found on this property. It is located on a northeast-facing slope at an elevation of 850 m, 50 m

uphill from Trench N7B. The surface is gently hummocky and the slope is 15 degrees. The shallow soil rests on bedrock and is a moderately well to imperfectly drained Orthic Turbic Cryosol. The turbated soil horizons are an indication of shallow permafrost. The organic mat is 8 cm thick. Mineral soil has a pH value of 6.0 and is a fine to medium sand and sandy loam with 10% coarse fragments. Abundant micro to coarse roots are present between 0 and 8 cm depth. Very few micro to very fine roots reached 50 cm deep.

This is a fairly dense black spruce/moss/lichen forest. The tree layer is sparsely (10%) populated by small black spruce with an average DBH of 10 cm and height of 10 m. The majority of the black spruce fall in the tall shrub category, covering 50% of it. The low shrub layer is dominated by labrador tea with 50%, and augmented by willow (3%) reaching up to 2 m in height, blueberry (15%), and prickly rose with 1% coverage. Low-bush cranberry covers 20% of the dwarf shrub layer. The forb layer is very sparsely populated by coltsfoot (2%), and a clubmoss (1%). The graminoid layer is also very sparse; a common grass covers 2%. Two feather mosses, *Hylocomnium splendens* and *Pleurozium schreberii*, dominate the moss community with 55% coverage of the moss/ lichen layer. A brown spagnum moss occurs here (2%), as does another common moss. Eight species of lichens, dominated by green reindeer lichen (30%) combine to cover the rest of the forest floor.

TRENCHES

Detailed Trench Description 1989

(Trench N1 1989 (Plate 3-3, 3-4, 3-5))

This trench is referred to in exploration reports as 89N-4, was excavated in 1989, and is located at an elevation of 930 to 990 m. It is approximately 3.4 m wide at the base and on average 4 m deep, facing in an easterly direction with a slope of 5 degrees. Two sample areas were chosen, one approximately halfway up the hill (**N1A**), and the other at the lowest extremity of the trench (**N1B**, Plates 3-4 and 3-5).

The higher portion of the trench is located at an elevation of approximately 965 m. The site is sub-divided into four sections to cover various aspects, the south facing wall (**N1Aa**), the north facing wall (**N1Ac**), the trench bottom (**N1Ab,** Plate 3-3), and the overburden pile beside the trench at N1A (**NIAd**). The trench cuts into friable Pelly Gneiss, and into the overlying gravelly loamy sand to loamy sandy gravel (70 to 80% coarse fragments).

The south facing trench wall (**N1Aa)** is approximately 4 m high and has a slope of 36 degrees. The upper portion of this trench wall has been undercut by run off from the undisturbed area, allowing the organic mat to overhang, and the fines to flow downwards. There is no soil development and the trench material consists of a friable, silty gravelly sand with a moisture content of 10% at the time of sampling. The slope is sparsely vegetated with a few fireweed stems and a single willow. Some grasses are growing (7% vegetation cover) on the lower portion where the fines are concentrated.

The north facing trench wall (**N1Ac**) is approximately 2.5 m high, has a slope of 57 degrees, and is unstable. Erosion has exposed the underlying bedrock stratum which has activated weathering processes. This site is very sparsely vegetated (less than 1%) with willow, a mustard (*Descurainia sp*) and three grasses.

The final segment of the trench (**N1Ab**) is 3.4 m wide, facing in a easterly direction with a slope of 5 degrees. The bottom of the trench is firm and fairly well compacted, and consists of exposed bedrock and loamy sandy gravel, with traces of clay, and a moisture content of 11.3%. Fines have washed down and accumulated at the toe of some slopes. This sparsely (<10%) vegetated site is dominated by four grasses and joined by a trace (<1%) of fireweed.

The overburden piled beside trench N1A (location **N1Ad**) has a very stony, friable surface, and a fairly stable slope of 20 to 30 degrees. The soil is a rapidly draining Orthic Regosol with a sandy loam matrix and 70% coarse fragments (gravel, cobbles), and has a pH of 6.2. This site has revegetated quite well with 60% of the ground covered by vegetation. A trace of willow (1%) and trembling aspen (5%) which grows up to 2.5 m tall comprise the shrub layer. The forb layer is composed of two species of fireweed (25%) and a mustard species at 5%. Four grasses complete the vegetation occurrences with 27% coverage.

The second location **N1B,** at a lower elevation of approximately 930 m, is also subdivided into four sites: the south facing wall (**N1Ba**), the north facing wall (**N1Bb**), the trench bottom (**N1Bb**), and an overburden pile (**N1Bd**).

The south facing trench wall (**N1Ba**) is approximately 4m high and has a slope of 37 degrees. Several slumps were noted on the trench wall, the source of this material is the overburden pile on the top of the slope (Plate 3-4). There is no soil developing on the well drained loamy sandy gravel (coarse fragment 40 to 60%). The moisture content is 7.6%. This site has a vegetation cover of 15% to 20%. The shrub layer is composed of two species of willow (6%), and a trace of paper birch (1%). The forb layer is represented by fireweed (5%), and the graminoid layer is represented by two grasses combining for 15%.

The north facing trench wall (**N1Bc**) is approximately 1 m high and has a slope of 45 degrees. The material slumping down off the

overburden piled on top of this wall contributes to the active and unstable slopes. Cracking caused by runoff and the soils dry nature is providing continual movement on the slope's surface. An ash layer, (Plate 3-5) likely the White River Tephra, dating from 1200 year B.P., has washed down on the slope in several locations. The soil profile here is very similar to the previous site, a gravelly sandy silt to sandy gravel, with a lower moisture content 6.4% and a coarse fragment content of 70%. This steep site is interesting because it has a tiny moss species (5%) growing on the vertical face of the original white volcanic ash layer. There is also a trace (<1%) of fireweed growing and two grass species at a combined 20%.

The bottom of the trench (**N1Bb**) is 2 to 3 m in width, facing in an easterly direction with a slope of 10 degrees. The bottom of the trench is full of cobbles up to 150 mm in diameter, and fines from the two adjoining unstable slopes, and grasses. Some gullying was noted, but these areas are well vegetated and the movement of fines remains minimal. The soil is similar to the trench material, but has a higher moisture content of 19%. This site is only vegetated by the grass *Agrostis scabra* with 25% coverage.

The overburden pile (location **N1Bd)** is very similar to N1Ad, with similar morphology, soil and revegetation.

Older Trenches

1984: N2; 1986: N3 (Plate 3-6), N4A (Plate 3-7), N6 (Plate 3-8), N7B, N8B.

These trenches all share similar characteristics. The originally near vertical walls now have slopes ranging between 32 and 40 degrees, are excavated into the same friable bedrock, and slumped colluvial material consists of a loamy sandy gravel with up to 90% coarse fragments. Most of the trench walls show active erosion, slope wash and slumping. In a few places, slumping materials from the above undisturbed area provide fines and portions of organic mat that assist in stabilization of the slopes (Plate 3-6). Volcanic ash (White River Tephra, dated at 1300 B.P.) occurs in several places and has also been washed down, as at trench N1.

The trenches are sparsely to moderately revegetated, with ground coverage varying between 10 and 25 %, including slumped vegetated mats. The 1984 trench, **N2**, has a greater vegetation coverage, with portions of the trench showing 70% regrowth on the gently sloping floor, and 40 to 50% regrowth on its walls. The south or east facing walls show a slightly greater growth than the north facing walls. Most sites show the grass layer as the dominant one, with coverage ranging between 20 to 30% (Plate 3-7). The low shrub layer is sparse and represented by alder, paper birch, balsam poplar and willow. The dwarf shrub layer is represented by white spruce which grows up to 0.2 m tall. The sparse forb layer is represented by fireweed.

Two of the trenches stand out for different reasons. Trench **N7B** is approximately 50 m long and runs perpendicular to the hillside. Signs of cryo-turbation can be seen on the adjacent undisturbed site, and the permafrost was disturbed on this site (**N7C**). The trench floor is composed of the same material as the walls, although here there is evidence of greater erosion and deposition of fine soil, pebbles, cobbles and blocks. The bedrock is partially exposed. The floor of the trench is fairly steep, at 39 degrees; this would account for the greater movement of material. The trench floor is less revegetated than the trench walls, with 15% of the surface covered by vegetation. The regrowth is concentrated at the base of the walls where there are fairly stable surfaces. A small gully exits the trench bottom and extends for 100 m downhill, carrying runoff, where fine sediments are channelled and redeposited.

Trench N8 is located north of trench N7B, and is very similar to it. The matrix of the parent material is slightly higher, up to 30%. Regrowth is greater, with approximately 35 to 40% of the surface being revegetated. The low shrub layer is dominated by alder (35%), and augmented by balsam poplar (5%), paper birch (1%), and willow (3%) which grows up to 0.8 m tall. Three grasses combine to cover 25% of the graminoid layer, and a tiny moss represents 5% of the moss/lichen layer. As in trench N7B, a gully is developing downhill from this trench, channelling surface runoff and sediments.

DRILL PADS

Sites N5A (Plate 3-9), N5B.

Site **N5A** is a drill pad associated with the 1989 drilling program and is referred to as DDH N 89/1 in assessment reports. Similar to other drill pads, it consists of a fairly level, square well compacted surface. The site is built on rapidly draining gravelly material with a fine sandy clay loam matrix and 60% coarse fragments. The pH of the soil is 6.0. This site is sparsely vegetated; no trees or tall shrubs are present. There is 80% open soil and rock visible. The low shrub layer consists of willow (1%) up to 0.6 m tall, and trembling aspen (2%) up to 1.5 m tall. There are no dwarf shrubs at this site. The forb layer is comprised of 1% fireweed and a trace (<1%) of arctic lupine. Four grasses combine for 54% coverage of the graminoid layer. No mosses or lichens are present at this site.

Site **N5B** was part of the 1991 drilling program and is referred to as DN91-2 in assessment reports. The surface has 100% stony coverage and no organic cover. The level surface is fairly well

compacted, and is comprised of well drained gravelly material with a loamy sand matrix and 90% coarse fragments. The soil pH is 6. This 4 year old site is very sparsely vegetated with 90% of the soil/rock surface showing. There are no trees, tall shrubs or low shrubs at this site. The dwarf shrub layer is represented by willow (5%) which grows up to 0.2 m tall, and trembling aspen (5%) reaching 0.3 m tall. Three grasses combine for 37% occupation of the graminoid layer. Mosses and lichens are not present at this site.

Both drill pads show greater revegetation where the surface is looser and rougher.

REVENUE PROPERTY

UNDISTURBED SOIL AND VEGETATION CONDITIONS

R3B (Plate 3-10)

Site R3B is an undisturbed forest uphill, and at an elevation of 790 m, on a north facing slope of 8 degrees. The site has an imperfectly drained Orthic Static Cryosol with permafrost at depth of 30 cm. The ground shows signs of slow soil creep which is expressed by the low hummocky ridges. The organic mat is 13 cm thick overlying 30cm of silt loam with less than 10% coarse fragments (gravel). Abundant micro to coarse roots are present between 0 and 20cm; few micro to fine roots reached 50cm deep, where the permafrost is root restricting.

The open black spruce forest has well stratified understorey of low shrubs, mosses and lichens. The tree layer is entirely composed of small black spruce (5%) up to 6 m tall with an average DBH of 12 cm. Most of the black spruce is in the tall shrub layer, occupying 50% of it. The low shrub layer is dominated by labrador tea (50%), willow (10%) reaching 1.2 m in height, and blueberry. The dwarf shrub layer is represented solely by low-bush cranberry with 30% coverage. The very sparse forb layer is occupied by horsetail and coltsfoot, with 2% coverage each. The graminoid layer is also very sparse with only one grass covering 5% of the layer. Four mosses, including a feathermoss (*Hylocomnium splendens* 20%) and a red sphagnum moss (5%) combine for 36%. Six lichen species, combining for 52% coverage add to the dense cover of this moss/lichen layer.

TRENCHES

Trenches at the Revenue property were difficult to date, as there were three major exploration program involving trenching. The trenches were lumped in one of four general exploration periods: 1967 to 1969, 1974 to 1979, 1987 to 1988, or 1991 and younger.

Recent Trenches - 1991 to 1993

Trench R2B (Plate 3-11)

This trench **R2B** is located at an elevation of 780 m, and is roughly parallel to the slope of the hillside. The trench was excavated into friable and crumbly bedrock and is basically unvegetated. There is no sign of permafrost. The south facing wall (location **R2Bc**) of the trench is approximately 1.7 m wide at the base and 1.0 m high, facing in a westerly direction with a slope of 14 degrees. The adjoining north facing wall (**R2Ba**) has an approximate height of 4.8 m and a slope of 42 degrees. The excavated material was placed on the north side of the trench. The north facing wall is very steep, with a slope of 80 to 90 degrees and is mostly exposed rock. Revegetation is very sparse, with only traces of fireweed, a liverwort, and two mosses. At the bottom of the trench, in the loose rock, two grass species occur (11%), of which *Agrostis scabra* dominates with 10%.

A pile of tailings located downhill from the trench shows more successful revegetation. The surface is loose and hummocky, and the material consists of a gravel with sandy matrix and 70 to 80% coarse fragment content. Approximately 20 to 30% of the ground is revegetated. The low shrub layer is composed of balsam poplar (5%), willow (10%) growing up to 2 m tall, trembling aspen (5%), alder (10%) reaching a height of 1.8 m, white spruce (10%) up to 0.4 m tall, and paper birch (2%) reaching 0.6 m in height. The forb layer is represented by fireweed (10%), and arctic lupine (2%). A grass (1%) and a moss (5%) complete the vegetation occurrence at this site.

Detailed Trench Description 1988

R1A (Plate 3-12)

Trench R1A is located at an elevation of 825 m a.s.l., and is facing in an easterly direction with a slope of 3 degrees. It is approximately 1.7 m wide at the base, has a south facing wall 1.7 m high, and a north facing wall 4.2 m high. Three sample locations were chosen, one on the north wall (**R1Aa**), one on the south wall (**R1Ac**) and one on the trench bottom (**R1Ab**).

The north facing trench wall (R1Aa) is approximately 4 m high, with a slope of 47 degrees. This wall is still actively slumping; portions of the organic overhang are failing and have exposed the original soil surface which is now washing down the colluviated slope. The slope consists of fine particles at the top, and coarse size fragments have rolled down to the foot of the wall. A sample confirms that this material is a sandy gravel, has a moisture content of 7% and a pH value of 5.8. This site is very sparsely revegetated, with most of the vegetation orginating from the slumped material on the original surface (Plate 3-12).

The south facing trench wall (R1Ac) is

approximately 1.7 m high, with a slope of 45 degrees. The slope has some movement with cobble size particles falling to the lower portion of the slope. Minor erosion was noted; this is due to a small berm at the top of the slope which directs the flow of the runoff away from the trench. The material is the same as for the north wall. This wall is basically unvegetated.

The floor of the trench (R1Ab) is 1.7 m wide, faces east and has a slope of 3 degrees. The trench bottom has a loose surface, and there is no ponding nor gullying. The material is still a sandy gravel, with a higher content of fines (only 50% coarse fragments) and a higher moisture content (19%). Although these two factors encourage more growth, the site is also very sparsely vegetated.

The very sparse low shrub layer is made up of white spruce, willow, and paper birch. The very sparse forb layer is occupied by traces of fireweed. Two common grasses combine for 4% coverage. A tiny moss species and the ever present *Polygonum juniperinum* combine to cover 10% of the moss/lichen layer.

Older Trenches
1969: R2A (Plates 3-13 and 3-14), R2E.

These two trenches are located at an elevation of approximately 745 m on a northeastern facing hillside. R2A runs diagonally to the slope and R2E is roughly parallel to it. In both cases, ice-rich permafrost was exposed during excavation and continues to melt causing considerable movement of material on the slope. This regressive slumping will continue until the thermal regime in the ground has stabilized.

Water from the melting ice and surface runoff forms a small pond on the floor of trench R2A. Its excavated surface is now fairly covered by colluvial, patches of organic mat, and original forest vegetation mats. The incoming vegetation fills in areas where slumping mats are not present. The low shrub layer is composed of willow (17%), and labrador tea (1%). The very sparse dwarf shrub layer is occupied by low-bush cranberry and white spruce. The forb layer is very dense with two horsetails combining for 80% coverage, fireweed adds another 2% to this layer. The very sparse graminoid layer is composed of a sedge, a rush (*Luzula parviflora*) and a grass. Ten percent coverage by a common moss completes the vegetation description of this site.

The trench floor, R2Ab, is partially covered by shallow ponds and small channels. Original material from the crest is slumping down the trench cut and this give the surface a loose hummocky appearance. The site is densely revegetated (Plate 3-13); the supply of water and fine texture of the matrix, as well as the gentle slope of this low lying area encourages regrowth. At one site, willow which grows up to 3 m tall covers 60% of the low shrub layer. The forb layer is very dense with two horsetails (*Equisetum arvense* 70% and *E. sylvaticum* 30%) dominating. An unidentified waterplant contributes 5%, and fireweed adds 1% coverage to this layer. Two mosses cover 51% of the plot; and no lichens are found here.

Trench R2E has a north facing wall approximately 20 m high, with a slope of 30 degrees. The exposed permafrost is now melting and providing an unstable trench wall with large blocks of slumping soil, organic mat and water. This site is on a very long, densely vegetated old trench which is heavily used by moose for browsing. The trench floor is densely vegetated, with as much as 80% of the ground being revegetated. There are no trees on this site, but the tall shrub layer is well represented by two species of willow (50%), one of which reaches 6 cm diameter at the base. Both species reach a height of three metres. The sparse low shrub layer is made up of white spruce, paper birch and trembling aspen, all up to 0.5 m tall. The moderately dense forb layer is represented by two horsetail species, Northern starwort (*Stellaria calycantha*) which is rare in this area, fireweed and yarrow. A grass (*Calamagrostis sp*) covers 30% of the graminoid layer. Two mosses and a liverwort each add 10% to the ground cover.

The slumping trench wall is a mixture of displaced vegetation mats and incoming vegetation. The displaced vegetation blocks belong to the same community described in the undisturbed vegetation plot. The new regeneration includes willow in the low shrub layer (20%), and horsetail 20%, fireweed 5%, and a starwort (1%) in the forb layer. Two grasses at 25% combine to form the graminoid layer. A large moss species (20%) and a little moss species (60%) combine to dominate the vegetation on this permafrost slump site.

DRILL PADS
1984: R6 (Plates 3-15 and 3-16); 1968: R8A.

The 1984 drill pad (**R6,** S-84-4 in assessment report) is a fairly level square surface facing west. Site **R6A** the drill pad itself (Plate 3-15) has been levelled by heavy equipment. The surface has 95% stony coverage and is fairly compacted. The soil is a moderately well drained gravel with a sandy clay loam matrix with 20% coarse fragments. The sparse vegetation is limited to white spruce (5%) in the low shrub layer, willow (3%) and traces of dwarf birch and trembling aspen. Fireweed (3%) and arctic lupine (1%) constitute the very sparse forb layer. Two common grasses combine for 15% in the graminoid layer. A common moss contributes 1% to the moss/lichen layer.

Site **R6B** is an overburden pile with a loose, rough surface, beside the drill pad. The soil is the same gravelly silty loam mixed with some organic matter from the old drill pad surface. This site has good regeneration with only 10% bare ground showing. The looser surface and mixed in organics are probably responsible for the more productive regrowth. The low shrub layer is denser and more varied, consisting of willow (15%), white spruce (15%), and a trace of balsam poplar, trembling aspen, paper birch, prickly rose and Labrador tea. The dwarf shrubs crowberry and low-bush cranberry are also found here. Fireweed dominates the sparse forb layer with 20% coverage. Traces of other species found here are yarrow, arctic lupine, and a spike like goldenrod (*Solidago spathulata*). A common grass covers 25% of the graminoid layer. One common moss occupies the moss/lichen layer with 20% coverage.

This 1986 drill pad is located at an elevation of 1010 metres, is approximately ten square metres, and is fairly level with a compacted surface. The material is a gravelly sandy loam with up to 30% coarse fragments and ashy pockets. **R8Aa** is located at the centre of this well compacted and sparsely re-vegetated drill pad. The low shrub layer is sparsely occupied by white spuce reaching 0.4 m high, alder, willow, trembling aspen and Labrador tea. A trace of crowberry represents the dwarf shrub layer. The sparse forb layer is made up of arctic lupine and a trace of fireweed. Two common grasses combine to cover 6% of the graminoid layer. One moss and two lichens each cover 5% of the moss/lichen layer.

Location R8 Ab is on the hummocky looser surface at the perimeter of the drill pad. The soil is very similar to the previous location, except that it is less compact, and shows much greater regeneration. No soil is visible here, but some exposed rock covers 2% of the site. The tall shrub layer is represented by paper birch (10%) reaching 4 m in height and 4 cm DBH, white spruce (15%) up to 3 m tall, and alder (10%) up to 2.5 m tall. Five species occupy the low shrub layer: Lodgepole pine (*Pinus contorta*, 2%) up to 1m tall, willow (10%) up to 2 m tall, dwarf birch (2%), labrador tea (5%), and blueberry (5%). The dwarf shrub layer is sparsely represented by crowberry, low-bush cranberry, and a trace of kinnikinnick. Fireweed and arctic lupine combine to cover 5% of the forb layer. Two common grasses combine to cover 4% of the graminoid layer. Two mosses, combining for 3%, and five lichens combining for 6% cover the moss/lichen layer of the site.

SUMMARY

TRENCHES

The regrowth on the trenches in this area respond to similar factors as in the Klondike area with slope stability, moisture content and matrix content being the most important. Slopes showing active erosion and slumping are still very sparsely vegetated by pioneer shrubs, forb and grass species. A significant exception to this seem to be the slopes affected by permafrost degradation. The melting ice provides abundant moisture to the soil and accelerates slumping and reprofiling of the excavated wall. The original forest surface moves down as large blocks and carries organic rich soil, as well as established vegetation pockets.

As was the case in the Klondike area, gullying is more active in trenches parallel to the slope of the hillside. Gullying causes the transportation of fine particles downhill from the trench, and increases surface erosion of the trench wall and colluvium. This has affected roads and sites located downhill from such trenches.

Revegetation rates in the Carmacks area are comparable to the revegetation rates in the Klondike, considering the matrix content and climatic differences (Carmacks is slightly drier). Shrubs of similar age are slightly taller in the Klondike area. Pioneer tree and shrub species are similar in the two areas, and many of the forb and grass pioneer species are the same (fireweed, Arctic lupine, horsetail, coltfoot, yarrow, etc). A few species are encountered in the Klondike area, but not in the Carmacks area, such as alder; or are less common, like crowberry and raspberry. Other species, like the lodge pole pine, are absent in the property visited in the Klondike; but overall, there is a great deal of similarity between the early stage of revegetation in the two areas.

DRILL PADS

As noted in the Klondike area, drill pads have a compact, nearly level surfaces and are built with overburden from surrounding areas. The soil has a chemistry similar to the trench walls, and colluvium has little nutrients available to plants and commonly a matrix of at least 20%. Revegetation is definitely more successful, both in ground coverage and variety of species for each layer, on the looser more friable surface of the rim surrounding drill pads. Drill pads as recent as 1984 show 90% ground coverage on their looser rough rim surfaces.

CHAPTER FOUR

HARD ROCK EXPLORATION DISTURBANCES ANNIE LAKE AREA

INTRODUCTION

The Annie Lake area is part of the Wheaton River mining district. This area has been an actively explored and mined for the last several decades. The two properties selected, Red Ridge and Idaho Hill, are high elevation sites and are now inactive. Both properties can be accessed via a road branching off the Annie Lake Road. Access to the exploration trenches on Red Ridge is by foot or helicopter, as the cat trail running uphill from the camp has been eroded and has slumped in several locations. The Red Ridge property is located above treeline. Access to the Idaho Hill property is by vehicle and foot. A total of 14 sites are described in this area (Figure 6), ranging in elevation from 1160 to 1525 metres a.s.l., and dating from 1988 on the Red Ridge Property, and possibly 1980 on the Idaho Hill Property.

CLIMATE

This area lies in the heart of the rain shadow to the lee side of the St. Elias Coast Mountains; the climate can be classified as arid. Precipitation ranges from 200 to 325 mm. One third to half of this falls as rain (primarily showers) during the summer months. A secondary maximum occurs in the fall and early winter and is associated with active storm centres in the Gulf of Alaska. Snow cover is generally in place from late October to mid April in the lowest valley floors, and a month longer over the higher terrain.

Mean annual temperatures are near -1° C. Mean January temperatures average -19° C and are usually 5° C warmer over higher terrain due to the inversion. Short periods with temperatures above zero can be expected during winter months. July mean temperatures average 14° C and are some 5° C cooler over higher terrain. Extreme temperatures have ranged from -55° to plus 34° C. The average temperature from May to September is 11 degrees. Mean annual precipitation is 260 mm, with precipitation from June to August averaging 98 mm. Most of this weather information is obtained from the Whitehorse Airport weather station located at an elevation of 698 m.

Winds are generally moderate, particularly in valleys with southeast to northwest orientation, due to the proximity of storm centres in the Gulf of Alaska. Strong winds 30 to 50 km/hr are common; winds can occasionally reach destructive force with gusts over 100 km/hr, primarily from a southerly direction.

GEOLOGY

The properties occur in the Coast Plutonic Belt near its eastern border with the Intermontane Belt. The Coast Plutonic Complex intrudes the Paleozoic and possibly older rocks of the Nisling Terrane. The Nisling rocks are quartz-rich metamorphic rocks which extend from Alaska, through the Yukon to northern British Columbia. The Nisling Terrane, along with 2 other allocthonous terranes (Atlin and Stikine) make up the Intermontane Belt; the Coast Plutonic Complex is within the Coast Belt. The Atlin Terrane is composed of rocks of the Cache Creek Group, an ophiolite (oceanic) assemblage of altered basic volcanic rocks and gabbro, chert and limestone of Late Mississippian to Middle Triassic age. Fossil evidence from Permian rocks indicate an exotic origin. The Stikine Terrane is composed of Upper Triassic volcanic arc rocks resting unconformably on Paleozoic oceanic sedimentary rocks. The Whitehorse Trough is an elongate belt of basalt, porphyry and associated sedimentary rocks of the lower Lewes River and upper Laberge Groups. These were deposited during Upper Triassic to Middle Jurassic time, on the northern Stikine and Nisling Terranes. Eastern portions of the Trough may overlie Atlin Terrane (Cache Creek Group).

The Coast Plutonic Complex is made up of numerous intrusions in the following five age-based groups: Late Triassic, Early Jurassic, Mid-Cretaceous, Late Cretaceous/Paleocene and Early Eocene. Intrusions of all groups occur in both the Coast Belt and in the Intermontane Belt to the east, although there are few Late Triassic and Early Jurassic intrusions east of the Tally Ho Shear Zone. The intrusive complex is likely the magmatic and metamorphic response to accretion.

Terrane-bounding faults show evidence of the structural history of accretion in the region. The Tally Ho Shear Zone and Llewelyn Fault form a prominent northwest-trending structure which separates the Nisling Terrane and Coast Plutonic Complex, on the west, from the Stikine Terrane. It was later reactivated and involves the younger rocks of the Whitehorse Trough which only occur to the east of the Zone.

More locally, the area is composed of Wheaton River volcanic flows, breccias and epiclastic rocks of Late Cretaceous age, cut by Late Cretaceous alaskite and granite of the Perkins Peak Plug and

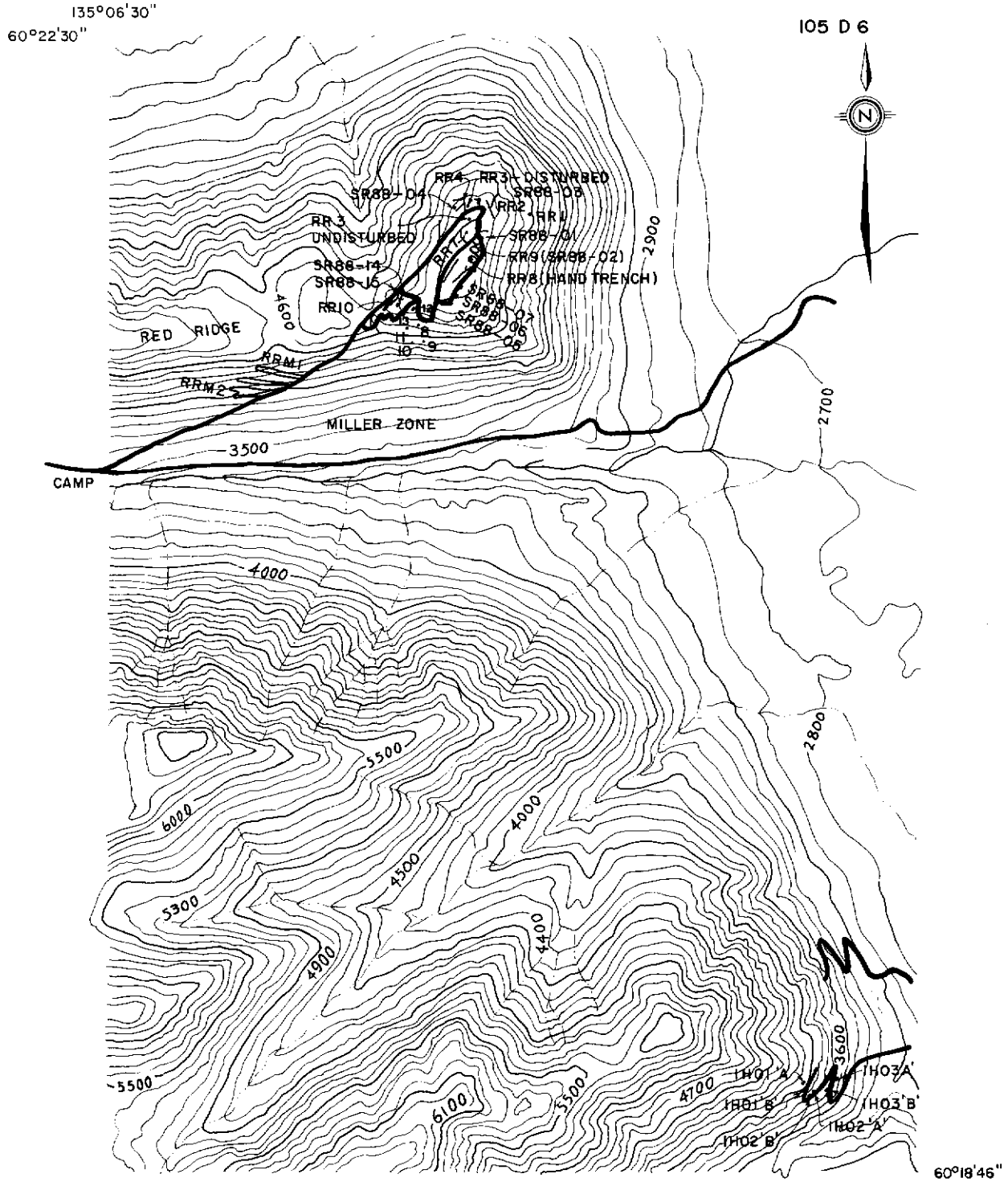

FIGURE 6

ANTHROPOGENIC FEATURES AND SITE LOCATION ANNIE LAKE AREA

associated with undifferentiated granitic intrusions also of Mesozoic age. The area is cut by northwest- to northeast-trending faults and fractures which bring slivers of Lewes River Group rocks into juxtaposition with the much younger intrusive rocks. Laberge Group conglomerates also occur in the area, and are intruded by the Perkins Peak Plug. Mineralization includes copper, molybdenum, gold, silver, and lead (Inco property).

SURFICIAL GEOLOGY

The Annie Lake area lies within the limits of the McConnell Glaciation (Bostock, 1966). Typically, morainic and colluvial blankets overlying the bedrock are found at high elevations above valley bottoms (Figure 7). Glaciofluvial sand and gravel terraces flank the valley sides, and locally pitted, or hummocky deposits of sand and gravel line the bottom of the valley. Colluvial fans or aprons are common.

The Annie Lake area is located within the scattered permafrost zone (Brown, 1978). Permafrost is probably more common at high elevations, in morainal and colluvial deposits with visible ice, and nivation and cryoplanation features. At lower elevations, alluvial and glaciolacustrine sediments may have less extensive permafrost, but higher ice content. There were no visible signs of permafrost in the trenches described in this area, but it is possible that localized pockets of permafrost occur in sheltered sites with a thick organic cover.

MINERAL EXPLORATION HISTORY

Although there has been extensive exploration activity in the Wheaton River area since the early days of the Klondike Gold Rush, it appears that the property on Red Ridge was staked for the first time in 1970. Early exploration included soil sampling and geological mapping. The area has since been further explored by additional mapping, geochemical sampling, trenching and diamond drilling. Reports indicate that the most recent activity in the area occurred in 1988, when soil sampling, geological mapping, trenching and diamond drilling projects were carried out. The company which undertook this work was delisted from the Vancouver Stock Exchange in 1992.

The Idaho Hill property was first developed in the late 1920's, when 3 adits were completed. In 1946, the main adit in Showing Number One was completed. Ongoing trenching and surveying has followed. The trenches observed during this project are beleived to belong to the 1980 exploration program, when trenching in the Number 1 showing took place.

In the vicinity of the property, diorites of the Coast Plutonic Complex are cut by rhyolite and andesite dykes. Gold and silver mineralization occurs in veins, pods, and shear zones closely associated with Tertiary rhyolite, dacite and andesite dykes. Clay, limonite, silica and manganese alteration occurs with the showings.

Mineralization occurs as chalcopyrite and molybdenite in quartz veinlets and disseminations in the diorite, and as steep-dipping, north-trending vein zones associated with the dykes. Vein zone mineralization includes pyrite, galena, chalcopyrite, malachite, azurite, sphalerite and some tetrahedrite with associated quartz, barite and carbonate. Assays of 6200 g/t silver and 28 g/t gold have been obtained from the Red Ridge property. Mineralization on the Idaho Hill property appears to be related to the Skukum Group low level intrusives. Precious metal are confined to steep to shallow dipping shear zones and quartz-carbonate veins.

RED RIDGE PROPERTY

UNDISTURBED SOIL AND VEGETATION CONDITIONS

RR5 and RR6 (Plate 4-1).

The undisturbed surfaces consist of hillsides and crests, gently rounded to hummocky, with some exposed bedrock. The exposed rock is visible in varying proportions at each site. Weathering processes, such as frost shattering have been very active. In most areas, a veneer of colluviated overburden or residual bedrock covers the surface. This material consists of up to two metres of colluviated or weathered bedrock, usually a very gravelly (more than 80% clasts content) material with a fine sandy matrix. Stones are very angular to sharp, imbricated and channery. The soils developed on these friable deposits consist mainly of Brunisols or Regosols which means that there has been no significant mineral soil development. An organic mat with thicknesses ranging from 4 to 21 cm rests on the mineral soil. The fairly dense ground vegetation is typical of high alpine areas. Two vegetation assemblages considered representative of the properties vegetation are described sites RR5 and RR6.

Site **RR5** is at the top of the eastern edge of Red Ridge on a north facing slope, with a gently inclined surface at elevation of 1524 m. This site is located above tree line and the vegetation cover is fairly continuous except for a few bedrock outcrops. The low shrub layer is represented by two willow species, combining for a coverage of 15%. The dwarf shrub layer is composed of mountain aven (*Dryass sp*, 20%) and low-bush cranberry (1%). Moss campion (*Silene acaulis*), showy Jacob's-ladder (*Polemonium pulcherrimum*, 1%), red-stemmed saxifrage (*Saxi-*

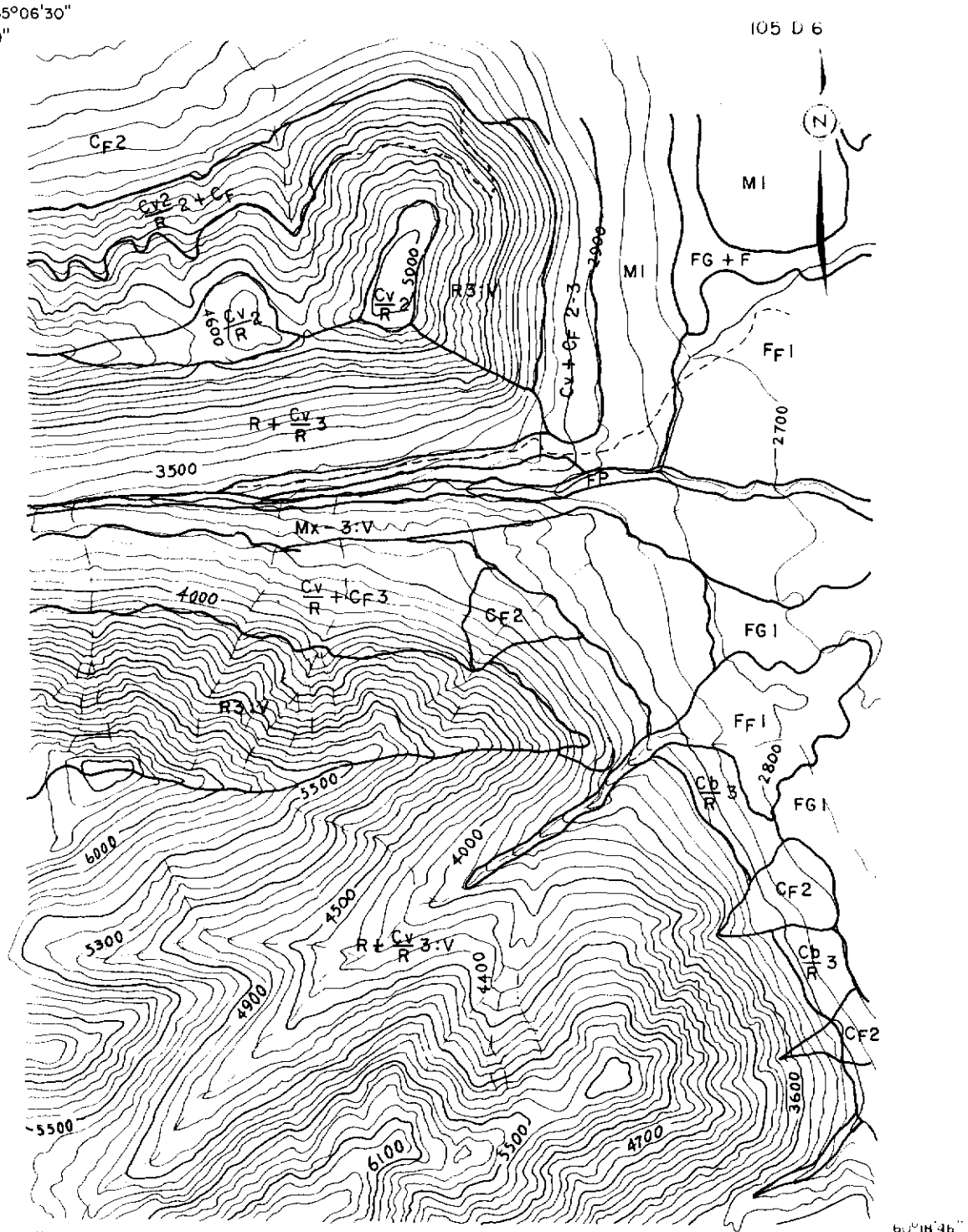

FIGURE 7

DISTANCES IN METRES

500 0 500 1000 1500 METRES

SCALE 1:30 000

SURFICIAL GEOLOGY- ANNIE LAKE AREA

fraga lyallii), and a starwort make up the sparse forb layer. The graminoid layer is comprised of two grasses combining for 10%, and a sedge (Carex sp) covering 2%. Two common mosses combine for 7%, and three lichens dominated by *Cetreria cucculata* (25%) cover 27% of the moss/lichen layer.

The next undisturbed site (**RR6**) is located near sites RR3 and RR4. Apart from 5% of the ground which is composed of rock outcrop, the vegetation coverage is fairly continuous. The shrub layer is represented by willow with 15% coverage. The dwarf shrub layer is more diverse, composed of dwarf birch (10%), low-bush cranberry (10%), blueberry (5%), a trace of shrubby cinquefoil (*Potentilla fruticosa*), and mountain aven (20%). The sparse forb layer, composed of different vegetation than the first site contains: prickly saxifrage (*Saxifraga tricuspidata*, 5%), a wintergreen (*Pyrola sp*, 3%), a trace of black-tipped groundsel (*Senecio lugens*), and 1% each of Arctic lupine and moss campion. Two grasses combine to cover 25% of the graminoid layer. Four mosses and eight lichens species together cover more than half of the ground.

TRENCHES

General Trench Description

RR1b, RR2A (Plate 4-2), RR3 (Plate 4-3), RR4, RR8, RRM10A (Plate 4-1).

All trenches on this property were assigned to the 1988 exploration program. All disturbances are located above treeline and are basically unvegetated. Trenches are 1 to 3 metres deep; some walls are still near vertical and others have slumped, and have slopes ranging from 35 to 55 degrees. The trench tailings and overburden are dominantly composed of fragments of bedrock, coarse gravel and a very low proportion of fine-grained matrix, less than 10% in most cases. Incoming vegetation is very sparse and forms small isolated clumps. Fireweed, prickly saxifrage, sage, a starwort species are the forb species coming back with small showing of grasses (Calmagrostis). Mosses are also present.

Detailed Trench Description 1988

RR3 1988 (Plate 4-3)

The excavation is located at an elevation of 1500 m, and is approximately 6 m wide at its midpoint and on average 3 m in height, facing northwest with a slope of 55 degrees. During excavation, the organic and fine layers were removed and deposited first; they compose the base of the overburden piles. These piles consist primarily of bedrock fragments up to 15 cm in size, and are the source of the slumping material. Runoff is transporting the finer particles of the excavated material back into the trench. Runoff is also exposing fragmented portions of the trench walls which when loose enough will create even greater wall/slope instability. The material in the trenches and piles has a pH of 4.6, and is dominantly composed of coarse fragments of very angular bedrock. The matrix is mainly sand-sized crushed bedrock and averages 10%. The trench bottom consists nearly entirely of coarse fragments. The original soil exposed at the edges of the trench, shows a 7 cm thick organic mat, and abundant micro to medium roots to a depth of 7 cm.

The site is very sparsely revegetated. The three species found here are fireweed (2%), a starwort (5%), and a tiny moss species covering 5% of the site.

DRILL PADS

RR9 1988 (Plate 4-4).

The drill pad **RR9,** identified as SR88-02 in assessment reports, was built in 1988. It is located below RR7, on an east facing slope at an elevation of 1465 m. The surface is composed of a compact stony gravel, with a sandy loam matrix of pH value 5.2. It is well drained and has no soil development. This site is very sparsely vegetated and more than 90% of the surface is bare.

OTHERS

Cat Trails

RR7 (Plate 4-5).

Site **RR7** is at the top of a ridge that was disrupted by the movement of heavy equipment; it is partially stripped, with clumps of organic mat preserved on more than 50% of the surface. Vegetation regeneration is limited to patches which have some topsoil present. The surface on site consists of 20 cm of gravelly colluvial material on bedrock, is well drained, and has numerous fine roots.

A touch (1%) of mountain aven is the only dwarf shrub on the site. A starwort covers 2% of the sparse forb layer, and the following species cover 1% each: fireweed, tall bluebell, a saxifrage and an artemesia species. The grass *Festuca altaica* covers 10%, and a tiny moss adds 5% vegetation cover to this site.

IDAHO HILL PROPERTY

UNDISTURBED SOIL AND VEGETATION CONDITIONS

IDA1B (Plate 4-6), ID2B, IH3B.

Site **IDA1B** is a subalpine site on a moderately steep southeast facing slope, at an elevation of 1240 m. The surface is 90% covered by loose stones and appears to be actively colluviating. The soil is a rapidly draining Orthic Eutric Brunisol formed on colluvial parent material. The top 15cm of the mineral

soil is mixed with organic material and has a soft crumbly consistency. The BC horizon is a loamy coarse sand with 30% coarse fragments, and plenty of microfine and fine roots.

The vegetation plot was selected on a densely vegetated portion of the slope. It is dominated by forbs and shrubs, and open soil covers 20% of the area (Plate 4-6). The tree layer is formed of sparse white spruce with DBH's of 10 to 15 cm, and HT's 5 to 8 m. The low shrub layer is composed of willow (10%), subalpine fir (*Abies lasiocarpa*, 5%), dwarf birch (1%), and common juniper (3%). Five percent of the dwarf shrub layer is covered by kinnikinnick. The forb layer is well represented by prickly saxifrage which dominates with 25% coverage. The other species included in this layer are field locoweed (*Oxytropis campestris*, 15%), a goldenrod species (*Solidago sp*, 5%), yarrow (1%), a gentian species (*Gentiana* or *Gentianella sp*, 2%), an Artemesia species (1%), and a starwort species (5%). The graminoid layer is strongly represented by the common indigenous grass *Festuca altaica* with 50% coverage, and a sedge with 5%. No mosses are found at this site but three lichens combine to cover 11% of this moss/lichen layer.

Site **IH2B** located approximately 100 metres lower on the hillside represents a subalpine vegetation community with low lying plants, dominated by low willow shrubs and dwarf kinnikinnick shrubs with a sparse forb layer. Site **IH3B** has similar soil and morphology, but has a slightly different vegetation community. It is the lowest site looked at in this area and is composed of a subalpine graminoid/forb community. No trees or tall shrubs are found at this site, but nearby there is a stand of trembling aspen. The sparse low shrub layer is represented by willow, white spruce and juniper. Thirty percent of the dwarf shrub layer is covered by kinnikinnick. The forb layer is sparse and composed of traces of many species: Mountain death camas, gentians, a groundsel, prickly saxifrage, twin-flower, yarrow, showy Jacob's-ladder (5%), and an Artemesia species. The graminoid layer is represented by the common indigenous grass *Festuca altaica* (40%), and sedge (10%). Two lichens cover 2% of the moss/lichen layer.

TRENCHES

IH1A (Plate 4-7), IH2A (Plate 4-8), IH3A.

This property was the last one visited and field work was cut short due to poor weather. Trenches are believed to date from the 1980 exploration program, and therefore no detailed trench description is presented here.

Trenches observed in this area are excavated into bedrock. The colluviated material in the trench and the tailings are composed of very coarse to boulder gravel with little fine-grained matrix. Trench walls seemed to be unstable, with slumping and failure occurring frequently enough to impede revegetation. The sparse incoming vegetation consists mainly of juniper and willow shrubs, several alpine and subalpine forb species, and a few grasses and lichen species.

SUMMARY

TRENCHES AND DRILL PADS

The Red Ridge property is not truly comparable to the Lone Star, Revenue and Nucleus properties. The vegetation at this site are different than at the subalpine sites: moss campion, red-stemmed saxifrage, mountain aven, and wintergreen. This site is located above treeline at higher elevations, and climatic conditions are harsher for vegetation. This combined with the coarse nature of the colluvium in the trenches are the main reasons for the poor revegetation of the walls and overburden piles.

The trenches show little regrowth, except for the slumping surface material. The drill pad investigated also shows very sparse regrowth. These sites, and sites similar to these would definitely require a more aggressive revegetation program. Preparation of the overburden to be replaced onto the disturbances and a seeding/fertilizing program would probably be needed.

OTHERS

The cat trails at the Red Ridge property show that the disturbed surfaces left with organic matter and vegetation recover from the impact of the equipment. The stripped surfaces, though, do not revegetate rapidly even on gently sloping, relatively undisturbed surfaces. The high alpine areas appear distinctively more sensitive to surface disruptions.

CHAPTER FIVE

PLACER MINE DISTURBANCES KLONDIKE AND CARMACKS AREAS

INTRODUCTION

Methods for placer mining in Yukon are very different from those employed by hard rock mining. Commonly, the target consists of approximately 2 to 5 m of gravel overlying weathered or altered bedrock, as well as the top 0.5 m of this weathered bedrock. To reach this "pay streak" which commonly occurs in narrow valleys or gulches, placer miners strip the overburden to the desired depth. The stripped/ excavated overburden is piled, and the pay gravel is gradually processed into a fine gravel which is sluiced and the gold is extracted from the finer fractions. The coarser fraction of the pay gravel consists of fairly well- to well-sorted sand and gravel (depending on the technology involved in the sorting process) which is again piled. The remainder of the processed material is collected in settling ponds where the suspended solids eventually settle, and the decanted water is returned to the stream. Placer mines are usually small-scale operations, operated by two to six people. Unlike high alpine sites, they are usually located close to a stream and surrounded by densely vegetated areas. The reader is referred to Chapters 2 and 3 for geological and climatic information in those two areas.

In the Klondike area, four operations were visited in the vicinity of the Lone Star property. They are the 7 Pup, Oro Grande and Nugget Gulches placer mines, all of them excavated in ice-rich, organic, silty alluvial deposits (Figure 3) except for the 7 Pup operation which processed old tailings and some terrace deposits. One placer site (Discovery Claim) is located on a bedrock bench which probably supported White Channel Gravel. Walls, overburden piles, and a few settling ponds, ranging from 1912 to 1993, for a total of 26 sites in the Klondike area (Figure 2) are described in this chapter. Mine operators were very cooperative and it would have been impossible to date surfaces without their help. Two groups of observations are summarized in this chapter. The 7 Pup operation presented a range of surfaces dating from 1912 to 1993 and each site is summarized here. The Oro Grande operation provides a record of tailings and cuts from 1988 to 1993. In the Carmacks area, five placer mine sites were investigated along Mechanic Creek (Figure 4).

7 PUP PLACER OPERATION

INTRODUCTION

This placer operation is located east of the Lone Star bunkhouse, on tributary of Victoria Gulch, at elevations of 600 to 890 m. The operation is currently reworking old tailings dating from the early 1910's to the 1930's, as well as breaking new ground on benches at a higher elevation than the original old workings. The operator, Mr. G. Bride helped our team locate and date the features described here. At this site there are tailings dated at 1912, the 1970's, and 1990, and two recent settling ponds (1993).

UNDISTURBED SOIL AND VEGETATION CONDITIONS

7P 02

This site is located at an elevation of 885m on a north to northeast facing slope, and is approximately 200 m southwest of site 7P1. The surface is moderately hummocky with randomly leaning trees, evidence of slow creep. Permafrost is present at shallow depth, and the soil is classified as a Static Cryosol, or a soil with permafrost, but no cryoturbation. The soil is developed on colluvial deposits overlying bedrock and is poorly draining with a slight seepage on top of the permafrost at depth of 47 cm. The organic layer is 20 cm thick and the mineral soil has a 6 cm thick Ah horizon with a pH of 4.6. Soil texture is a sandy loam with minor coarse fragments. The moisture content is high at 32%. The roots reach 47 cm in depth, where the permafrost is a root restricting horizon.

This site is densely vegetated, with the ground predominantly covered by a typical black spruce community underlain by permafrost in a late successional stage. The forest component of this undisturbed site is composed of very sparse small black spruce (< 5%, HT 5 to 6m, DBH of 7 to 8cm). The tall shrub layer is sparse at 10% coverage and comprised entirely of smaller black spruce (HT between 0.3 - 5 m). The low shrub layer is composed of alder (1%), willow (2%), dwarf birch (10%), and Labrador tea (30%). The dense (80%) dwarf shrub layer consists of low bush cranberry (40%), blueberry (25%), cloudberry (10%), and moss berry (5%). The two species in the sparse forb layer are horsetail and bastard toad-flax. The graminoid community is represented by a grass (Calamagrostis spp) at 5% and a medium (25%) coverage of sedge. The

remainder of the forest floor is nearly completely covered by mosses and lichen.

TAILING PILES

1980 TO 1985: 7P4; 1912: 7P1 (Plate 5-1)

The two tailing piles investigated were of different age. At site **7P4,** the surface, dated at approximately 10 to 15 years old, is hummocky and loose, and shows some signs of gullying and surface erosion, such as fine-depleted crests and fine-enriched depressions. There is no sign of permafrost or water seepage. There is no soil development and the material consists of medium to coarse size sand, with very few coarse fragments and very low content of silt. There is a thin litter of leaves and grasses at the surface.

This site is a very well regenerated dense shrub-grass thicket. There are no trees here but the tall shrubs are very tall; the dense alder (*Alnus crispa*, 60%) reaches four metres in height, and the willow, five metres. The low shrub layer is less obvious (17%) than the very thick (80%) tall grass (*Calamagrostis spp*). Three forbs (20%) are dominated by fireweed. A feathermoss (*Hylocomnium splendens*) and another moss (*Polytricum juniperinum*) at 5% each complete the site vegetation picture.

Site **7P1** is believed to have been undisturbed since the 1910's. Although the trees were hand cleared in 1991, most of the 1912 surface vegetation and soil had not been affected by this recent disturbance. The surface appears fairly stable, but sensitive to change in ground cover. Slow creep, and visible cracking in the mosses are probably a response to the removal of trees. Some water seepage was observed at the interface of the moss and the mineral soil. The overall surface is gently hummocky and densely vegetated. There is no mineral soil development, but a 14 cm thick surface organic mat has formed over the last 70 years. The parent material is a gravelly silty sand with 23% coarse fragments, has a moisture content of 23% and a low pH value of 4.8.

Vegetation at this site is very similar to the undisturbed vegetation described at site 7P2, both in species present and density of layers with the exception of the stumps (average diameter at ground level 7 cm) which remain from the 1990 clearing of trees. Tree ring counts on those stumps, using hand lenses provided us with ages ranging from 78 to 65 years. Unlike in the undisturbed area nearby, lichens are almost absent with the sparse occurrence of *Cladonia cornuta* (2%).

CUTS

1980: 7P 05

This site is a seven metre long, about four metre tall cut bank, approximately 15 years old, and now has a slope of 39 degrees. There was evidence of previous colluvial slope processes stabilized over time by the establishment of alder. Tiny mosses were present on the soil surface which reduced surface erosion. The mineral soil is a well drained gravel with a sandy loam matrix and 60% coarse fragments.

The site supports moderate revegetation: the willows reach four metres in height. Four other low shrub species are dominated (50%) by alder (Alnus crispa). The sparse forb layer consists of fireweed (10%), and horsetail (5%). Three moss species and three lichens (<10%) complete the vegetative description of this plot.

SETTLING PONDS

1991: 7P 03 (Plate 5-2)

The settling pond consisted of two fairly flat surfaces approximately 10 by 10 metres square, composed of very moist to wet silt, micaceous silt and fine sand with pH value of 5.2 to 5.8, with a rim of piled overburden.

The lower and wetter portion of the settling pond **(7P 03A)** has a sparse (20%) low shrub community of two willows which show signs of snowshoe hare browsing. Forbs are represented (35%) by wild rhubarb, horsetail and a mustard spp. Graminoids are represented entirely by grasses (no sedges), very dense at 75% cover. A young, tiny moss spp covers the soil very densely at 80%.

The upper portion of the settling pond, **7P3-B,** has very dense (>90%) vegetation cover. The low shrub layer is well (35%) represented by two willow species. The forb layer of six species (25%) is dominated by horsetail. The graminoid layer is very strong at this site with near complete coverage by a very common short grass (*Agrostis scabra*) and two tall, common grasses of the Calamagrostis genus. A very dense mat (80%) of a tiny moss spp completes the vegetation community.

ORO GRANDE PLACER OPERATION

INTRODUCTION

The Oro Grande placer operations is located along Oro Grande Gulch which is a tributary of Eldorado Creek. The gulch has been mined from 1988 to 1993 by Beron Placer Co. Ltd. owned by B and R Johnson. B Johnson was very cooperative in dating cuts and tailing piles and in explaining their excavation methods, and also their valley floor and stream flow management. This creek is particularly interesting because it records rates of revegetation and slope movement for four successive years of

both excavations and pilings, with the surfaces getting younger upcreek. The site is now left to its own natural evolution. The stream base, now a gravelly gently inclined surface, has been worked into steps, or terraces, and dammed at its interception of Eldorado Creek to regulate flow and sediment intake into Eldorado Creek.

The miners used hydraulic and mechanical excavation techniques, and moved approximately 300 metres up creek every year from 1988 to 1993 except in 1991. The material, once processed, was piled downstream nearly as high as the original creek side surface. Walls or excavated faces dating from 1989, 1990, 1992, and 1993 are described. All of these were composed of what is locally known as black muck, an organic rich silt with abundant permafrost, both in large ice bodies and small interstitial ice lenses. Original surfaces covered with thick organic mat and mosses overhang and eventually slide down, importing much needed organic material to the active slope face.

The piles of tailings are generally steep faced, hummocky with a rough surface, and are approximately 20 metres high. The sites described here dated from 1989, 1990, 1992 and 1993, the older sites located upcreek (Plate 5-3). They are separated from the original valley side by an access road, but are roughly at the same elevation as the untouched surfaces.

UNDISTURBED SOIL AND VEGETATION CONDITIONS

Undisturbed conditions at creek level could not be observed. Conditions at higher elevation is similar to the vegetation and soil described for the Lone Star property. The undisturbed original area is a typical permafrost black spruce forest of small trees, mixed with sparse small to medium sized paper birch. The tall shrub layer includes the tree species mentioned above and a few balsam poplars. The low shrub layer is comprised of Labrador tea, willow and blueberry. Forbs include coltsfoot, twin flower and bluebell. The area also has a strong feathermoss and lichen (Cladina spp) component. The area is entirely vegetated and a game trail was noted.

CUTS

1989: OG1A (Plate 5-4), 1990: OG1B (Plates 5-5 & 5-6), 1992: OG1C (Plate 5-7), 1993: OG1G (Plate 5-10)

1989 Cut

This north facing cut (**OG1A**) was excavated in 1989 and extends approximately 320 metres upcreek from the mouth of Oro Grande Gulch. When abandoned in 1989, the slope was near vertical. The present slope is approximately 15 metres high with a slope of 45 degrees (Plate 5-4). The thawing permafrost and fine-grained nature of the material facilitates slumping and re-establishment of a stable slope. There is still active gullying caused by runoff from the above undisturbed ground, and slumping is still common both at the surface of the receding wall and at the base of the slope. This slope, however, has modified its original vertical face into a much more gentle profile (35 to 45 degrees). The high moisture content of the material and the slumping of the original surface vegetation has allowed mosses and grasses to take hold of the more stable portions of the slope.

This plot is densely (>90%) vegetated, mostly by forbs (Plate 5-4). The sparse (10%) low shrub layer is dominated by a willow. The dense (60%) forbs layer is dominated by a very tall (1 m) mustard spp (30%). The graminoid layer is well represented (30%) by a grass (Calamagrostis spp). This plot is unusual because of the fairly substantial (40%) presence of liverwort. There are two moss species (45%), the dominant (40%) of which is very tiny. The mat of roots from the mosses and liverwort has reduced soil surface runoff.

1990 Cut

Site **0G1B** was excavated in 1990 and is located approximately 300 metres up creek from OG01. This face was also near vertical when abandoned at the end of summer, 1990. The present slope is approximately 23 metres high with a slope of 43 degrees. The high moisture content of the material has allowed mosses and grasses to take hold, stabilizing portions of the slope (Plate 5-5). Gullying caused by runoff from the above undisturbed ground and melting permafrost is responsible for cracking (Plate 5-6) and some slumping at the base of the slope. This will eventually cause further failures in areas effected. Evidence of such activity includes the discontinuous cover of organic mat slumped from the original surface, banding of parent material and organic rich horizons, and fresh, unvegetated mineral surfaces. Soil is a fine sandy loam with a very low coarse fragment content.

Vegetation, mainly a tiny moss, covers up to 70% of the surface. Other plants are very sparse, a mustard (Rorippa spp) is dominant (10%). Clumps of original surface are sliding down, and carrying their original ground cover species.

1992 Cut

Site **OG1C** was excavated upcreek from site OG1B and was also abandoned as a near vertical wall. It is now approximately 18 metres high and has a average slope of 39 to 48 degrees, slightly steeper than the previous wall (Plate 5-7). Slope wash, slumping and gullying are present on this slope, as

evidenced by large slumped blocks, recent failure cracks, and numerous colluvial fans at the toe of the slope. Abundant moisture provided by the melting permafrost contributes to the general instability of the material. Coarse material is also more evident at this part of the slope; boulders and cobbles constitute up to 70%.

This site is very sparsely vegetated, with more than 80% of the surface being bare, not including the tiny moss which covers approximately 40% of the ground. Some patches of original mat have sloughed down from above, but are not included in this site description. The dwarf shrub layer is very sparsely occupied by paper birch and alder which are both 0.1 m tall. The forbs are dominated by a mustard (10%). The graminoids are represented by two grasses.

1993 Cut

This section (**OG1F**) of the gulch is the last part to be placer mined and is a one-year old surface at the time of field work. The wall is approximately 22 metres high and south-southwest facing. It now has a 50 degree slope on the lower portion and a near vertical upper portion. The slope is very unstable, numerous deep and long cracks at the surface will eventually cause slumps of considerable size. Gullying, slumping and slope wash are very active on this slope. Due to instability of the slope, no soil pit was excavated. The wall is unvegetated, except for the few slumped blocks of surface material.

TAILINGS PILES

1990: OG1D (Plate 5-8), 1992: OG1E (Plate 5-4), 1993: OG1F (Plate 5-10)

1990 Tailings Piles

Site **OG1D** consists of a tall pile of processed (sluiced and pushed) material and overburden approximately 15 metres tall with a slope ranging from 22 to 28 degrees. The pile faces south and has a rough, ribbed to hummocky surface, slightly compacted to friable. The slope seems stable, with minor gullying and slope wash. Soil at this site is a well drained sandy loam with 15 to 20% coarse fragments and with a thin leaf litter (less than 10 cm).

This very densely vegetated site (Plate 5-9) has a well populated shrub layer, dominated by up to three metre tall willows (two Salix spp, 70%) and paper birch (20%). The dense forb component of the site (60% of ground surface) is dominated by horsetail (35%). Graminoids are well represented (55%) by four grasses (Calamagrostis canadensis and Agrostis scabra dominating) and a sedge. A tiny moss covers most of the soil (60%) and is joined by a liverwort (1%).

1992 Tailings Piles

Site **OG1E**, a tailings pile dating from the summer of 1992 located directly upcreek from site OG1D, on the south facing side of Oro Grande Gulch. The pile is approximately 17 metres high. The upper third of the pile has a slope of 28 to 31 degrees and the lower portion of the pile has a steeper slope of approximately 50 degrees (Plate 5-9). Overall surface topography is rough, hummocky, and loose to friable. This slope is severely gullied and eroded, and failure cracks and associated slumps are developing at several locations. Soil is a moderately well to well drained fine sandy loam.

This is also a very densely vegetated site (more than 80% ground cover). This site has a very slight low shrub component dominated by a willow, however, raspberry (2%) is present. The forbs are strongly (70%) dominated by a mustard (Descurainia pinnata), as is the entire site. Three grasses and a sedge represent less than 15% coverage.

1993 Tailings Piles

This portion of the tailings site **OG1F** is the least stable and least vegetated. Located upcreek from OG1E, the face has a steep slope, more than 50% at most places, and is severely fractured (Plate 5-10) at the top, for as far as 15 metres behind the pile face, and at several places along the face. Piping was also observed at several places. Recent slumping is evident and gullying is developing along some of the fractures. This pile of tailings was judged unsafe to climb around and only the back portion of its surface was observed in detail. Overall surface is loose, friable, very rough and hummocky. The soil is very similar to OG1E, moderately well to well drained, with a fine sandy loam to loamy, micaceous texture and a low content of clasts, woods debris and some bones.

The surface portion of the site is densely vegetated, but less so than the previous two sites. A 0.1 m paper birch makes up the nearly non-existing dwarf shrub layer. The forb layer is strongly (70%) dominated by the pioneer fireweed, as is the entire site. The sparse (10%) graminoid layer is composed of two grasses (Agrostis scabra and Calamagrostis spp). The site is nearly entirely (90%) covered by a tiny moss spp. The part of waste pile which slopes down towards creek has a lower vegetation density. The dwarf shrub component of this site only has one 0.1 m paper birch. The very dense forb component is almost entirely composed of a mustard (60%), and fireweed (30%). The graminoid community is minuscule. A tiny moss species covers 30% of the site. The steep portion of the wall was not surveyed in detail due to the active erosion. Most of the face is sparsely vegetated by grasses and mosses.

NUGGET GULCH

INTRODUCTION

The placer operation ceased in 1988 on this gulch. The main interests of this mined creek are: 1) a 1988 cut into organic rich permafrost-rich silt deposits, 2) well sorted surfaces of sand and gravel, 3) 1988 tailing piles.

CUTS

NG1: 1988 (Plate 5-11), NG2: 1988 (Plate 5-12)

Site **NG1**, a north facing cut, dates from a 1988 mining program area and was left with a near vertical slope. It is now approximately 20 metres high with a slope of 32 degrees on the upper portion and 54 degrees on the lower portion. The slope shows signs of instability due to melting permafrost which is ice-rich with lenses up to 5 millimetre thick. The permafrost is partially covered by peat and organic matter which support the upper vegetation. Exposure of the permafrost face has caused continuous melting allowing the organic layer to overhang the underlying material and eventually slump down the slope. Some fairly stable benches have been created on the lower portion of the slope by the large slumped organic masses allowing some stable areas to form (Plate 5-11).

The soil is imperfectly drained with slight seepage. The mineral soil has a sandy loam to loam matrix and 70% coarse fragments.

Vegetation at this site includes patches of original vegetation communities (50%) and pioneering species. The whole area is a combination of old and new vegetation. Some black spruce are still standing on sloughing patches of original mat. The sparse tall shrub layer is composed of black spruce. The dense shrub layer is composed of colonizing species and indigenous species from the immediate area. Three species of willows, combined for 32%, dominate the dense low shrub layer which includes paper birch (5%), dwarf birch (5%), blueberry (10%), and Labrador tea (10%). The sparse forb layer is made up of wild rhubarb (5%), horsetail (5%), traces of black-tipped groundsel, fireweed, and tall bluebell. The graminoid layer is made up of four grasses, combining for 20% cover, and a sedge which adds 2%. Six mosses combine for 16% cover, and four lichens add 12%.

Site **NG2** is a south facing slope, opposite to NG1 and approximately 20 metres below, at creek level. It is approximately 10 metres high with a slope of 41 degrees. The slope shows signs of instability caused by runoff. A large gully east of the sample area 1.2 metres in width at the top and 2.7 metres in width at the bottom is causing regression of the wall which will soon fail. Grass patches are present where various size slumps have fallen (Plate 5-12). The soil is a very rapidly drained sandy loam with 80% coarse fragments.

The sparse (12%) low shrub layer is comprised of two species of willow and dwarf birch. The sparse herb layer is made up of fireweed, yarrow, and black-tipped groundsel. Three grasses, combining for 32% are in the graminoid layer.

TAILINGS PILES

1988: NG3 (Plate 5-13), NG4 (Plate 5-13), NG5 (Plate 5-14).

The area selected, Site **NG3** is about 50 m northeast and downstream of NG 01, 02 and is a tailings pile which was leveled in 1988, and used to direct the creek flow. The nearly level pad consists of mainly of loamy sand and sand which were machine compacted during placement. Gullying at the edge of this low terrace like feature is very active. The sandy nature and the compact surface of this feature result in a poorly revegetated surface (Plate 5-13). The shrub layer is represented by willow (3%), spruce seedlings (2%), balsam poplar seedlings (3%), and traces of alder and paper birch. A very sparse forb layer shows traces of Arctic lupine. Two pioneer grass species cover 15% of the graminoid layer.

Site **NG4** consists of a flat area composed of gravel and sand which were machine compacted during placement, directly down creek from NG3. This area shows faint signs of revegetation. The sparse low shrub layer is represented by up to 1 m tall willow, a trace of 0.4 m tall trembling aspen, balsam poplar and paper birch. No dwarf shrubs are found at this site. The forb layer is comprised of fireweed (5%), a senecio species (5%) and yarrow (1%). The graminoid layer is represented by three common grasses with a combined coverage of 13%.

Site **NG5** is a 1988 tailings pile located at the intersection of Nugget and Eldorado Creeks. Slopes face northwest, at a variable angle between 10 and 35 degrees. The soil is a rapidly drained fine sandy loam with 40% coarse fragments. This site has revegetated nicely with good representation from most vegetation layers (Plate 5-14). The tall shrub layer is well represented (50%) by up to 4 m tall willow. The low shrub layer is represented by wild raspberry (5%), and 0.6 m tall paper birch (2%). The herb layer has great variety. It is dominated by fireweed (50%), and joined by the following species: wild rhubarb (10%), a cinquefoil species (15%), and traces of bedstraw , black-tipped groundsell, horsetail and tall bluebell (Mertensia paniculata). Two grasses combine for 50%, and a tiny moss species adds another 30% coverage.

ELDORADO CREEK

SETTLING POND

Site **ED1A** is a large settling pond located slightly above creek level on Eldorado Creek. This two level pond is probably two seasons old and is pleasing to the eye because of the dense vegetation cover. The soil is an imperfectly drained silty loam and fine sandy loam matrix, respectively with slight seepage. The side of the settling pond was undercut by the stream (Plate 5-15).

Tiny mosses formed a root mat at the soil surface reducing possible wind erosion. The low shrub layer is sparsely (20%) represented by a willow. The forb component of the site is overwhelmingly (80%) dominated by horsetail (Plate 5-16). The graminoid layer is very sparse (10%), but a grass species (Alopecurus aequalis), rarely seen in this study occurs here at 5% coverage.

DISCOVERY CLAIM

DC 01 Old workings on Parks Canada claim.

This area is a rocky hillside with a 20 degree slope, and medium density vegetation from tall shrubs down to lichen and moss. An island of medium sized trees (birch and spruce) and push piles of old logs indicate deforestation. The tall shrub layer is well (35%) represented by two tree species, paper birch and trembling aspen which are up to three metres tall. The dense (50%) low shrub layer is dominated by alder. Forbs are very sparse (<5%) on this site. The dwarf shrub layer is almost non-existent except for a small amount (1%) of low bush cranberry plants (Vaccinium vitis idaea). Graminoids are sparsely (20%) represented by the common grass Festuca altaica. The two mosses (35%) at the site are dominated (30%) by Polytricum juniperinum. Three lichens are found at the site at a very sparse 3% coverage.

DC 02 (Plate 5-17)

Site **DC 02** is located on a bedrock bench on top of hill, approximately 200 m uphill and west of DC 01. Aspect is variable and slope is 2%. There is a thin discontinuous veneer of gravelly loamy sand over the bedrock which is fractured and friable. This plot is sparsely vegetated mostly by shrubs, grass and moss. Tall shrubs are well represented (45 %) by balsam poplar and alder. Low and dwarf shrubs are very sparse (12%), as are forbs (7%), and the graminoid layer is only represented by a grass (Calamagrostis spp) at 20%. Two lichens (<5%), and a moss (Polytricum juniperinum 30%) round out the low vegetation component of this site.

REVENUE CREEK PLACER PROPERTY

Cuts

1960?: RC3

This site is situated on a cut bank about 300m long which is in various stages of erosion. A burm (push pile) is at the top of the bank, breaking off and falling down. This burm is caused from the building of a trail (1958-64) about 2 m from the top of, and adjacent to, the bank. About 30 m uphill another road was built between 1975 and 1977. The cut is approximately 10 metres in height, facing in a westerly direction with a slope of 40 degrees. The slope is unstable with visible signs of slumping and there are numerous cracks at the top.

This site is well revegetated. The tall shrub layer is represented by willow (25%) which grows up to 3 m tall. The low shrub layer is very sparsely represented by white spruce. The herb layer is occupied by a 1.3 m tall mustard (25%), fireweed (10%), a cinquefoil (5%), traces of a starwort, a mustard, and yarrow. The graminoid layer is represented by four grasses, combining for 45% coverage. A tiny moss species (5%) completes the vegetation picture of this site.

SETTLING POND

1991: RC1, RC2 (Plate 5-18)

This site is a settling pond with side berms to 4.8 metres in height having average slopes of 38 degrees. These berms are cracking and sloughing due to the low moisture content of the soils. Exposure to the elements, i.e., wind and rain, have largly been the cause of the surface erosion present. The floor of the settling pond shows considerable cracking on the surface. The in situ condition of the soils used to make the berms can be classified as 'hard'. The in situ condition of the soil on the floor of the pond is classified as stiff. **RC1A** is located on the upper settling pond in Big Creek valley at base of Revenue Creek hills (Plate 5-18). **RC1B** is located in the same settling pond as RC1A. It was included to show the different vegetation make up. The in situ condition of the soil in the adjoining pond **(RC2)** is also stiff to hard.

Site **RC1A** is a moderately well drained fine sand without coarse fragments in the C1 horizon, whereas the C2 horizon was gravelly. The pH value is 7.8. Willow, growing up to 0.4 m in height is the only shrub on this site. The herb layer consists of two mustards - mustard sp (23%) and Descurainia sp (<1%), a horsetail (10%), yarrow (1%) and a trace of fireweed. Grasses are very strong at this site with 70% coverage. Two common pioneering species combine to add 25%.

RC1B is on a silty clay loam with 10% coarse fragments over a coarse sand with 90% coarse fragments. Willow represents the dwarf shrub layer of

this sparsely vegetated site. The herb layer is composed of two mustards combining for 4% and a horsetail (5%). The grasses agrostis scabra (10%), Beckmannia syzigachne (10%) and foxtail barley (Hordeum jubatum, 1%) represent the graminoid layer.

The settling pond walls are vegetated variously, depending on wall stability and height from bottom (various water levels).

Site **RC2** is a silt loam, silty fine sand, and coarse sand with coarse fragments and has a pH value of 4.6. Plentiful, micro to medium roots were present between 0 and 18 cm. This settling pond has two islands 0.5 m tall with 2.5 m willow growing on them. Vegetation density is very low, therefore percent coverage was not determined.

SUMMARY PLACER MINES

CUTS

The cuts investigated during this study were restricted to a specific environment; all cuts were excavated in 'black muck', the common term for thick organic- and ice-rich deposits found throughout the Klondike and surrounding valleys. Cuts in this material were also seen from the roads and from other creeks in the area. Generally, the exposed permafrost melts rapidly, turning the previously solid frozen wall into a unstable saturated pile of silt and fine-grained material. This process can go on for several years. Observations at Oro Grande tell us that cuts as recent as 1989 now have significantly reduced slope angles and revegetation is coming back in most layers. A 1988 cut on Nugget Gulch now looks like a benched or terraced slope, mostly revegetated by the failing blocks of original surface. A 1978 cut briefly observed in Gay Gulch shows minor slumping and near complete ground coverage. In general, such cuts contain sufficient fine textured soil and moisture to revegetate reasonably rapidly. However, the unstable slope can present a hazard and access should be restricted. Trees falling down the tall cuts can also present risk of injury for at least the first two years.

Excavations on the bedrock bench did not revegetate very successfully and should be treated as exploration disturbances.

TAILINGS PILES

The tailings and overburden piles investigated in the placer mines presented similar relationships as the exploration features. Sufficient fine-grained matrix is necessary, and slope must be fairly stable for revegetation to take place. In most cases, this was accomplished and the abundant moisture supplied by either the creeks or the melting permafrost accelerates growth. Very gravelly material, such as the well sorted gravel and sand of Nugget Gulch (NG4 and NG3) did not revegetate quickly in spite of their gentle topography. This was likely due to the lack of moisture holding fine-texture matrix and total lack of nutrients and organic matter.

Tall steep tailings piles are unstable for at least a few years and gullying and failing can occur. Access should be restricted and there should be no development at the surface of these piles.

SETTLING PONDS

Settling ponds revegetate successfully within a few growing seasons. The abundance of moisture, fine-grained texture sediments and low topography provide good seed beds for the plants. Adverse soil chemistry could be a deterrent factor, but such case was not encountered. Erosion of the pond sidewalls can occur if undercut by stream. The soil in these ponds is in some cases saturated for the first few years, and access should be restricted until the ground is firm enough.

CHAPTER SIX

SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

HARD ROCK EXPLORATION SITES

INTRODUCTION

The observations collected during this study provide a base for making general observations concerning natural revegetation of various hard rock exploration sites. Sites mostly in the range of eight to fifteen years old were identified and visited. Although some revegetation is taking place in most sites, the majority of trenches visited dated from 1988 still showed sparse revegetation. The successfully re-vegetated sites, such as the 1961 trench in the Lone Star property, had topography quite uncharacteristic of the other trenches, but demonstrate that with optimum physical conditions natural revegetation can happen within 30 years. To minimize impact on wildlife habitat and enhance general equilibrium of local vegetation, soil, surface run off and shallow groundwater, proper trench design and trench abandonment can be accompanied by active mitigation such as seeding and fertilizing (see next chapter).

Assuming that available plant nutrients and soil fertility are low in most cases and that soil pH's are between 5 and 7, success of the natural revegetation was strongly dependent on:

1. Elevation
2. Slope stability
3. Matrix content

Other factors which seem to contribute significantly to the successful revegetation are:

4. Presence of permafrost
5. Trench orientation
6. Trench depth
7. Surface compaction
8. Presence of organic matter, mixed with the surface 20 cm.

Factors which had a lesser influence are:

9. Aspect
10. Slope position
11. Latitude.

1. ELEVATION

Sites at high elevation, or above tree line, such as the exploration trenches at Red Ridge, were the least successfully revegetated. Although sites at the Red Ridge property were also in a very coarse material, the overall poor revegetation rate is also noticeable at the toe of tailing piles, where more fines accumulated.

Sites located above treeline will require aggressive revegetation strategy. Seeding and fertilizing will most definitely be required, in addition to physical alteration to the abandoned features.

2. SLOPE STABILITY

Stable slopes revegetate more quickly, given similar soils and climatic conditions. In several trenches, both in the Carmacks and in the Dawson areas, tailings piles with slopes as steep as 45 degrees revegetated in a denser and richer fashion than the nearby colluvium of trench wall where slope processes still prevented vegetation from establishing permanent roots. The oldest trench studied in this project, 11TR1, on the Lone Star property had vigorous growth on stable slopes, yet slumping and sheet erosion caused a large portion of the trench to be bare. Stable surfaces of comparable age, such as 7P2, a tailing pile also dated from the early 1910's, showed formation of a significant organic mat at the soil surface and supported a vegetation community of composition close to the one occupying undisturbed land.

On the other hand, slumping of the overhang or surface mat speeds up revegetation by providing organic and nutrient rich patches of rooted vegetation to an otherwise bare slope. This is very well illustrated in the case of permafrost-rich slopes, where sloughing vegetated mats rapidly recover the colluviating surface. Trench wall stability is dependent on the type of material excavated, the trench orientation, presence of permafrost and/or seepage.

It is recommended that trench walls be stabilized to at least 1 metre from the original surface. In most cases, slopes gentler than 45 degrees seem stable, although gullying and surface runoff can still take place until the slope is revegetated.

3. PROPORTION OF FINE-GRAINED MATRIX

Given similar low nutrients and negligible organic matter contents of soils on stable surfaces, soil moisture retention is a key factor to the re-establishment of vegetation. A loamy sand and finer grained matrix of 15 to 20% seem to be the minimum

requirement in the Dawson and Carmacks area for successful plant growth. Based on observations of the stripped surface (LSFIELD) on the Lone Star property, 20 centimetres of such material over bedrock is judged a sufficient base to insure plant survival. Sandy matrix without the finer fraction will not support revegetation as well (NG4), and will erode easily.

It is recommended that the surface 20 centimetres of material on moderate slope contain at least 15 to 20% loamy sand or finer matrix. Steeper slopes may require a thicker base as surface runoff may entrain fine-grained particles during the first years when the soil is still bare.

4. PRESENCE OR ABSENCE OF PERMAFROST

Permafrost equilibrium depends partially on the thermal insulation provided by vegetation and soil. Once removed, the active layer will retreat below or behind the exposed surface until a new thermal equilibrium is reached. A slope cutting through frozen soil with a high ice content will therefore be affected in several ways: the thawed material will become saturated, have a lower cohesion and will lose a significant volume due to the melting of ice, and therefore will move, even on a gentle slope. Vegetation sitting on such unstable surfaces will also move downwards, this includes large trees as well as ground cover.

On most slopes investigated, the melting of permafrost resulted in the creation of a organic overhang, as material below the surface became saturated and fell. This overhang will eventually slump onto the colluviated overburden and form islands or patches of vegetated, organic-rich clumps. As the active layer recedes behind the wall face, the surface at the interface of the frozen sediment and the thawed sediment separates and causes fractures, followed by failure. Failure results in the slumping of large masses of vegetated surfaces and the exposure of a fresh surface which then proceeds to re-establish its own thermal regime. This retrogressive cycle of thawing can affect large areas behind the trench, especially if the trench is excavated parallel to the slope of the hillside. Melting of the permafrost also results in excess water. In trenches excavated parallel to the hillside, this excess water can affect the surface below and cause sedimentation, erosion, gullying or ponding. On the other hand, permafrost affected slopes revegetated rapidly, as the slumping of original surface provides an ample supply of moist, organic rich and vegetated sheets of material. Shallow trenches excavated perpendicular to the slope of the hillside would probably stabilize and revegetate themselves faster than the non-permafrost affected areas, but this process will affect a larger area on each side of the trench. On Mount Nansen (EBA et al., 1993), fractures were measured up to 4 metres behind the trench wall.

It is recommended that trenches excavated into frozen ground should either be filled, or at least that sufficient fill is put back in the trench to reach its original surface and provide insulation for the exposed frozen soil. This will not only reduce the regression of the active layer but provide a stable base and slow down slope movement.

Trees located at the surface of the escarpment should be cut by hand and the stumps and ground vegetation left in place. Temporary roads located at the surface of these cuts are likely to become unstable, and therefore should be closed.

Trenches cutting through significant thickness of ice rich material should be excavated perpendicular to the slope of the hillside to reduce the impact of excess water and related sedimentation, erosion and ponding.

5. TRENCH ORIENTATION

Based on observations gathered during this project, trenches excavated parallel to the slope showed greater trench floor erosion in the form of gullying, slope wash, transport and deposition of fans or sheets of fine-grained material below the trench. In some cases, gullying and deposition of fines occurred up to a hundred metres downhill from the trench. Trenches with slopes a low as 30 degrees were thus affected. This process affects the trench wall of narrow and wide trenches as the side walls do not achieve stability if their base gets eroded on a continuous basis.

It is recommended that trenches be excavated perpendicular or oblique to the natural slope to minimize erosion, to accelerate side wall stabilization and to contain the impact of the trench excavation to the trench itself. Refilling trenches excavated parallel to the slope may slow down this process. However the overburden usually consists of loose porous gravel with large fragments of rocks with fine sandy to loamy matrix, and it is likely that water and fine particles will find their way down onto the floor and below the trench.

6. TRENCH DEPTH

Shallow trenches (2 to 4 metres), abandoned with near vertical walls excavated in unconsolidated

material will eventually achieve stable, gentler slopes through slumping and slope wash. This process can take several decades, and in most cases, certainly takes more than ten years. Most 1988 trenches described in this report still show significant slope movement on large sections of their walls and consequently, still showed large bare surfaces. Trench 11TR1, excavated in 1911, is 8 metres deep and it is still actively decreasing its wall slope through slumping and gullying. Slopes will aim at the angle of repose regardless of their height, and therefore the process takes longer for the higher wall. Overburden piles with stable slopes showed successful revegetation with high ground coverage within 8 years on slopes as steep as 40 degrees.

It is recommended that all trench walls be left with an acceptable slope angle, regardless of their depth. That slope angle may vary with the composition of the material excavated or used as a fill but can be estimated as about 45 degrees for the purpose of this report.

7. SURFACE COMPACTION

Well compacted surfaces were noted at the bottom of some trenches and on the drilling pads. In trenches, a well compacted surface will allow for faster and more concentrated run off. In most cases, these surfaces were unvegetated to very sparsely vegetated. Drilling sites are usually built on fairly level surfaces and erosion is usually not a concern. The main factor affecting plant growth would be the surface compaction. It has been clearly demonstrated in this report that revegetation is more successful on the perimeter of the drill pads, where the surface is looser and rougher, all other site characteristics being equal.

Surfaces of roads, camps, yards and drill sites should be loosened.

8. PRESENCE OF ORGANIC MATTER WITHIN 20 CM OF THE SURFACE

In a few instances, the original surface material had been mixed with tailing piles. These sites, and areas affected by cat tracks, as well as areas where organic rich material is slumping and mixing, have a more successful revegetation.

The lack of organic rich soil horizon in most of Yukon prevents a systematic application of organic rich surface material. However, whenever possible, overburden which contains organic mat or organic rich horizons should be stockpiled and replaced at the surface of disturbances.

9. ASPECT

Aspect did not seem to play a very important role in the natural revegetation of sites. Undisturbed vegetation showed some differences, but these were not reflected by the pioneer species colonizing sites. Two sites in the Carmacks area seem to have a slightly greater vegetation coverage on south facing sites than on similar north facing sites.

10. LATITUDE

Although one would expect latitude to play an important role in the revegetation of an area, the data obtained from this study does not seem to enhance such differences. Regional climate and elevation seem to override general natural revegetation trends.

Further surveying of disturbed land and undisturbed vegetated sites is required to formulate any kind of recommendations based on latitude differences.

PLACER MINING

Many of the recommendations above could apply to placer mining abandonment procedures if placer mining is done at high or mid-elevation, in coarse, gravelly deposits. Placer mines in permafrost-rich areas with organic rich, fine grained deposits and in close proximity to streams have different concerns. This includes a large proportion of the placer operations, in the Klondike area.

CUTS AND PERMAFROST

There is often insufficient room to manage, recontour or terrace excavated faces, due to valley geometry.

According to the observations made in this project, 1988 to 1990 faces had significantly lowered their profile and showed dense revegetation by remobilization of natural vegetation clumps as well as pioneer species. The abundance of moisture and organic rich soil, and the nature of slumping will probably result in fairly stable slopes with gentler profiles and dense surface vegetation within 10 years of excavation.

Tall cuts excavated in permafrost are very unstable and their surface should not be accessed with heavy equipment. Tall trees should be hand logged to prevent damage, with stumps and ground vegetation left intact. Access both to surface and lower slope restricted, as regressive slumping and fracturing is sure to take place and to involve slumping of large blocks of sediments.

Natural revegetation of such cuts will benefit from the abundant moisture and slope profile modifications caused by melting permafrost.

SETTLING PONDS

Settling ponds were not observed systematically during this study, and thus the following comments may not apply to all settling ponds. Erosion of the settling pond walls may cause heavy sediment import downstream from the pond as the stream erodes into the settled sediments.

Revegetation takes place rapidly in the moist silt and fine sand. It is not known how the vegetation community will evolve as the material dries and if a new ecosystem will be created. Soft and moist surfaces may harden when dry.

A long term observation of plant communities, moisture regimes and soil changes over a few years would provide valuable information and would help determine if natural revegetation and abandonment of these sites are ecologically viable.

TAILINGS PILES

Tailings piles can be dealt with as the hard rock exploration features if they are composed of coarse gravelly material. Sufficient matrix and stable slopes are required for optimum growth conditions. In cases where flat surfaces composed of gravel and coarse sand were left, very little growth had taken place in 6 years. Material with sufficient matrix should be overlain on top of such deposits.

Tall, steep tailings piles are very unstable for at least 5 years and possibly longer, due to the erodibility of the loosely packed material. Contouring or benching of the tailing piles will speed up stabilization and natural revegetation.

CHAPTER SEVEN

TESTING THE RECOMMENDATIONS

APPROACH

Reclamation is generally defined as returning the land to a productivity or capability equal to, or greater than that of its pre-disturbance state. The ultimate goal in any reclamation project is to promote the development of a self-sustaining plant community that is in harmony with the surrounding environment. The "successional reclamation" approach as described by Polster (1989, 1991) seeks to achieve this goal through the enhancement of successional processes. In addition to following basic guidelines for soil handling and seedbed preparation, adverse physical conditions are ameliorated through planting strategies that are designed to work in concert with natural successional forces.

The first item to address is the physical conditions of the disturbed site. Sites abandoned in optimun conditions might host natural regrowth within a reasonable period of time (five to ten years). Some tailing piles and loose friable surfaces at the perimeter of drill pads did in fact revegetate at least half of the disturbed surface within five years. The least intrusive approach to site abandonment might be to leave disturbed sites in such conditions that native pioneer grasses, mosses, forbs and shrubs will initiate the colonization of bare surfaces. The introduction of new grass species to any area may also introduce changes in the local ecosystems. Whenever natural re-vegetation is likely to take place rapidly, sites could be left to revegetate on their own, as is the case with placer mine cuts in organic-rich, fine-grained frozen sediments.

For other sites, however, natural colonization of a site may take more than a decade. Unvegetated slope surfaces left exposed to the elements for such a long period of time will be subjected to runoff and sheet erosion which will in turn slow down the successful rooting of plants. For this reason, as well as water quality issues, physical improvement of disturbed sites, such as slope recontouring, surface soil improvement and plant nutrient additives are desirable. In such cases, seeding and likely fertilizing are also necessary.

SURFACE STABILIZATION

In the case of mineral exploration activities in the Yukon, most of trenching and stripping activity takes place during the summer and wraps up by October. Although the trenches themselves are of limited extent, at the most a few hundred of metres long and a few metres wide, the cumulative results of several exploration programs can cover a significant surface of a particular hillside or valley. The first objectives of the reclamation program is to put in place stable surfaces of suitable material replace surfaces which are either too steep, too compact, or too coarse.

Optimally, trenches should be refilled. More realistically, trench walls should be recontoured to adequate slope that will be stable which in most case ranges between 40 and 45 degrees. Localized gullying may occur in certain types of material in spite of appropriate slope angle, but for most of the surface, gentle slope angles will slow down slumping, regressive failure and excessive slope wash if recommendations from previous chapter are followed.

According to the observations made during this study, trenches up to 8 metres deep may still be undergoing significant slope re-stabilization, through slumping and remobilization of fine-grained soil (trench 11TR1, Lone Star property). On the stable portion of this trench vegetation is dense, with a range of species typical of pioneer community in the area. However, several areas in that trench were bare either because they consisted of steep rock faces, or recently failed surfaces. Generally, shallow trenches, up to 3 metres deep are actively slumping and failing, and show sparse regrowth within the trench itself (trench 88TR20, Lone Star property). By comparison, tailing piles or overburden piles with stable slopes show greater incoming vegetation in terms of ground coverage and species variety (pioneer shrubs and forbs species, grasses and mosses) within 6 years. Trench 61TR1 which has gentle, stable slopes, shows a dense revegetation within 30 years and testifies to the importance and positive impact of stable surface, given similar textural and pedological characteristics of the host material.

SITE RECLAMATION

Species seeded in areas considered wildlife habitat should not compete so successfully with native plants as to impede their re-introduction on the disturbed site or to propagate in such a way as to modify the local ecosystem permanently. This requirement is very different than when considering the revegetation of highway corridor for example, where the revegetation objectives involve slope stabilization, but also such successful growth that shrubs will not re-enter the plant community and

decrease visibility. Therefore when considering a seeding program, the objectives and purpose of the program must be taken into consideration as well as climate, soil properties and surrounding vegetation. Cost, germination time and rate, and seed availability are also important factors. Seed mixtures provide the opportunity to achieve immediate objectives, such as slope erosion control with a fast growing dense grass cover which will only grow for one or two summers; and long term objectives such as the development of a maintenance free and non-intrusive ground cover of native grasses compatible with the surrounding ecosystems.

It is recommended that plots be established to test the effectiveness of various reclamation techniques as follows:

Plot 1. Replace overburden; seed with native grass/legume mix and fertilizer; no addition of mulch.
Plot 2. Replace overburden material; seed with native grass/legume mix; addition of fertilizer and mulch.
Plot 3. Replace overburden material; import topsoil; seed with native grass/legume mixture; add fertilizer.
Plot 4. Control; replace overburden; no amendments nor seeding.

Several seed mixtures could be tried depending on resources available.

METHODOLOGY

STUDY DESIGN AND SITE SELECTION

Sites should be selected in early June. Preferably, the same properties should be used for the test plots, as soil and vegetation information is readily available. Accessible alpine sites will need to be found, as the Annie Lake sites are not accessible by road and therefore would not be accessible to heavy equipment. Final decision on the program objectives and design will be followed by order and preparation of seed and fertilizer mixtures.

Estimated cost: $3000. Includes seed and preparation for all three sites.

SITE PREPARATION

Trenches

In general, erosion occurring on steep side and end walls of exploration trenches examined in the 1993 study can be seen as a major factor inhibiting the re-establishment of vegetation communities. Recontouring and/or backfilling to reduce slopes and inhibit erosion is the first step in returning these sites to pre-disturbance conditions.

The goal in recontouring is to minimize erosion and enhance favorable micro-sites for plant establishment. In most cases, recontouring can be achieved by backfilling with overburden or "push-pile" material. Where this is not possible, operators may be required to blade, or, in extreme cases, blast material from the crest of the trench wall and place it at the toe to achieve an appropriate slope; terracing on extreme slopes is also a possibility. Final slopes of 2:1 (27°), or less are desirable when working with unconsolidated materials to reduce surface runoff and minimize erosion. For both economic and ecological reasons, consideration can only be given to importing topsoil when suitable soils are readily available in sufficient quantities.

Backfilling and recontouring operations should take into consideration the following:

1. avoiding the creation of defined ditches or swales parallel to slopes serves to mini-mize runoff and gullying;

2. compaction can be considerably reduced by replacing overburden materials in thicker lifts (1 m, if possible), by mini-mizing machine traffic on the site, and by avoiding over-working of the materials, especially in wet conditions; and,

3. leaving a rough surface is preferable to a uniform surface; track and cleat marks, or ridges and troughs across slopes aid in slowing surface run-off, and provide physical micro-sites that promote the establishment of a greater diversity of vegetation.

Drill Pads

Replacement of overburden materials (where available) should be carried out in a manner similar to that described above. Where subsoil compaction is minimal, replacement of excavated materials and surface scarification by discing, or raking may be sufficient. However, the physical state of the subsoil can have a marked influence on plant growth regardless of surface soil. Since considerable soil compaction was observed on drill pad sites, decompaction of deeper soil layers is recommended. This can be achieved by a bulldozer equipped with a ripper.

In addition, the following considerations should be addressed when preparing drill pad sites:

1. decompaction operations are sensitive to soil moisture content; operations should ideally be carried out under drier conditions;

2. fibrous materials (e.g. manure, peat, shavings, straw) can be worked into the soil to improve texture, aeration, and water infiltration);

3. deep-ripping should be carried out, so as not disturb and/or incorporate parent materials into subsoil material; and

4. additional surface scarification may be necessary to create a suitable environment for seed germination, and to promote root and shoot penetration.

Plot Design

Final dimensions of experimental plots will be determined once recontouring has been completed, since exploration trenches vary considerably in size. In general, plots should be square or rectangular, with areas of approximately 30-40 square metres, and demarcated by metal rods at each corner, and further divided into replicate quadrants by staking.

Fertilization and Seed Application

Fertilizer application rates outlined for specific seed mixtures in "Guidelines for Reclamation/ Revegetation in the Yukon" (Kennedy, 1993) are recommended for disturbances where planned topsoil salvage and replacement procedures were followed. Since the development of exploration trenches is carried without regard to topsoil and subsoil salvage, overburden piles comprise upper and lower soil horizons resulting in a correspondingly lower nutrient status.

Laboratory analysis of soils from site investigations in 1993 are available and, in general, confirm that very low nutrient levels prevail. Fertilizer application rates will be adjusted to site specific conditions.

Seeding rates will be based on those recommended in Kennedy (1993) and/or as recommended by seed suppliers. Native species, especially those adapted to stressed environments are suitable for both aesthetic and practical reasons. However, the selection and availability of native seed in Yukon, and indeed in most Northern areas, is limited. In cases where native seed is not available, it is accepted practice to opt for the selection, or substitution of non-persistent, but prolific agronomic species that serve a similar purpose in providing a suitable micro-habitat for native species to re-establish. Yukon Renewable Resources (Agriculture and Habitat Branches) and DIAND (Forest Resources) should be consulted before seed mixtures are finalized.

Parameters considered in the formulation of seed mixtures include gross morphology, growth characteristics, and adaptation to soil and climatic conditions. Relevant traits of species were investigated (Kennedy 1992, Hardy BBT LTD, 1989, Vartnou, 1994) and matched to general site conditions in the Dawson and Carmacks areas.

Consideration was given to selecting species with varied growth habits, and tolerance to allow for changes and/or diversity in micro environmental and climatic conditions. In keeping with a successional reclamation approach, greater emphasis was placed upon selecting species with growth habit (i.e. bunch forming grasses) that will provide the space necessary to encourage reintegration of natural pioneer species and therefore natural local plant succession.

Finally, preliminary inquiries were made into the availability of seed from northern suppliers (Yukon and Alaska). When extremely limited quantities, or no seed were available, species were eliminated from the seed mixture and substitution with either an agronomic variety or next best fit native seed was made.

PRELIMINARY SPECIES SELECTION OF GRASSES AND LEGUMES:

Lone Star Property (Dawson area)

Violet wheat grass	Agropyron violaceum
Northern fescue	Festuca saximontana
Altai fescue	Festuca altaica
Glaucous bluegrass	Poa glauca
Bluejoint	Calamagrostis canadensis
Alsike clover	Trifolium hybridum

Nucleus & Revenue Properties (Carmacks area)

Ticklegrass	Agrostis scabra
Violet wheatgrass	Agropyron violaceum
Northern fescue	Festuca saximontana
Glaucous bluegrass	Poa glauca
Bluejoint	Calamagrostis canadensis
Alsike clover	Trifolium hybridum

High elevation Site (location unknown)

To be determined after site selection.

This portion of the program is estimated to cost approximately $9,000 to $10,000 per site ($27,000 to $30,000 for three sites). This includes rental of truck and heavy equipment, equipment, field expenses, seeds, fertilizer and other required equipment, salary of 3 crew for 6 days per site and heavy equipment operator.

ASSESSMENT AND MONITORING

The study should include two visits per season per site, one in July to determine if fall reseeding is necessary and one in Mid to late-September for

harvesting and assessment of plant growth and slope stability, soil erosion, etc. If a fall seeding is chosen, then the site should be visited early the following summer. Monitoring should go on for a minimum of 3 growing seasons. Plots are to be assessed in terms of density (number of plants per plot), cover (percentage of plot covered with foliage), and rooting depth. Observations on slope stability will be made at each site.

This portion of the project is estimated to cost approximately $2,000 per visit per site. This include truck rental, field expenses and crew salary for two to three days.

REPORTING

Reporting format and timeline would need to be discussed with Scientific Authority. Estimated cost would have to be determined (possibly $3,000 to 4,000). Report should include, in addition to plot performance optimum seed mixtures and soil conditions, advice and comments on reclamation procedures in the various areas, types of equipment used, and characteristics and difficulties encountered during the project.

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APPENDIX ONE

PLATES

Plate 2-1 Adit dated at 1912, Lone Star Property.

Plate 2-4 Overview of Lone Star trenches. Large stripped area is LSFIELD.

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Plate 2-2 Site 93LS24D, undisturbed vegetation, Black spruce/moss/shrub sub alpine forest on colluvial or residual bedrock

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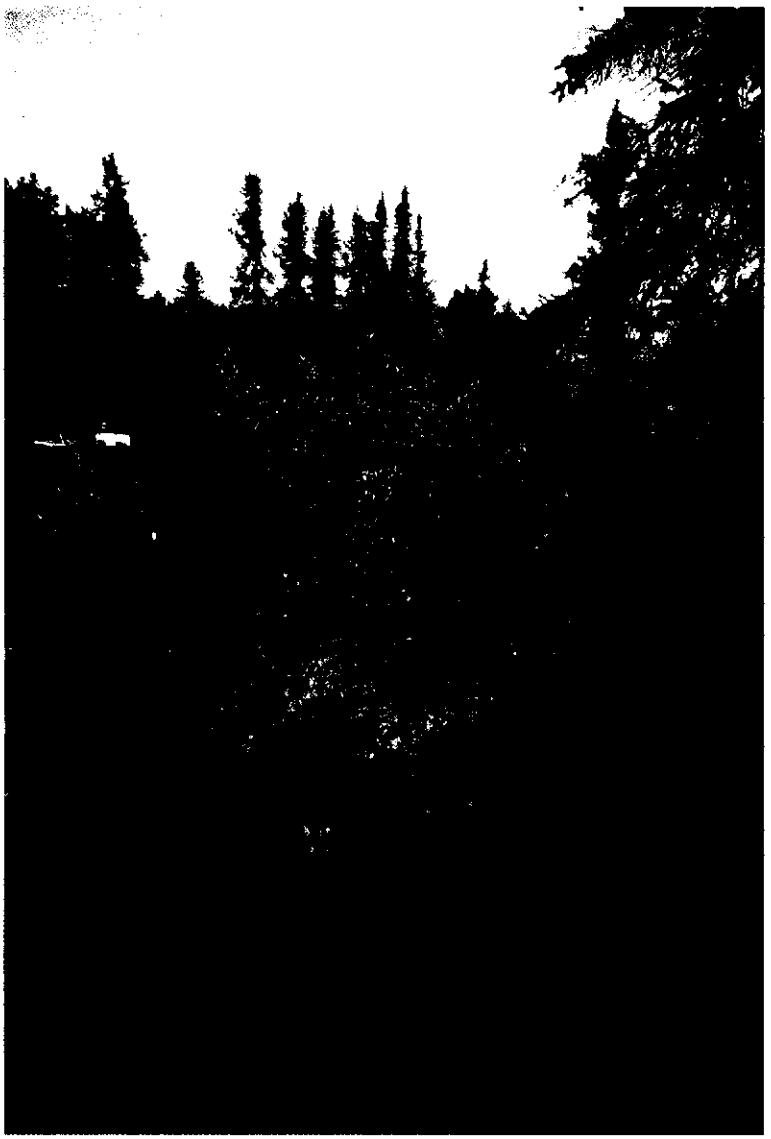

Plate 2-3 Undisturbed 88TR20. Open subalpine black spruce forest with shrub birch and blueberry, NNE aspect

Plate 2-5 Trench LS3. Very sparse revegetation is concentrated at the bottom of the slumped wall material. Gullying is developing at the floor of this steep trench parallel to the hill side.

Plate 2-6 Overview of trench 88TR20.

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Plate 2-7 Portion of 88TR20 originating at the crest of the hill. Sites 88TR1a, 88TR1b and 88TR1c. This trench is very sparsely revegetated. Steep bedrock wall are not vegetated.

Plate 2-8 Trench 88TR20, sites 88TR2a, 88TR2b and 88TR2c. Vegetation patches visible on the wall are slumping from the surface. Pioneer vegetation is concentrated at the toe of the colluviated material.

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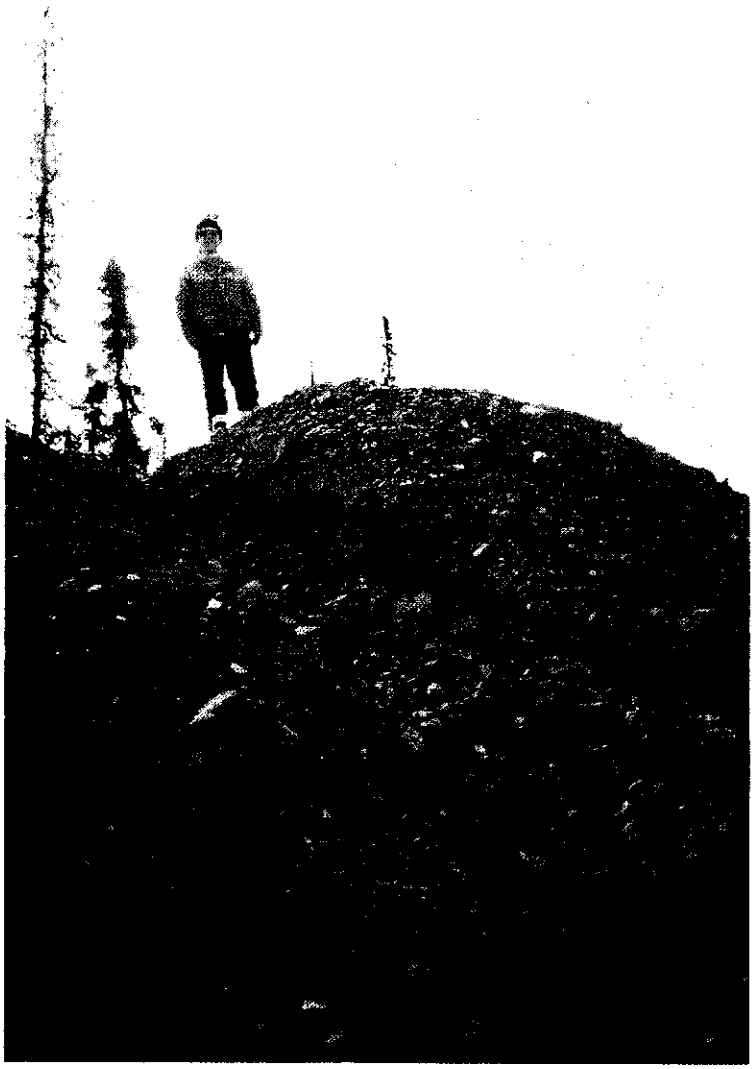

Plate 2-9 Drill pad at the lower end of trench 88TR20. Gullies are developing in the soft material.

Plate 2-10 Trenches parallel to the contour lines, Lone Star Property.

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Plate 2-12 Site 11TRd, thick regrowth and stable slopes on the inactive walls of the trench.

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Plate 2-11 Dense shrub growth on the floor of TR61.

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Plate 2-13 Slumping on unstable wall portion are still occurring. Such surfaces are bare of vegetation (site 11TR1e).

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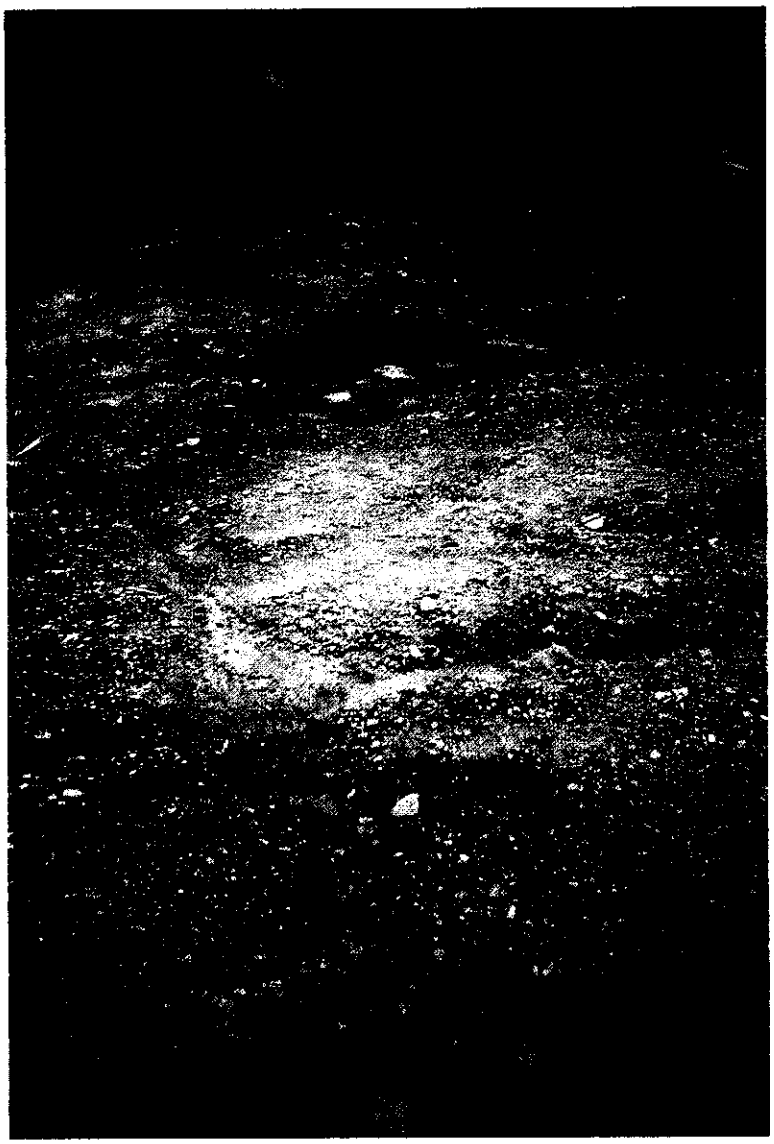


Plate 2-14 Drill pad 90R11, Lone Star Property.

Plate 2-15 Drill pad 93LS24, Lone Star Property.

REFER TO COLOUR CD

Plate 2-17 Very dense vegetation beside bunkhouse. Surface has probably been undisturbed since 1912.

REFER TO COLOUR CD

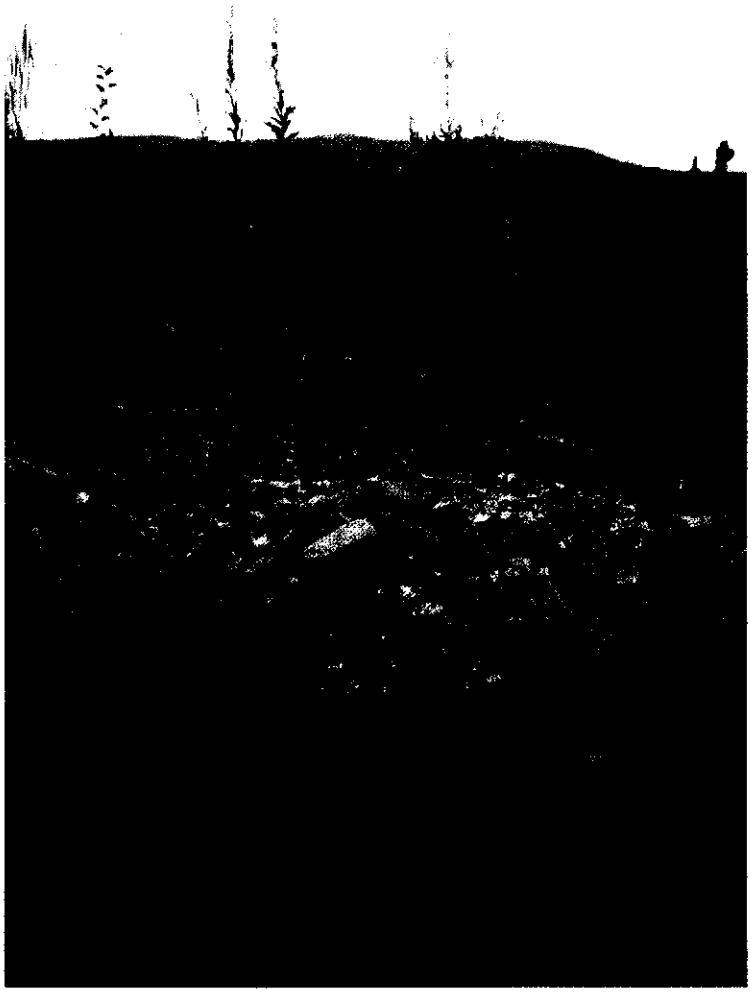


Plate 2-16 Overburden pile at site LSFIELD6.

Plate 3-1 Nucleus Property.

REFER TO COLOUR CD

Plate 3-3 Trench N1A, dated at 1989.

REFER TO COLOUR CD

Plate 3-2 Undisturbed vegetation, site N4B.

Plate 3-4 Slumping vegetation, trench N1B, 1989.

REFER TO COLOUR CD

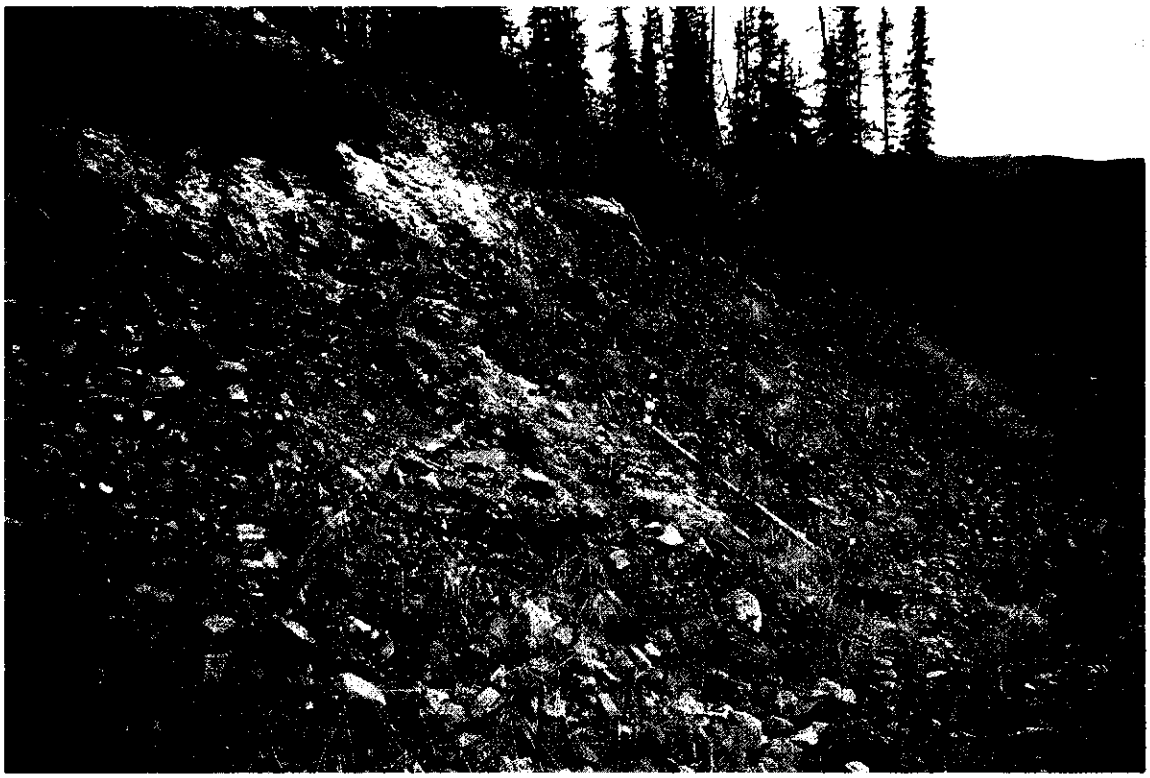


Plate 3-5 Trench N1B, with thick ash layer close to the surface. Slope is partially revegetated.

Plate 3-6 Trench N3. Fine-grained material accumulates at the floor and lower end of the trench.

REFER TO COLOUR CD

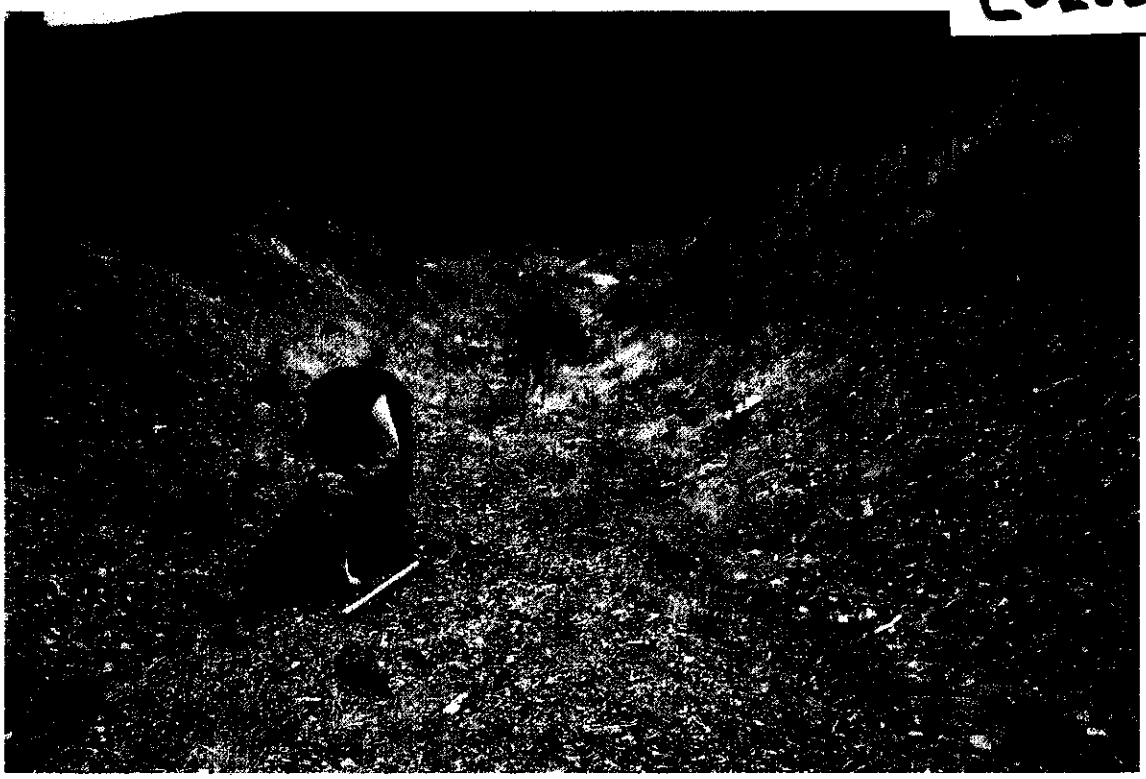


Plate 3-7 Trench N4A. Vegetation is dominated by grass and forb species and is concentrated on the lower colluviated portion of the wall and floor of the trench.

Plate 3-8 Trench N6.

REFER TO COLOUR CD

Plate 3-9 Drill site N5A, 1989.

Plate 3-10 Natural forest, Revenue property, site R3B. Open black forest with shrubs and lichens.

REFER TO COLOUR CD

Plate 3-11 Trench R2B, very sparse to no revegetation on this recent trench (1993?).

Plate 3-12 Trench R1A. 1988.

REFER TO COLOUR CD

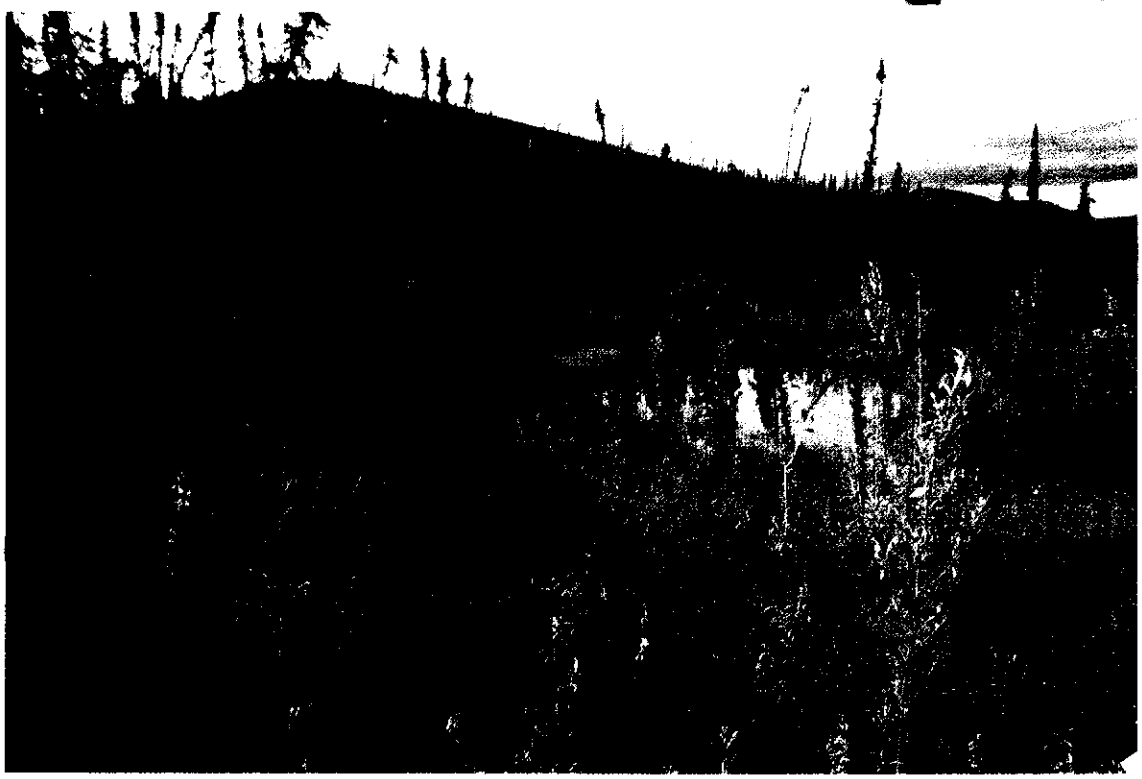


Plate 3-13 Site R2Aa . Melting permafrost contributes to the abundant moisture at this site. Slumping (tipping trees) is still active.

Plate 3-14 Site R2Ab, densely revegetated trench. This successful revegetation is partially due to the degrading permafrost which provides ample moisture and remobilized vegetation clumps.

REFER TO COLOUR CD

Plate 3-15 Drill pad R6. Compact surface is sparsely revegetated.

REFER TO COLOUR CD

Plate 3-16 Drill pad R6. Dense growth of grasses and fireweed on the loose surface of drill pad rim.

Plate 4-1 Undisturbed vegetation above trench RRM10, similar to vegetation found at sites RR4 and RR5.

REFER TO COLOUR CD

Plate 4-3 Trench RR3, 1988. Trench is unvegetated except for a very sparse forb layer and slumping patches of the original surface. Trench material is very coarse.

REFER TO COLOUR CD

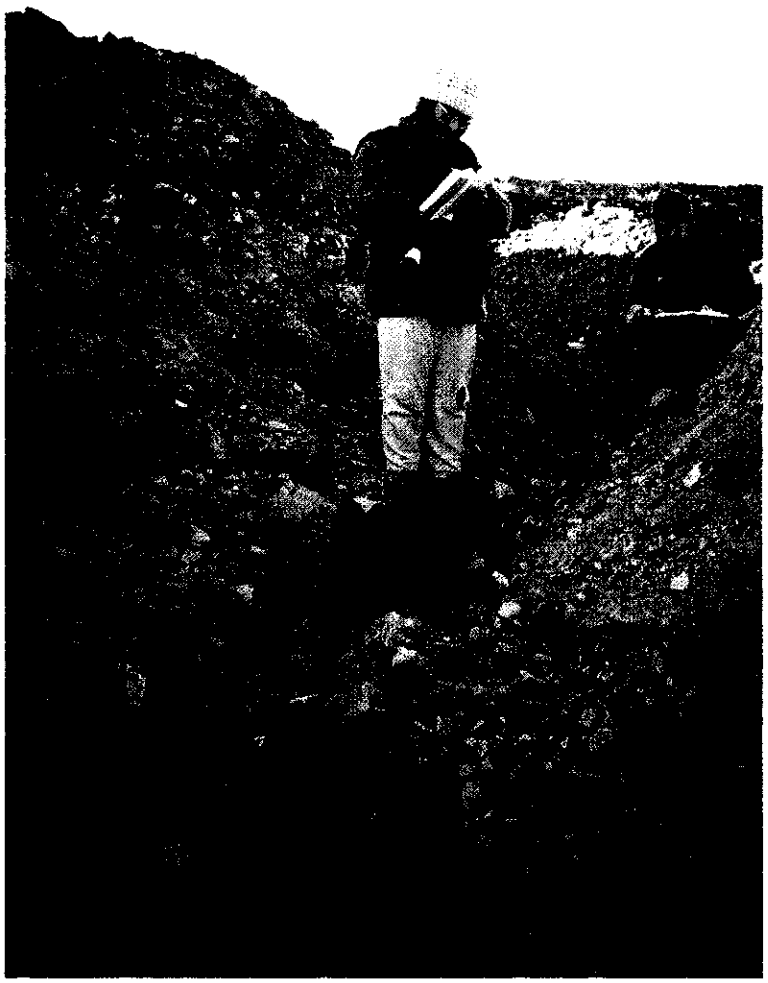


Plate 4-2 Trench RR2, 1988, trench is basically unvegetated.

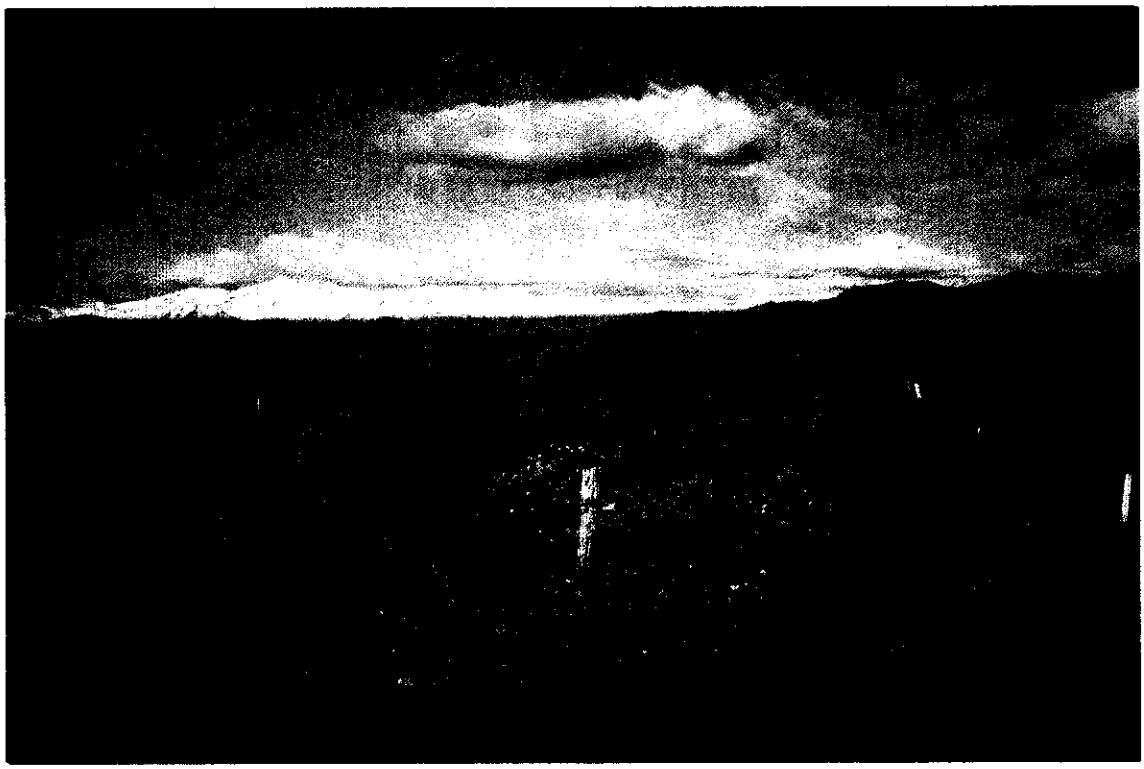


Plate 4-4 Drill pad SR8802, Site RR9. Site is very sparsely revegetated.

REFER TO COLOUR CD

Plate 4-5 Site RR7 consists of cat tracks. Ripped surface has remnants of original vegetation and incoming pioneer plants.

Plate 4-6 Undisturbed site, Idaho Hill, IH1B.

REFER TO COLOUR CD

REFER TO COLOUR CD

Plate 4-7 Trench HI1A.

REFER TO COLOUR CD

Plate 4-8 Trench HI2A.

Plate 5-1 7 Pup placer property, site 7P1, 1912 tailing piles.

REFER TO COLOUR CD

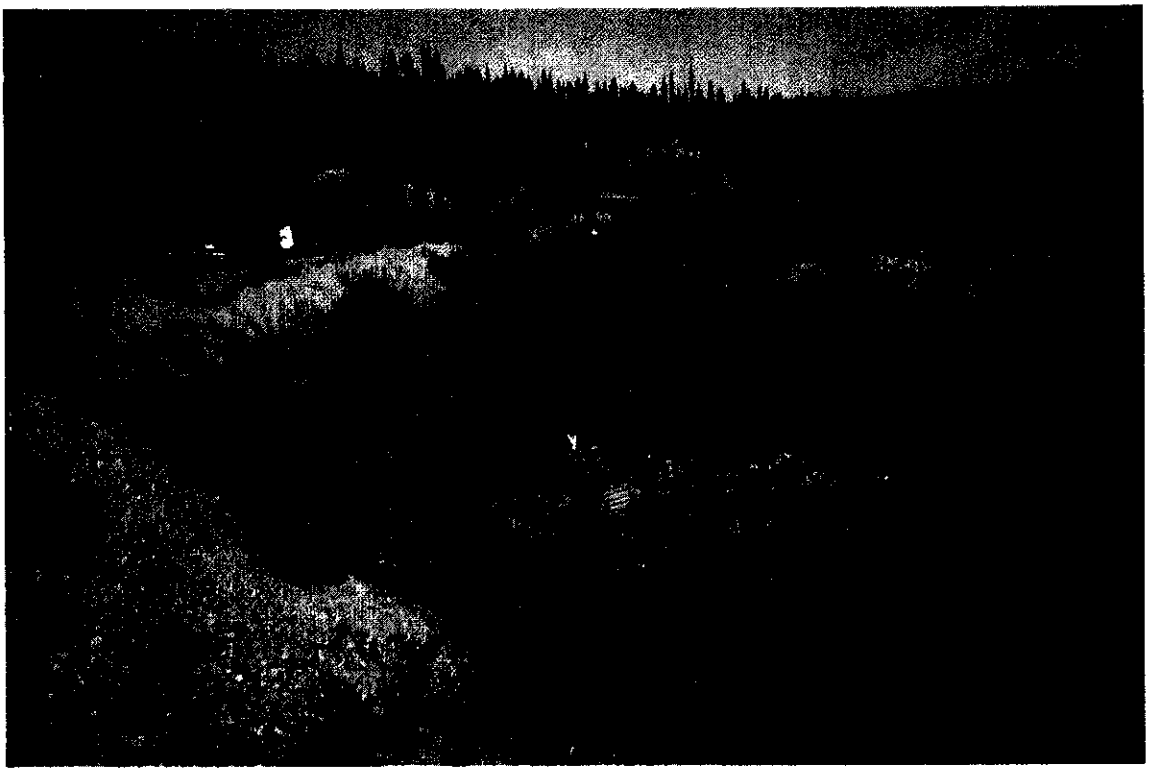


Plate 5-2 7 Pup property, 1991 settling pond surface is densely revegetated by shrubs, grasses, forbs and mosses.

Plate 5-3 Overview of Oro Grande Operation. Cuts (on the right) and overburden/tailing piles (left) are younger upcreek.

REFER TO COLOUR CD

Plate 5-4 1989 cut. Oro Grande.

REFER TO COLOUR CD

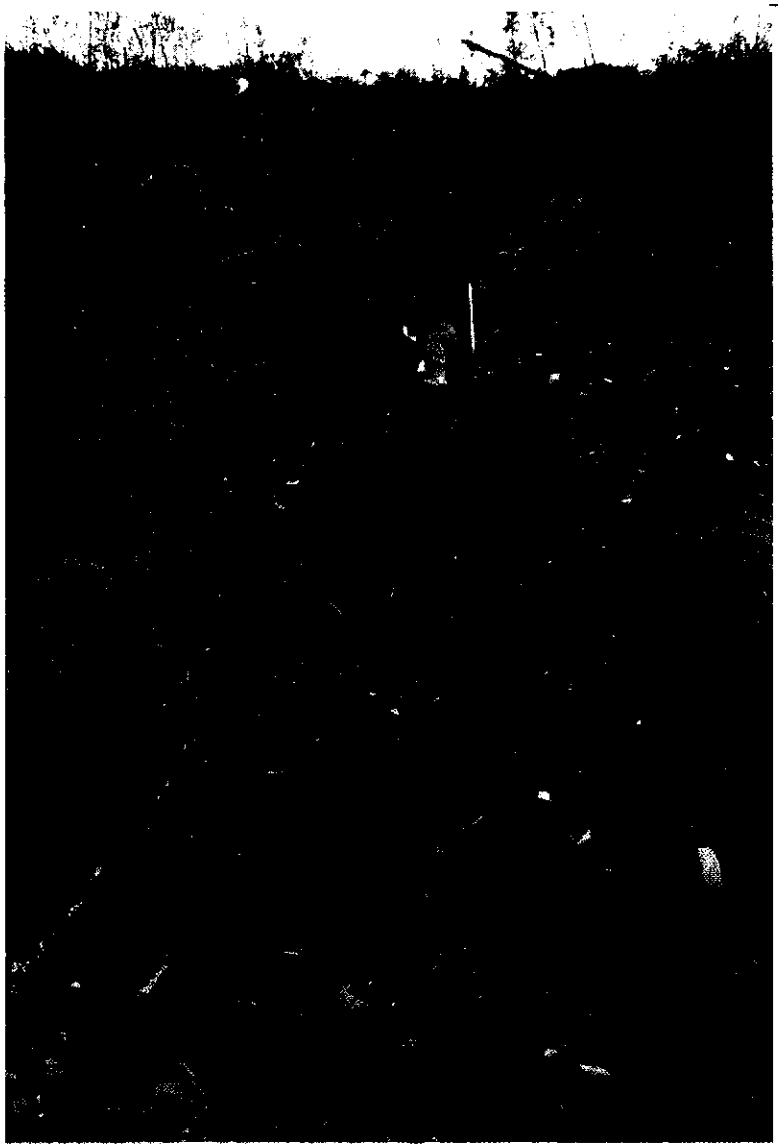


Plate 5-5 1990 cut, Oro Grande

REFER TO COLOUR CD

Plate 5-6 1990 cut, Oro Grande operation. Slope is actively slumping and failing as permafrost is melting.

Plate 5-7 1992 cut. Oro Grande operation. Most of the vegetation consists of slumped fragment of original forest floor.

REFER TO COLOUR CD

Plate 5-8 1990 Tailing and overburden pile, densely vegetated. Oro Grande operation

Plate 5-9 1992 Tailing pile, Oro Grande operation. Gullying and surface erosion very active.

REFER TO COLOUR CD

Plate 5-10 1993 tailing pile, Oro Grande operation. Separation fractures at the surface of the pile. Revegetation by forb is quite dense.

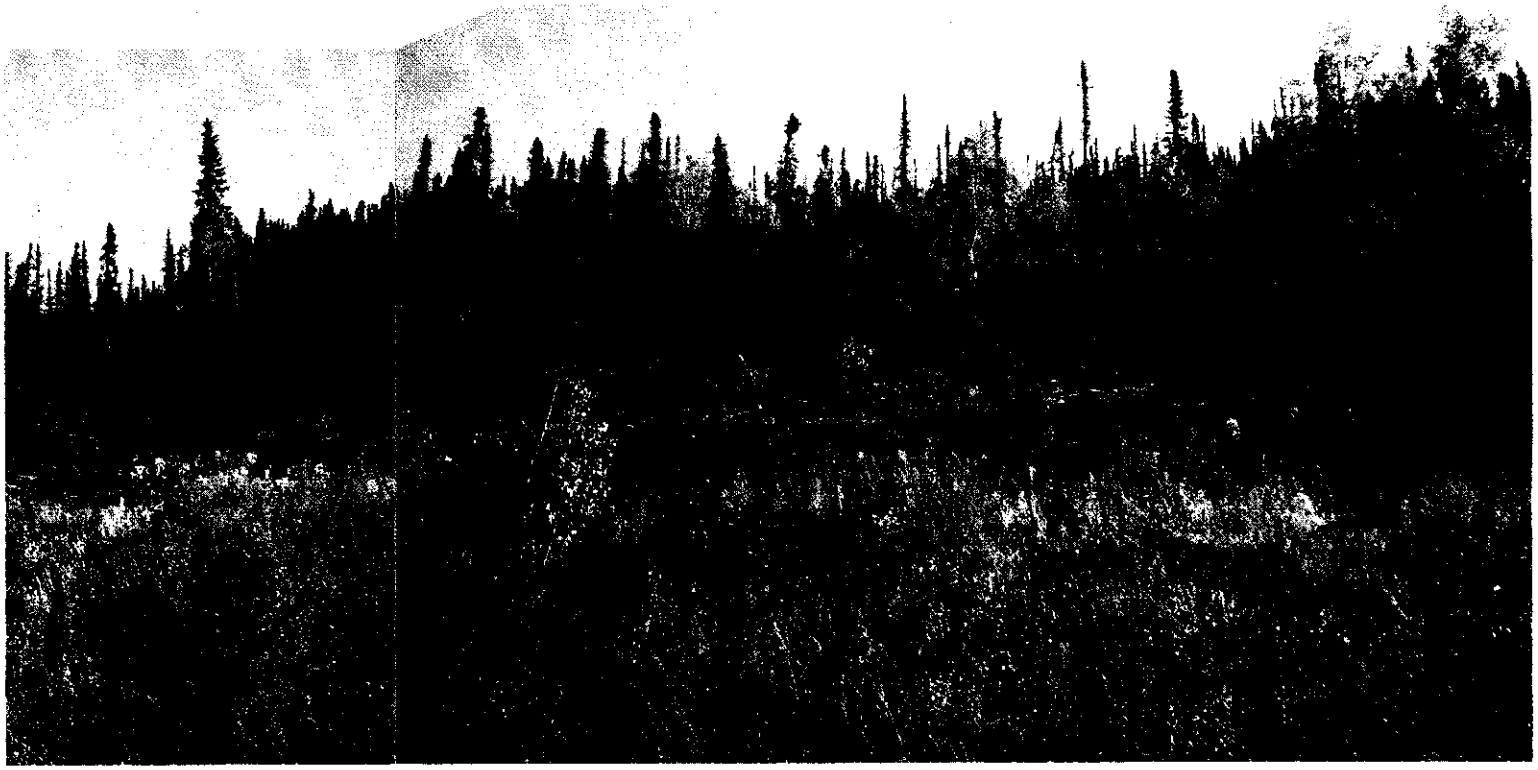


Plate 5-11 NG1, 1978 cut, Nugget Gulch. The slumping material appears terraced or benched and the slope profile is much lower than the original near vertical cut.

REFER TO COLOUR CD

Plate 5-12 NG2, 1988 cut, Nugget Gulch.

REFER TO COLOUR CD

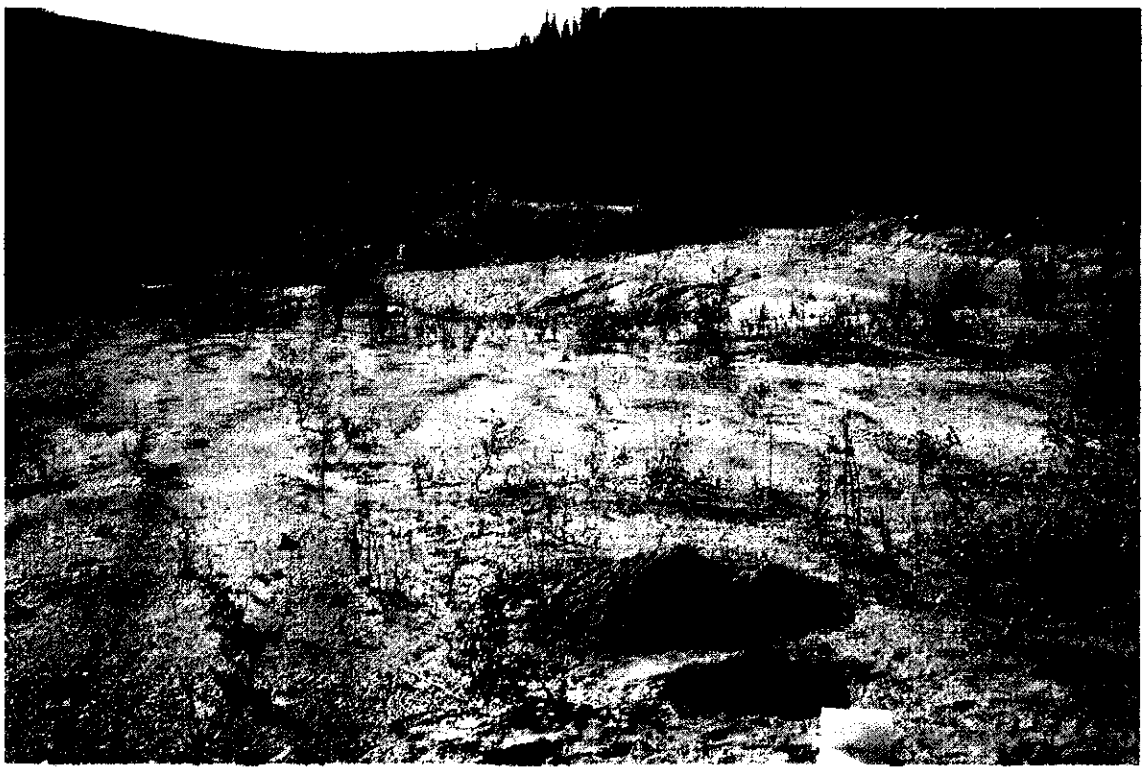


Plate 5-13 NG3 and NG4. Well sorted tailings composed mainly of gravel and sand show low rate of revegetation. Gullying is visible on the slope in background.

Plate 5-14 NG5, 1988 tailing pile and overburden, Nugget Gulch. Revegetation is fairly dense on the loose surface in the background and less so on the more compacted surface in the foreground

REFER TO COLOUR CD

Plate 5-15 Settling pond on Eldorado Creek. Surface is densely revegetated. Sidewall is undercut by stream

Plate 5-16 Surface vegetation and soil of site ED1

REFER TO COLOUR CD

Plate 5-17 RC1, moderately well revegetated settling pond, Revenue Creek

APPENDIX TWO

DETAILED SITE DESCRIPTION

LONE STAR PROPERTY

UNDISTURBED CONDITIONS

61-TR1 F

This site is located on a northeast facing slope at an elevation of 825 m, adjacent to trench 61 TR 1. The original surface around the trench shows a slightly hummocky, sloping hillside with a slope varying from 10 to 23 degrees.

The soil profile shows a thin cover of mosses and lichens (2 cm) over an Ah horizon (4 cm), and shallow soil composed of sandy loam matrix (30 to 40%) and cobbles overlying bedrock. There is no evidence of permafrost along this trench.

The original vegetation consists of a continuous ground cover comprised of black spruce forest which is the only tree species on the plot and covers 30% of it. The trees are small; some sample measurements in the order of diameter at breast height (DBH) and height of tree (HT) are as follows: DBH 7 cm, HT 6 m; DBH 7 cm, HT 6 m; DBH 14 cm, HT 7 m; and DBH 8 cm, HT 5 m. Black spruce, from 0.4 to 4 m high, is also part of the tall and low shrub layers which combined cover 30% of the plot. Blueberry (20%) completes the low shrub component of this site. The dwarf shrub layer (30%) is represented by low-bush cranberry (25%), and crowberry (5%). Bastard toadflax (15%) is the only forb on site, and the common grass *Festuca altaica* (5%) is the only graminoid. Lichens are a very strong component of the flora in this area, covering nearly the entire forest floor (>80%), whereas mosses cover only 20%.

88 TR 20 U

This site is located on a northeast facing slope at an elevation of 1020 m, with a gentle slope of 7 degrees, and is directly west of trench 88 TR 20. The undisturbed topography consists of gently concave to rolling hillside, with a slightly hummocky surface. Faint signs of solifluction can be seen on surrounding north facing valley walls, but not in the immediate vicinity of the trench. This area consists of a very open black and white spruce subalpine forest with a very strong shrub component.

The soil profile shows a well draining Orthic Eutric Brunisol with slight seepage at 19 cm depth. The organic mat is 18 cm thick, mostly composed of lichen and mosses. The mineral soil (Bmugj 0-19 cm, Ahu 19-25 cm, and BC 25-62 cm) has a silty loam (L) matrix and 40% coarse fragments. The surface horizon (Ah) contains 6% organic matter; this decreases rapidly in the lower horizons which contain less than 1% organic matter. The pH values range from 5.4 to 5.6.

Vegetation covers the entire undisturbed surface. The tree layer is composed of both black spruce (15%, DBH 16 cm, HT 6 m), and white spruce (15%, DBH 13 cm, HT 9 m). The shrub layer is very dense; dwarf birch dominates with 40% coverage. The other species present are blueberry (30%), Labrador tea (25%), willow (10%), and black spruce (1 m tall, 5%). Dwarf shrubs are represented by crowberry (25%) and low-bush cranberry (15%). The sparse (<15%) graminoid layer consists of a grass and a sedge. Ten lichen species are a significant (>70%) aspect of this community, as are three mosses (dominated by *Pleurozium schreberii*) which ensure total coverage of the forest floor.

Although found on the same ridge, the aspect and elevations differences amount for differences in vegetation cover. The area surrounding trench 88TR20, with a NNE aspect and approximate elevation of 1020 m is basically an open subalpine black spruce forest with substantial shrub birch and blueberry components.

The other side of the ridge, with a SW aspect, is characterized by a much denser black spruce cover augmented by Labrador tea and low-bush cranberry. However, this side of the hill displayed a greater variety of vegetation communities with patches of open aspen forest found at all elevations.

LS7-D

Site **LS7 D** is representative of undisturbed conditions on a moderately gentle (9 degree) southwest facing slope. The site is located between Oro Grande Gulch and Gay Gulch, at an elevation of 680m. The hillside has a hummocky surface with poorly developed, narrow lobes, possibly related to slow slope movement due to permafrost.

The soil is a moderately well drained Orthic Eutric Brunisol, on a weathered bedrock of dominantly muscovite quartz schist. The organic mat is 12 cm thick overlying colluviated, gravelly sandy loam with 20% coarse fragments. Soil pH values average 6.4. Abundant micro to coarse roots are present between 0 and 12 cm, few micro to coarse roots reached 30 cm deep. There are no outcrops of bedrock around this site.

The surface is completely covered by vegetation. The tree layer is well represented by three species dominated by black spruce (40%). Diameters (DBH) of the trees ranges from 8 to 13 cm, and height averages 9 metres. White spruce is also

present at 5% coverage with an average DBH of 10 cm, and heights of 9 m. Paper birch covers 5% with an average DBH of 21 cm, and a height of 14 m.

The tall shrub layer is represented by black spruce (15%). The low shrub layer is comprised of willow (10%) which grows up to 3 m tall, Labrador tea (25%), and prickly rose (*Rosa accicularis,* 5%). The graminoid layer is composed of Arctic lupine (*Lupinus arcticus,* 5%), bastard toadflax (2%), and tall bluebell (*Mertensia paniculata,* 2%). No grasses or sedges are found at this site. Four mosses, with a combined coverage of 66%, are dominated by *Hylocomnium splendens* with 50% coverage. Five lichens combine to add another 46% forest floor coverage.

LSFIELD

This site **(LSFIELDD)** faces northeast and is located on a moderately gentle slope (9 degree) directly north of the stripped field. The site has a very rapidly draining Typic Folisol developing in the bedrock. The organic mat is 11cm thick and the thin mineral soil (9cm) consists of a fine sandy loam matrix and 30% coarse fragments (gravel), and overlies friable bedrock. This soil has a pH value of 4.2. Abundant micro to medium roots are present between 0 and 11 cm; few micro to medium roots are present at 20 cm, where the bedrock becomes root restricting.

This site is a representative example of an open subalpine forest of black spruce and dwarf birch. The sparse (5%) trees on this site are black spruce with an average diameter (DBH) of 16 cm and average height of 7 m. Black spruce are also part of the tall shrub layer at 10%, as is a willow species (5%) which grows up to 3 m tall. The very dense low shrub layer is represented by dwarf birch (60%), Labrador tea (40%), and blueberry (15%). Low-bush cranberry (20%) and crowberry (2%) make up the dwarf shrub layer.

The moss component is very strong with three species covering 80% of this vegetation layer. The feather mosses *Pleurozium schreberii* (50%) and *Hylocomnium splendens* (30%) dominate *Polytricum juniperinum* at 2%. An unusually large number (8) of lichen species combine for approximately 35% coverage.

LS4 (DRILL PAD AREA)

This site (**LS4**) is represented by a subalpine, open, black spruce forest, dominated by dwarf birch located on a moderately gentle northeast facing slope of 10 degrees.

The trees in this area are sparse (5%) with an average diameter (DBH) of 9 to 15 cm and height 5 to 10 m. The tall shrub layer is represented by 10% willow which grows up to 4 m tall. The low shrub layer is very densely (130%) represented by three species at different heights: Dwarf birch (70%), Labrador tea (30%), and blueberry (30%). The dwarf shrub layer is occupied by low-bush cranberry (10%), and crowberry (5%). Forbs are very sparsely (2%) represented by coltsfoot (*Petasites frigidus*). Mosses (60%) and lichens (40%) cover the forest floor completely.

93 LS 24D

This undisturbed site is near the drill site located west of trench 88TR1, on a west facing hillside, at an elevation of 950 m and slope of 12 degrees. The hummocky, frost heaved surface shows signs of subsurface runoff channels between hummocks. Although this site is also located close to the undisturbed site associated with trench 88TR1, it shows some significant differences.

The soil consists of an imperfectly drained Static Orthic Cryosol with significant seepage at 30 to 47 cm from the surface. The organic mat is 30 cm thick and the mineral soil is a gravel with a fine sandy loam matrix and 40% coarse fragments (gravel to stones). The pH values are around 5.4. Permafrost was encountered at a depth of 34 cm and contains 80 to 90% ice crystals by volume. Abundant micro to coarse roots are present between 0 and 30 cm, few micro to fine roots reached 47 cm deep, where the permafrost was a root restricting layer. The trees are leaning in several directions which suggests slow soil creep.

This site is comprised of a typical black spruce, moss, shrub, permafrost, subalpine forest. Although black spruce covers 50% of the tall shrub layer, very few individual specimens can be considered trees by height alone (>5 m tall, DBH >7 cm). The majority of this species is between 0.3 m and 5 m tall, and some have a DBH of 9 cm. The dense shrub layer is represented by four species: dwarf birch and Labrador tea each cover 25%, blueberry covers 15%, and willow adds 2%. The dwarf shrub layer is represented by low-bush cranberry and crowberry, each at 20%, as well as cloudberry (*Rubus chamaemorus*) at 15%. The forb layer is very sparsely represented by coltsfoot at 5% coverage. The very sparse graminoid layer is made up of one grass (*Calamagrostis sp,* 10%), and a sedge (*Carex sp,* 2%). The dense moss layer is well represented by four species, including spagnum (20%), and dominated by *Hylocomnium splendens* (30%). Five lichen species combine to form 50% coverage of this area.

Trenches

11TR-1 (1911)

This trench was excavated in 1911 and is the oldest trench of the entire program. Excavated material consists dominantly of altered and

weathered schist, with a blanket (1 to 2 m) of gravelly colluvium, with a high content of bedrock fragments. It is approximately 10 m wide at the surface, 8 m deep, 150 m long, facing an easterly direction, and runs into a gently sloping hill. It is assumed that the trench was abandoned with near vertical walls and a fairly level floor. A gully measuring up to 1 m wide and 0.6 m deep runs the full length of the trench. No water was present at the time of observation, but water likely runs through it during snow melt. This deep trench provides a micro environment isolated from wind, and runoff provides moisture at the bottom. Slumping has been important in creating the present slopes, most of the wall faces have slopes ranging from 35 to 85 degrees and parts of the trench walls are still actively slumping. Soil samples and vegetation surveys were collected at 5 locations on disturbed surfaces, i.e.: trench walls and slumps.

The end wall of the trench is formed by a near vertical rock face with a rough, irregular surface, facing east (site **11 TR 01 "A" (b)**). The face seems quite stable and shows very little growth. A dwarf birch (2%) clings to the face and the sparse ground cover is composed of a moss (15%) and three lichens (5%).

Site **11 TR 01 A** is a southeast facing slope on the same wall as above, but with a gentler slope (47 degrees). The slope is composed mainly of rock fragments of cobble size. This lower part of the wall has a greater vegetation cover (40 %). The tall shrub layer is represented by paper birch (10%) and willow (10%). Low shrubs are the most abundant (35%) vegetation classification at this site: alder (10%), blueberry (10%), Labrador tea (5%), willow (5%), dwarf birch (5%), black spruce (1%), and white spruce (1%).

The very sparse forb layer is composed of Arctic lupine (1%), Labrador lousewort (*Pedicularis labradorica*, 1%), bunchberry (1%), fireweed (*Epilobuim angustifolium*, 1%), yarrow (*Achillea millefolium*, 1%), and black-tipped groundsel (*Senecio lugens*, 1%). Six lichens combine for 50% of the ground coverage, and three mosses contribute another 20%. An unidentified fern species (1%) is found in the bottom of the trench.

SOUTHWEST FACING TRENCH WALL: The southwest facing trench wall has a 35 to 40 degree slope on the upper portion and up to a 65 degree slope on the lower portion. This wall shows signs of active erosion and deposition in the form of large fragments of bedrock up to 70 cm in diameter scattered on the lower and bottom portions of the trench wall. These fragments still carry their organic cover, surface vegetation, and even shrubs and trees down the slope. Exposed patches of steeply sloping bedrock are visible where slumping has recently occurred. The friable quartz muscovite schist bedrock weathers easily which contributes to the erosion of the original steep cut, creating a gentler slope and forming a fine-grained matrix necessary for revegetation.

Soil profiles measured from upper to lower slopes (**Site 11TR1B** - upper slope, **11TR1C** - mid-slope and **11TR1D** - foot of slope) show very rapidly drained Cumulic Regosol, with 80% of the soil composed of coarse, channery cobbles and 20% matrix composed of loam to sandy loam. The organic mat varied between 1 and 5 cm. Fine roots were present at depth of 49 cm. The pH values range between 4.8 to 5.8.

This trench wall shows a dense vegetation, small shrubs, and trees that make walking difficult. Several of the larger trees appear to have traveled down the slope on a slumped block, or as the overhanging organic mat fell into the trench.

NORTHEAST FACING WALL: The upper portion of the northeast facing wall has a very steep slope (75 to 85 degrees) and at least 3 m has recently failed. The lower portion of this wall is composed of smaller bedrock fragments mixed with less than 10% of fine sand and silt size particles. Boulders as large as 90 cm were noted. On this wall, the recent movement of debris and failure has erased traces of past revegetation. The original surface's organic mat will most likely slump onto the debris pile and re-initiate revegetation of the talus scree; very little vegetation is present in this part of the trench.

This wall section is located on the northeast facing wall, with a 42 degree slope, with micro-mounded surface. The wall shows some stability even though small local slumps are visible. The primary reason for this stability is the relatively dense vegetation. Runoff has caused some gullying, and loosened cobbles up to 30 cm in size. The gullying is localized towards the centre of the trench wall. Soil profile at location **11 TR 01 E** shows a loose, micaceous to loamy matrix with more than 80 to 85% of coarse channery cobbles. Fine to medium size roots were found at a depth of 29 cm. The soil horizons are poorly developed and immature as in the other soil profiles in this trench. Very little rock is showing and no newly disturbed rock is visible.

There are no trees or tall shrubs on this site (**11 TR 01 E**), but the low shrub layer is very dense and consists of the following species: dwarf birch (50%), alder (35%), willow (20%), Labrador tea (10%) and blueberry (10%). Dwarf shrubs present are crowberry (15%), and low-bush cranberry. The three species of forbs on this site are Arctic lupines (15%), black-tipped groundsel (5%) and fireweed (5%). Grasses cover approximately 15% of the site. The moss community includes a trace (<1%) of a clubmoss

(*Lycopodium clavatum*), and has a strong component (30%) of a liverwort species. Three more common species combine for another 70%. Nine lichens combine for 45% coverage and are dominated by *Cladonia borealis* (20%).

White spruce with DBH's of 4 cm and 5 cm is found in the bottom of the trench, as well as paper birch measuring 20 cm and 14 cm DBH. These trees have likely moved down from the original surface, possibly as saplings on slumped blocks, and matured into trees with little evidence of displacement.

Trench 61TR1A

This trench is located at an elevation of approximately 820 m and intersects the access road from Eldorado Creek. It is one of a series of trenches excavated in 1961 more or less parallel to elevation contours. These trenches are easily identifiable from the air, and this trench now resembles an access road; originally it must have been a shallow feature. It is approximately 4 m wide at the base with a 1.3 m berm on the north side, and several hundreds of metres long. The north facing trench wall has a slope between 10 to 15 degrees and shows signs of some past movement. This movement now seems to be halted possibly due to the ground temperature being stable and the presence of fairly dense vegetation. The south facing berm consists of three levels of stable compacted material, all of which are highly vegetated. There is a noticeable difference in vegetation in the bottom or base of the trench; this is possibly due to its higher density i.e., machine compacted.

Two major groups of observations were collected from this trench. The first concentrated on the northwest facing arm of this trench, located north of the mine access road. The second group of observations are located on the east facing arm of the trench, south of the mine access road.

NORTHWEST FACING ARM OF TRENCH: The northwest facing trench has a floor sloping 11 degrees and trench wall sloping 20 to 40 degrees. Drill site 87R53 is located at the west end of this arm and indicates that heavy equipment walked on the bottom of the trench in 1987 to access it. Little evidence of this disturbance was found in the trench.

Soil profiles at sites **61-TR-1-A** and **61-TR-1-Ab** show well drained, poorly developed Orthic Regosol and Cumulic Regosol soils. The mineral soil has pH values ranging from 5.4 to 6.2 has a loamy sand matrix (27%) with a coarse fragment content of 72% and in situ moisture of 7.7%. The surface is moderately dense to dense. The bottom of the trench has a slightly to moderately compacted surface and maximum root depth is 20 cm. A discontinuous organic soil is developing, with thicknesses up to 11 cm in places on both walls of the trench; and the surface there is friable to slightly compacted. The walls of the trench have slowly slumped and stabilized themselves, and very little erosion is now taking place.

This shallow trench is densely revegetated predominantly by alder, with shrubs as tall as 2 m covering 70% of the layer. Black spruce (0.1-1 m tall, 10%), blueberry (5%), willow (2%), and paper birch (0.4 m tall, <1%) round out the shrub layer. The dwarf shrubs crowberry and low-bush cranberry are present. The very sparse forb layer consists of horsetail (2%), and fireweed (1%). Graminoids are represented by two common grasses combining for 12%. Three lichens combine for 12%, and a common moss adds 20% coverage.

For a short distance along this arm of the trench, a small creek intersects the trench and the water is now ponding on the flattened trench surface, forming a small marsh overflowing onto the surrounding original vegetation.

EAST FACING ARM OF THE TRENCH: The east facing arm of the trench (**Site 61 TR 1D**) has a similar surface, morphology and soils to the northwest facing arm of the trench. Plentiful micro to medium roots were present between 0 and 25 cm. Few micro to medium roots reached from 25 cm to 42 cm.

Even though the indigenous vegetation is re-establishing itself on the cut slope, the site is dominated (50%) by the pioneer shrub alder which reaches two metres in height. The other six vascular plant species on the slope are all common shrubs covering another 45%. The site has a strong lichen component (35%), but very little moss.

The vegetation stabilized the trench surface, but the trench bottom receives fresh sediments from a more recent trench (possibly dating from 1988) located upslope. The sediments wash through an undisturbed forest floor and settle principally at the bottom of this trench. This washed out silt deposit found at the base of the old trench slope is sparsely vegetated and hosts two pioneering grasses, *Agrostis scabra* and grass spp, and fireweed.

A few hundred metres east of site 61TR 1 D, a bulldozer rode over the trench bottom (blade up). The trees are cut close to the ground and the site is significantly covered with the washed out sand mentioned above. Although the black spruce trees are cut off, the species remains on site in the form of tall shrubs (25%) up to three metres in height. Most of the remaining vegetation is also in the form of shrubs, dominated by blueberry (50%), and Labrador tea (30%). The sparse (<15%) dwarf shrub layer is dominated by low-bush cranberries. Forbs are sparsely (10%) represented by bastard toadflax.

Graminoids are also very sparse (<10%) in the form of two grasses (*Calamagrostis spp* and *Agrostis scabra*). A tiny moss spp at 30% coverage occurs at this site.

Trench 88TR20

This trench is situated at the crest of a ridge south and east of the main Lone Star camp. At its point of origin, the access road, its elevation is 1040 m; and it is 1000 m at its lowest point. The trench cuts through 3 to 4 m of weathered and altered bedrock and is perpendicular to the hill slope. It is approximately 3m wide at the base and on average 5.5 m wide at the top, facing in a northeasterly direction. Approximately 250 m long, the trench runs down the slope of a hill with the upper portion sloping gently, and the middle and lower portions having slopes to a maximum of 50 degrees, before leveling off towards the end of the excavation. Three different sample locations were chosen ensuring a variety of characteristics. Soil samples were collected from several disturbed surfaces, i.e. trench walls, toe of slopes and the trench bottom.

GENTLY SLOPING PORTION OF THE TRENCH: The first segment of the trench was excavated at the crest of the hill into bedrock, and has unstable, steep sidewalls formed of weathered friable bedrock. Slopes along the trench floor range from 2 to 5 degrees. There is no soil development; all soils are classified as Orthic Regosols or Lithosols.

The steep upper wall consists predominantly of weathered to altered schist. Texture of the trench wall material (**88TR 1a**) is classified as a sandy gravel with some silt (12.9%), with a high content of fractured and angular bedrock clasts. The trench wall surface is considered soft and friable, with a moisture content of 6.2%. There is no vegetation growing on this steep slope.

The foot of the trench wall is covered by colluviated schist blocks and cobbles; at the toe there is a fringe of finer textured sediment. Sample **88 TR 1b** taken at this site shows a higher content in fines (24.4% silt and traces of clay) as well as a higher moisture content (13.9%). The surface is soft and slope washed; also remobilization of colluvium is an active process occurring at this part of the wall. A very sparse vegetation cover (less than 15%) is concentrated at the toe of the wall because the fine-grained material accumulated there acts as a moisture and seed trap. Vegetation is mainly composed of the following species: willow, fireweed, two grasses and a moss.

The very bottom of the trench is a flat, gently dipping, moderately well to well compacted surface approximately 3 m wide. The texture is dominantly silt with a trace of clay, and an in situ moisture of 42%. Several segments of the trench floor are composed of scraped bedrock. Ponds are forming in small depressions; here vegetation patches with coverage ranging from 10 to 30% are concentrated. This sparse incoming vegetation consists of the shrubs willow and Labrador tea, and grasses, dominantly *Agrostis scabra*.

The colluviated weathered bedrock at the bottom of the west facing wall supports more vegetation which still occurs in a patchy manner and covers less than 50% of the surface. The forbs fireweed and Arctic lupine combine for 2%; whereas four grasses achieve a cover of 45%, and a moss adds 1%.

STEEP PORTION OF THE TRENCH: The second segment of the trench sampled (**88TR 2a and b**) is located approximately 115 m downwards from the upper portion. The weathered bedrock surface is highly friable, and the localized alteration composed of clay rich zones contribute to the active erosion and material transport taking place on the excavated walls. Here the trench walls have sloughed inwards providing evidence of instability. The colluviated material at the base of the wall is classified as a silty sandy gravel, with as much as 27% silt and a moisture content of 14%. Slopes along the trench floor range from 20 to 25 degrees, and along the trench walls, they range from 30 to 35 degrees to vertical. Erosion and/or gullying at the base of the trench walls and along the floor of the trench has been caused by runoff, exposing large fragments of bedrock up to 20 cm in diameter.

The trench floor is composed of a densely compacted sandy gravel with an 8% moisture content. There are small patches of loosely compacted gravelly colluviated bedrock, and in several areas, scraped bedrock is exposed. There is no evidence of development of a soil horizon. The floor of the trench has a patchy vegetation coverage varying from 0-30%, and overall coverage is sparse. The shrubs willow and Labrador tea combine to cover 2%. The other four plant species on site are all grasses, dominated by *Agrostis scabra,* combining for 45%.

The top part of the east facing wall has a discontinuous, sparse vegetation cover consisting of the following species: willow, fireweed, two grasses, and a moss, originating mostly from the surface vegetation mat that is slumping down.

The colluviated material again shows the most vegetation, due to the loose surface, and availability of fine-grained material acting as a seed and moisture trap. Discontinuous vegetation totals less than 50%. The forbs fireweed and Arctic lupine combine for 2%, whereas four grasses achieve a cover of 45%, with a trace of moss.

BOTTOM OF TRENCH: The last 25 m of trench (88TR3) have steeper slopes ranging up to 50 degrees. This is the most eroded area of the trench and overburden piles placed at the top of the excavation have been slumping inwards. The upper portion of the trench wall consists primarily of dry decomposing bedrock fragments protected by an overhanging organic layer. Larger pieces of bedrock up to 20 cm in diameter are present at the toe of the sloped trench walls. These pieces of bedrock are trapping fine sediment which supports localized vegetation, providing a more stable slope. No soil is developing on this wall, nor at the toe because of the recent and active surfaces.

This site has a greater vegetation coverage than the rest of the trench due to the import of slumping organic matter and vegetation. The moss and lichen still clinging to these clumps are not included in the regeneration description. Two percent willow and 1% fireweed represent the shrub and forb layers. Three species of grasses dominate (65%), especially *Agrostis scabra* (40%). A liverwort (15%) and two other mosses (35%) complete the vegetation occurrences at this site.

The lowest extremity of the trench consists of material excavated from the trench above. Due to the method of material placement, there are distinct signs of gullying and localized accumulations of fine sediment. A very large and deep gully is actively cutting the edge of the drill platform built at this site.

Trench LS3

This trench is believed to belong to the 1990 exploration program. Its highest point originates from an access road at approximately 885 m elevation. Its lower end intersects trench 11TR1 at an elevation of 840 m. It cuts through friable, altered schist and colluvium or residual bedrock blanket with micaceous loamy matrix. The trench is several hundred metres long, 2 to 4 m deep, and is roughly parallel to the slope of the hillside. Observations on this trench focus on mid-slope and lower slope sites.

MID-SLOPE TRENCH WALLS: Approximately mid-way down the trench profile (**LS3B**), the trench floor slope ranges from 20 to 30 degrees. The profiles of these steep walls are constantly changing due to sediment wash out, slumping, and localized gullying. There is no soil development on these recent surfaces. There is no vegetation on the steep portions of the wall. The sparse vegetation growing back is concentrated on the loose piles of slumped material at the base of the walls. The forb layer is sparsely represented by fireweed (5%), with some wild rhubarb (*Polygonum alaskanum*, <1%), Arctic lupine (<1%) and traces of moss (<1%).

The bottom of the trench is quite compacted and deep gullies (0.5 m) are developing more or less parallel to vehicle tracks. Very little (<1 %) vegetation is growing back in this part of the trench. There is no soil development (Orthic Regosol) and the sandy gravelly silt has a moisture content of 29%. The higher compaction and active erosion processes, as well as the recent nature of this trench are probably the cause of the very low revegetation in this trench.

LOWER THIRD OF TRENCH: The trench profile **LS3A** is situated in the lower third of this trench, approximately 30 m downhill from site **LS3B**. This portion of the trench has a 4 m wide floor with two parallel eroded channels running down a 30 degree slope into the pool of fine sediment. The near vertical south facing wall of the trench shows active erosion and supports little vegetation. There is no development of a soil horizon, and the material is classified a sandy gravel, with trace of silt, and a moisture content of 5.5%. Vegetation is concentrated at the base of the wall on colluviated overburden and consists of willow (2%), wild rhubarb (5%), fireweed (5%) and three grasses (10%).

The opposing wall has a 45 degree slope, the original steep gradient has been reduced through erosion (**LS3Ac**). This wall appears more vegetated than the opposite bank of the trench (a) and supports willow (2%), fireweed (5%), a bedstraw (*Galium sp*), three grasses (combining together for a 23% coverage), a moss 5%, and strong showing (30%) of a liverwort species.

DEPRESSION AT TOE OF TRENCH: The pool of fine sediment (**LS3Ab**) consists of redeposited material from the slope wash and gullying affecting trench LS3 and 11TR-1. This site (**LS3Ab**) is not a typical runoff trap; it is nearly flat, adorned with moose tracks, and has a moderately well drained Cumulic Regosol. Ponded water is present approximately 4 m from the soil pit. There are two rock surfaces about 5 and 7 m from the soil pit which show that fine earth fractions wash along the wall, and temporarily stick to the surface until enough moisture accumulates to move the fine earth down into the soil pit location. The mineral soil consists of more than 105 cm of horizons of silty loam, loamy sand and gravelly loamy sand with an average pH value of 4.8.

This recent site is well vegetated due to the thickness of fine-grained material and abundant moisture. A trace of willow (2%), and a little wild rhubarb (2%) complement the 55% coverage of three grasses, of which *Agrostis scabra* dominates.

V01793A

This site traverses the hillside with an excavation that is 10 m by 200 m, and 2 m wide, bordered by an

8 m wide pile of overburden on the downhill side. The site faces north, has a moderate slope (12 degrees), is located at an elevation of 970 m, and is downhill from trench 88TR 1.

The steeply sided rocky trench is nearly unvegetated and shows no soil development. The wide pile of overburden beside the trench is very eye catching and stands out from other sites because of its very dense tall grass cover. This grass cover is dominated by the grass *Calamagrostis canadensis* (90%). Other species present are willow (5%), fireweed (5%), and two horsetail species (*Equisetum sylvaticum* and *pratense*, 7%). A trace of sedge (*Carex sp*) and the common moss *Polytricum juniperinum* (20%) complete the vegetation picture. The soil at this site is a moderately well drained Humic Regosol and has an unusually thick Ah (50 cm), underlain by loam (more than 40 cm) with very few coarse fragments, and with pH values of 4.8. Abundant, micro to medium roots are present between 0 and 25 cm. The maximum rooting depth is 40 cm. This site also has a litter of grasses and leaves.

LS7 1991

This is a 6 m wide trench of undetermined age which is interrupted by more recent roads and other workings. From assessment reports, this trench could be as recent as 1991. It is located on the southwest facing side of the property, between Oro Grande Gulch and Gay Gulch, at an elevation between 640 and 700 m. Through a cross-section this trench has been divided into three different sites to show different regeneration according to different slopes and aspects, as well, the overburden pile beside the trench has been examined.

The north facing wall of this trench is a near vertical bedrock face, approximately 4 metres high. This face of the trench is actively eroding; there is no soil development, and no vegetation (**LS7C**).

The floor of the trench is approximately 2 metres wide with a moderately compact surface. There is no soil development at this site either, but there is a thin litter (2 cm) of gravelly fine sandy loam to fine sandy clay loam overlying the bedrock (**LS7A**).

The tall shrub layer on this site (**LS7A**) achieves almost complete coverage. Paper birch at 40% reaches up to 8 m in height with a maximum DBH of 6 cm. Alder at 40% reaches up to 3 m in height. Black spruce at 20% coverage reaches up to 2 m tall with a maximum DBH of 2 cm. Balsam poplar at 5% reaches a maximum height of 5m and DBH of 3.5 cm. The very sparse shrub layer is confined to three species: Labrador tea 5%, willow 1%, and a trace of soapberry (*Sheperdia canadensis*, <1%). The three species making up the very sparse dwarf shrub layer are crowberry 5%, low-bush cranberry 3%, and kinnikinnick (*Arctostaphylos uva-ursi*, 2%). The very sparse forb layer is composed of the following species for a total of 10% coverage: tall bluebells, Arctic lupine, twin-flower (*Linaea borealis*) and black-tipped groundsel. A sedge and a grass combine for a 3% graminoid layer. Four lichens combine for 10% coverage and three mosses combine for 17%, with the feathermoss *Hylocomnium splendens* dominating at 10%. The ground is about 90% covered with broadleaf litter.

Site **LS7B** is located on the colluviated bedrock and overburden which form the north facing wall of the trench. Slumping is still going on, but the overall gradient seems stable with a 50 degree slope.

There are no trees on this site, but near by there are paper birch (20%), reaching up to 5 m tall with a DBH of 5 cm. The low shrub layer consists of Labrador tea 20%, black spruce 10%, and alder 5%. The very sparse (5%) dwarf shrub layer is represented by low-bush cranberry.

Five species, combining for 8%, make up the very sparse the forb layer: bastard toad-flax, Arctic lupine, tall bluebell, fireweed, and one-sided wintergreen (*Pyrola secunda*). The graminoid layer is limited to the indigenous forest grass *Festuca altaica* at 2%. Four lichens combine for 11%, and three mosses add a combined 25% coverage.

OVERBURDEN PILE: Beside trench LS7, heavy equipment piled overburden approximately 8 m wide by 8m long and 2m high (**site LS7E**). The stony gravel pile, consisting of more than 80% stones has a loamy sand matrix, is rapidly drained, has a pH of 6.6, and traces of litter at the surface. Few micro to medium roots are present between 0 and 20 cm.

A large portion of this pile is unvegetated (more than 50%); there are no trees, and a sparse tall shrub layer consisting of a few alders which reach a height of 3 m. The low shrub layer is well represented by alder 40%, black spruce (5%) which grows up to 0.8 m tall, white spruce (5%) reaching 1.2m in height, balsam poplar (5%) reaching up to 2m in height, and a trace of willow (<1%). The dwarf shrub layer is represented by low-bush cranberry 15%, and crowberry 5%.

The sparse forb layer is represented by a trace (<1%) of kinnikinnick. No forbs are found at this site, and one grass represents the very sparse (5%) graminoid layer. Only one moss is found here (5%) and lichens are well represented. *Stereocaulon* is the most obvious lichen on site, covering 30% of the layer. The other six species of lichens combine for another 30%, two of these *Umbilicaria hyperboria* (1%) and *Rhizocarpon geographicum* (5%) are growing on the rock surfaces.

Trench 91 TR 20

This trench was excavated with a backhoe in 1991. It is located above trench LS7 on a south facing slope, between Oro Grande and Gay Gulches, at elevations ranging from 720 to 740 m. The trench is cut more or less parallel to the slope of the hillside. The 2 to 3 m deep trench is cut through broken bedrock, is 4 m wide at the top, and the excavated materials were deposited beside the south east wall of the trench.

The northwest facing side of the trench is steep (>50 degrees) and consists of bedrock, mainly quartz muscovite schist. There is no vegetation on that face.

The southeast facing wall (site **91TR20**) has a large pile of overburden dumped directly on top. This overburden is washing and slumping down and covers part of the trench wall with a well drained loamy sand matrix with 70% coarse fragments (gravel to stones). Few plants are growing on the colluvial material, and vegetation is restricted to areas at the top where topsoil is exposed, and immediately below that line. The vegetation is a little more dense at the southeast side, at the top.

There are no trees or tall shrubs on the site. The low shrub layer is restricted to a trace, <1% of each of the following: willow, wild raspberry (*Rubus idaeus*), trembling aspen (0.4 m tall), and paper birch (0.2 m tall). The dwarf shrub layer is represented by a trace (<1%) of low-bush cranberry. The graminoid layer is made up of fireweed 5%, black-tipped groundsel <1%, and Arctic lupine <1%. One grass covers 5% of the layer. Two mosses cover 20% of the site. There are no lichens.

STRIPPED SURFACE

LSFIELD

This area was probably stripped in 1988, covers several hundred square metres, and is located west of the bunk house at elevations ranging from 1015 to 1040 m. This shallow pit is more like a stripped surface, facing north with slopes ranging from 1 to 12 degrees. The surface exposed is approximately 150 m wide by 250 m long and can be subdivided into zones of bare rock, ripped rock, rock a with blanket of fine-grained sediment, overburden and broken rock piles. Each of these zones were examined as they exhibit different vegetation and surface conditions.

The northernmost zone of the field (site **LSFIELD 4**) consists of a 20 m wide band of smooth, scraped bedrock, consisting of schist with quartz veins; it faces north to northeast and has a slope of 12 to 14 degrees. The site is very rapidly draining, and signs of surface runoff are visible. Ninety percent of the surface is bare rock. There are fans of fine mineral soil deposited in small depressions on the surface, where new plants could establish.

Two forbs are found in this northern zone at extremely low density: fireweed (2%), and Arctic lupine (<1%). Two grasses, *Calamagrostis sp* and *Agrostis scabra* grow here at 1% and 5% density, respectively. The moss *Polytricum juniperinum* (5%) completes the vegetation occurrence at this site. However a groove which runs through the site, harbors the following additional plants at a slightly higher density: willow, trembling aspen, wild rhubarb, and a tiny moss species.

Below this zone of smooth rock is a band of ripped bedrock and boulders (**site LSFIELD3**). The surface is very rough, and the average slope of the field itself is 12 degrees. The site is very rapidly draining. Several parallel ripped sections measuring 1 m wide at 2.5 to 3 m spacing are parallel to the contour of the slope. There is no organic matter or fine mineral soil on the surface, and no revegetation taking place at this site.

The lower part of this field (**site LSFIELD1**) is a fairly flat, very well revegetated, 20 m wide area at the base of the exploration field slope. The soil at this site is a rapidly to well drained Orthic Regosol with a pH value of 4.6. There is 20 to 35 cm of fine sandy loam overlying the bedrock surface. Plentiful micro to medium roots were present between 0 and 16 cm; maximum rooting depth is 32 cm.

Only 20% of the ground surface is unvegetated. The low shrub layer is well (60%) represented by willow which grows up to 2 m tall. The dwarf shrub layer has single occurrences (<1%) of dwarf birch and trembling aspen. The forb layer is well (55%) represented by three species, dominated by fireweed, Arctic lupine (5%), and black-tipped groundsel (<1%). There are two regularly occurring grasses *Calamagrostis sp.* (20%) and *Agrostis scabra* (10%) at this site.

The overburden pile located at the southern edge of the field was included to complete the suite of sites. Site **LSFIELD2** is a pile of pushed and broken rock less than 1 m high and approximately 4 m wide. The surface expression is marked by catblade hummocks (width 0.5m; height 0.25 m; and length 30 m+) which are parallel to the contours of the slope. The mineral soil (pH 4.6) has a well drained, sandy loam to loamy sand matrix. Few fine to medium roots were present between 0 and 15 cm, the maximum rooting depth reached 35 cm. The surface is moderately compacted to loose.

Approximately 30% of the surface is vegetated. The low shrub layer is very sparsely represented by willow (<1%) and 0.7 m tall trembling aspen (<1%). The forb layer is composed of fireweed (25%), and a single occurrence of Arctic lupine (<1%). The graminoid layer is well represented by two common grasses: *Calamagrostis sp* (25%) and *Agrostis scabra* (10%). There is a minute (<1%) showing of the moss *Polytricum juniperinum.*

Around the field there are several areas where equipment has disrupted the surface. Site **LSFIELD6** was chosen because of this unique kind of disturbance. This 10 m by 20 m partially stripped site with a slope of 6 degrees is disturbed by bulldozer tracks which compressed the vegetation mat. Approximately 20% of this site is open soil or rock. Signs of surface runoff are visible in the old compacted cat tracks which show exposed mineral soil. The discontinuous, ripped organic mat is 12 cm thick where left intact. The mineral soil (pH 4.6) has a fine sandy loam matrix and 70% coarse fragments (gravel to stones). Abundant micro to medium roots are present between 0 and 12 cm depth, few micro to fine roots reached to 35 cm.

Because of the partial disturbance, the plant community is a mix of indigenous plants (as described in LSField 5) and pioneer species. The low shrub layer is moderately dense (30%), and is dominated by dwarf birch (15%), followed by Labrador tea (5%), willow (5%), and blueberry (5%). The dwarf shrub layer has a tiny showing of crowberry (1%) and low-bush cranberry (2%). Forbs occur minimally, with a pioneering species of fireweed (2%) and Arctic lupine (<1%). Graminoids are represented by a rush (*Luzula parviflora*, 2%), and the two grasses *Agrostis scabra* (5%) and *Festuca altaica* (1%). Five mosses (30%) are fairly equally represented, and three lichens (<10%) complete the vegetation inventory for this site. Note that this site has two more moss species and five less species of lichens than the nearby undisturbed site.

Drill Pads

Borehole 87 R53

Site **87R53 A** is located at the west end of trench 61TR1, at an elevation of 810 m. The compacted drill pad (site **61TR1c**) is bordered on the north side by a steep wall probably re-excavated in 1987 (site **61TR1Ba and b**).

This site (**61TR1Ba and b)** was excavated to provide room for a drill and the required equipment. The excavated area is west-northwest facing; the lower portion has a slope of 39 degrees, and a height of 5 m; the upper portion has a slope of 11 degrees, with a height of 1.7 m. Peat and organic matter along with cobbles up to 20 cm in diameter have slumped onto the lower portion of the slope allowing more vegetation to take hold, stabilizing the slope. Little weathering of bedrock was noted due to a higher concentration of chlorite in the rock. Material is classified as a loose silty sandy gravel, with as much as 16% silt and a moisture content of 11 %.

This slope is sparsely vegetated (less than 25%). The shrub layer consists of alder (10%), willow (10%), paper birch (1%), and trembling aspen (1%).

The drill pad itself is densely compacted. Soil at this site consists of a well drained gravel with a silty loam matrix, 50% coarse fragments, and a pH value of 5.8. This surface is nearly bare where it is well compacted, and fairly well revegetated at the margins of the pad where the surface is less dense.

At the rim of this pad, the low shrub layer is represented by willow (25%), alder (0.1-1.5 m tall, 20%), and a 0.1 m tall white spruce seedling. Two common grasses are present (21%), dominated by *Agrostis scabra* (20%). A tiny moss species mat covers 60% of the site.

90R11

This site is located directly west of the bunkhouse at an elevation of approximately 950 m. It faces eastward at a general slope of 7 degrees. The surface expression of this site consists of complex short ridges and hummocks formed by the movements of heavy equipment. The site has a very rapidly to rapidly draining Orthic Regosol. The mineral soil is a gravel with a loamy sand matrix and 80% coarse fragments. Plentiful micro to fine roots are present between 0 and 15 cm depth.

The site is moderately revegetated, and three grasses (63%), especially *Agrostis scabra* (60%) dominate vegetation. The low shrub layer is represented by willow at 20% which grows up to 1.5 m tall. Very few forbs grow here: fireweed (5%), wild rhubarb (2%) and a mustard (*Rorippa sp*, <1%).

90R12

This drill pad is located 50 m uphill from site 90R11; it faces east-northeast and is flat. The soil is very compacted, due to the weight of the machinery which operated on the site in 1990. The site has a very rapidly to rapidly drained Orthic Regosol composed of a fine sandy loam without coarse fragments, and sand with 80% coarse fragments (gravel to stones) with pH values ranging from 6.4 to 7.2. Plentiful micro to fine roots are present between 0 and 15 cm depth, the total rooting depth is 25 cm.

The vegetation description at this site is done in two segments in order to show how much vegetation regeneration differs between the hard-packed drill site, and the looser more rugged surface at the perimeter of the drill pad.

The drill pad itself is vegetated with a tiny moss mat (30%), grass (*Agrostis scabra*, 10%) and willow (1%). The softer perimeter of the drill pad shows greater variety and abundance of vegetation. The low shrub layer is represented by willow (15%) which grows up to one metre tall, and dwarf birch (2%) which grows up to 0.7 m tall. Fireweed (10%), wild rhubarb (5%), and a touch of horsetail (0.5%) make up the forb layer. The dominant vegetation (60%) at this section of the site are two common grasses: *Calamagrostis sp.* (30%) and *Agrostis scabra* (60%).

92LS12

This pad (**92LS12**) faces east-northeast and is nearly flat. The surface is moderately compacted to very compacted. The soil consists of a moderately well drained Orthic Regosol with a pH of 4.8. The material itself is a fine sandy loam gravel. At a depth of 25 cm organic soil is intermixed with the mineral soil. Plentiful micro to medium roots are present between 0 and 9 cm, the total rooting depth is 35 cm.

This site has dense revegetation, due to its healthy grass layer. Shrubs are minimal on this site (3%), represented by dwarf birch (2%) and willow (1%). The sparse forb layer contains fireweed dominating at (25%) wild rhubarb (5%) and Arctic lupine (0.5%). Three grasses (*Calamagrostis canadensis*, 20%; *Calamagrostis sp*, 5%; and *Agrostis scabra*, 60%) dominate the vegetation community (85%). A small amount (5%) of a tiny moss mat completes the vegetation occurrence. However, the area around the pad, with a looser, rougher surface has 90% of its surface revegetated.

92S15

This 1992 surface is nearly flat and is well compacted as the drill pad is part of a road. Here again, there is no soil development, and the material consists of a gravel with a sandy loam matrix. The pH values average 5.0. Plentiful micro to very fine roots are present between 0 and 5 cm depth; the total rooting depth is 25 cm.

Low shrubs are very sparse at this site (<5%): willow (2%), blueberry (2%) and wild raspberry (<1%). The forb layer is also very sparse (<10%) with fireweed dominating (5%) wild rhubarb (2%) and Arctic lupine. The common grass *Agrostis scabra* dominates the vegetation at 30%, and another tall common grass *Calamagrostis canadensis* occurs at 2%. No mosses or lichens are present, and more than 50% of the surface is bare.

Once again, the softer perimeter of the drilling site allows for much greater vegetative regeneration, with only 20% of the surface being bare. Low shrubs are more abundant (30%) and represented by three species: willow (15%), wild raspberry (10%), and dwarf birch (5%). Forbs are well represented (35%) by fireweed (25%), and wild rhubarb (10%). The common grasses *Agrostis scabra* (80%) and *Calamagrostis canadensis* (15%) dominate this vegetation community with traces of moss.

93LS24

This drill site is located west of trench 88TR1, on a west facing hillside, at an elevation of 950 m and on a slope of 12 degrees. This site is described in four parts, to show how the melting permafrost black muck, and different slopes revegetate differently.

The drill pad itself (**93LS24A**) has a gentle slope (8 degrees) and a compact surface. There is no soil development, as would be expected on such a recent surface. Signs of surface runoff from the road such as gullies, and desiccation cracks are visible. The mineral soil has a pH value of 4.6 and is mainly a fine sandy loam with coarse fragment content ranging from 10 to 80%, with some intermixed organic matter. Less than 10% of the surface was revegetated by a single short willow shoot, Colts foot (1%), fireweed (1%), grass (*Agrostis scabra*, 2%) and some moss (6%).

This site (**93 LD 24B**) is located between the drill pad and a melting, crumbling permafrost cut, just upslope. The site has received slope wash material from melting permafrost which originates from exposed roadcuts near the site. The surface runoff created gullies in old cat tracks. Any excess sediments were transported into the undisturbed forest downslope. The mineral soil is a silty loam to fine sandy loam matrix.

This site is more vegetated than the drill pad itself. The vegetation community consists of 5% willow (up to 0.3 m tall), horsetail (30%), two common grasses combining for 7%, and a tiny moss species which covers 80% of the site. Clumps of fallen mat from the permafrost slough above are vegetated with the moss *polytricum juniperinum* (5%).

Site **93LS24C** is a roadcut adjacent to the drill pad. It is a four metre wide, north facing area located on a 20 degrees slope. The soil is a Cumulic Regosol on loamy sand with significant seepage which follows fractures in the ground. These fractures are connected to a gully fed by melting permafrost which in turn originates from areas where the surface cover of the natural forest was disturbed by cut lines. About 20% of this roadcut is open mineral soil with very light runoff, and has less than 20% open top soil mat.

The vegetation consists of 5% willow (up to 0.4 m tall), 2% horsetail, a grass (*Calamagrostis sp*, 20%), a tiny moss species (30%) and the moss *polytricum juniperinum* (25%).

Site **93 LS 24 E** is a push pile that has a similar soil to site **93 LS 24C**, except that it is well drained. It sits on an east facing, gentle slope, and has a loose, hummocky surface.

A single occurrence of willow composes the very sparse (1%) low shrub layer. The forb layer is dominated by fireweed (10%), and is joined by a single specimen (1%) of wild rhubarb. The only occurrence of chamomile (*Matricaria sp*) in the study makes its humble (5%) appearance here. Three grasses dominate the vegetation (45%) at this site and are joined by a rush (*Luzula parviflora*, 1%). No mosses, nor lichens occur here.

OTHERS

Cat Trails

A few sites under this unorthodox category were investigated. They consist of areas where heavy equipment walked, or drove, blade up, so that the surface vegetation cover is ripped and discontinuous, but still left on site, with portions of the original surface still intact.

Site **DC1** is associated with a 1990 drill pad and the disturbance is assumed to date from 1990. The site has a very rapidly draining Orthic Regosol. The soil is shallow (22 cm deep) without signs of soil erosion. The blade and track imprints are still easily seen on the ground. The soil consists of a mixture of exposed sandy loam and gravel (70% coarse material), and original soil with a organic mat over the parent material. The pH values average 5.8.

Camp Building (Bunk House)

LS 01 is located on the north side of the bunk house, and it is assumed that this surface is as old as the structure immediately beside it. The bunk house was built on a fairly flat, stable pad probably in 1912 or earlier (there are newspapers used as wallpaper in bunkhouse which are dated January, 1912). Small areas with a ridge or hummocky topography can be seen around the building. Two soil pits were dug close to the building. The soil from both of these pits is very hard and compact at a depth greater than 20 cm. They both consist of well drained Orthic Humic Regosol with pH value of 5.0. There is an organic mat as thick as 12 cm, and a humic A horizon as thick as 9 cm. The soils are composed of silty loam, sandy loam with 40% coarse fragments.

The entire area around the building itself is densely revegetated. The site is visually dominated by the tall shrub layer which consists of alder (20%), two willow species (25%), and white spruce (5%). The low shrub layer is composed of willow, black spruce (5%), dwarf birch (5%), paper birch (2%), wild raspberry (5%), blueberry (5%) and Labrador tea (5%). Dwarf shrubs are sparse; crowberry and low-bush cranberry together cover 10%.

The forb layer is made up of fireweed (10%), bunchberry (10%), twin-flower (2%), a groundsel (2%), coltsfoot (10%), and horsetail (2%). The graminoid layer consists of a rush and three grasses combining for 15% total coverage. Two mosses combine for 50% coverage, and two lichens add 7%. A clubmoss is also present at 2%.

REVENUE PROPERTY

Undisturbed Conditions

R 01 B

This natural forested site is located on a 19 degree slope facing northeast, approximately 30 m uphill from trench R1A. This is an open black spruce forest of small trees with mosses and lichens.

The tree layer is sparsely represented by black spruce, at 5% coverage. However, black spruce is a major component (40 %) of the site in the tall shrub layer. Labrador Tea represents the low shrub layer at 25%, and low-bush cranberry covers 20% of the dwarf shrub layer. The forb layer is very sparsely (1%) represented by *Lycopodium clavatum*, a clubmoss. Four mosses, dominated by *Hylocomnium splendens* (20%), combine to cover 40% of this layer. Six species of lichens combine to cover the rest of the forest floor.

Trenches

R1A

This trench is located at an elevation of 825 m a.s.l., is facing in an easterly direction with a slope of 3 degrees. It is approximately 1.7 m wide at the base, has a 1.7 m high south facing wall, and a 4.2 m high north facing wall. Three sample locations were chosen, one on the north wall (**R1Aa**), one on the south wall (**R1Ac**), and one on the trench bottom (**R1Ab**).

The north facing trench wall (**R1Aa**) is approximately 4 m high, with a slope of 47 degrees. This wall is still actively slumping; portions of the organic overhang are failing and have exposed the original soil surface which is now washing down the colluviated slope. The slope consists of fine size particles at the top, and coarse size fragments have rolled down to the foot of the wall. A sample confirms that this material is a sandy gravel, with a moisture content of 7% and a pH value of 5.8. This site very sparsely revegetated, with most of the vegetation originating from the slumped material from the original surface .

The south facing trench wall (R1Ac) is approximately 1.7 m high, with a slope of 45 degrees. The slope has some movement with cobble size particles falling to the lower portion of the slope. Minor erosion was noted, this is due to a small berm at the top of the slope which directs the flow of runoff away from the trench. The material is the same as for the north wall. This wall is basically unvegetated.

The floor of the trench (**R1Ab**) is 1.7 m wide, faces east and has a slope of 3 degrees. The trench bottom has a loose surface, and there is no ponding or gullying. The material is still a sandy gravel, with a higher content of fines (only 50% coarse fragments) and a higher moisture content (19%). Although these two factors encourage more growth the site is also very sparsely vegetated.

The low shrub layer is made up of white spruce (2%), willow (2%), and paper birch (1%). The forb layer is occupied by fireweed (2%). Two common

grasses combine for 4% coverage. A tiny moss species and the ever-present *Polygonum juniperinum* combine to cover 10% of the moss/lichen layer. No lichens are found at this site.

R2A

This trench is located at an elevation of 747 m and runs diagonally to the north facing hillside slope (27 degrees). The north facing trench wall has gentle profile with a slope of 27 degrees; at the base there is a fairly level area, approximately 5 m wide which is partially covered by ponded water. Ice-rich permafrost was exposed during excavation and continues to melt causing considerable movement of material on the slope. This regressive slumping will continue until the thermal regime in the ground has stabilized. Water from the melting ice and surface runoff forms a small pond on the floor of the trench.

The north facing wall (**R2Aa**) is well covered by slumped material. The excavated surface is now fairly covered by colluvial material, patches of organic mat, and original forest vegetation mats. The soil has a pH value of 5.6, a sandy loam matrix and 30% coarse fragment content. Plentiful micro to medium roots are present between 0 and 25 cm. The incoming vegetation fills in areas where slumping mats are not present. The low shrub layer is composed of willow (17%), and Labrador tea (1%). The very sparse dwarf shrub layer is occupied by low-bush cranberry (1%), and white spruce (1%) which grows up to 0.1 m tall. The forb layer is very dense with two horsetails combining for 80% coverage; fireweed adds another 2% to this layer. The very sparse graminoid layer is composed of a sedge (5%), a rush (*Luzula parviflora*, 2%), and a grass (1%). Ten percent coverage by a common moss completes the vegetation description of this site.

The trench floor, **R2Ab**, is partially covered by shallow ponds and small channels. Original material from the crest is slumping down the trench cut which gives the surface a loose hummocky appearance. The soil is an imperfectly drained Cumulic Regosol, with seepage at 30 cm depth. The mineral soil is mixed with the organic material, has a sandy loam matrix with 30% coarse fragments and a pH of 6.0. Abundant, fine and medium roots are concentrated from 0-18 cm depth, but roots extend below the seepage depth.

The site is densely revegetated; the supply of water and fine texture of the matrix, as well as the gentle slope of this low lying area encourages regrowth. At one site, willow which grows up to 3 m tall covers 60% of the low shrub layer. The forb layer is very dense with two horsetails (*Equisetum arvense,* 70% and *E. sylvaticum,* 30%) dominating. An unidentified water plant contributes 5%, and fireweed adds 1% coverage to this layer. Two mosses cover 51% of the plot, and no lichens are found here.

At another site, further away from the pond and the push pile, the shrub layer is very dense. Two willow species combine for 60% coverage and reach up to 3 m in height. Other shrubs are white spruce (5%) reaching heights of up to 1.5 m, and paper birch (1%) growing up to 0.5 m tall. The forb layer is dominated by two horsetails (*Equisetum arvense*, 40%, and *E. sylvaticum*, 40%). Fireweed adds another 10% coverage to the layer. One common grass represents the graminoid layer with 5%. Two mosses combine for 11% to complete the vegetation occurrences at this site.

R2B

This trench is located approximately 40 m uphill from trench R2A at an elevation of 780 m, roughly parallel to the slope of the hillside. The trench was excavated into friable and crumbly bedrock, and there is no sign of permafrost. The south facing wall (site **R2Bc**) of the trench is approximately 1.7 m wide at the base and 1.0 m high, facing in a westerly direction with a slope of 14 degrees. The adjoining north facing wall (**R2Ba**) has an approximate height of 4.8 m and a slope of 42 degrees. The excavated material was placed on the north side of the trench. This excavation is possibly as recent as two years old, and is basically unvegetated.

The rocky south facing slope was excavated into fractured and fragmented bedrock, and only 5% is revegetated. Traces of alder and willow represent the dwarf shrub layer. Other plants found here are fireweed, a grass (*Calamagrostis sp*, <1%), and a trace of moss (*Polytricum juniperinum*, 1%).

The north facing wall is very steep, with a slope of 80 to 90 degrees and is basically exposed rock. Revegetation is very sparse, with only traces of fireweed, a liverwort, and two mosses. At the bottom of the trench, in the loose rock, two grass species are present (11%), of which *Agrostis scabra* dominates at 10%.

On a pile of tailings, located downhill from the trench, revegetation is more successful. The surface is loose and hummocky, and the material consists of a gravel with sandy matrix and 70 to 80% coarse fragment content. Approximately 20 to 30% of the ground is revegetated. The low shrub layer is composed of balsam poplar (5%), willow (10%) growing up to 2 m tall, trembling aspen (5%), alder (10%) reaching a height of 1.8 m, white spruce (10%) up to 0.4 m tall, and paper birch (2%) reaching 0.6m in height. The forb layer is represented by fireweed (10%) and Arctic lupine (2%). A grass (1%) and a moss (5%) complete the vegetation occurrence at this site.

Site **R2D** is a cut line or an abandoned road perpendicular to the trench, forming a T intersection

with the trench **R2D.** This site is very rocky, with a north facing trench sloping downhill into an east-west facing trench, bringing with it drainage which flows even further downhill into an older easterly trench towards R2E.

The low shrub layer of this sparsely vegetated site is made up of trembling aspen (5%) which grows up to 2 m high, willow (5%) and paper birch (2%). White spruce growing 0.2 m tall adds another 5% to the layer. The forb layer is represented by fireweed at 5% coverage. A grass covers 2% of the graminoid layer. Two common mosses, *Polytricum juniperinum* (15%) and a tiny moss (10%), complete the vegetation picture of this site.

R2E

This trench is located an elevation of 740m and is roughly parallel to the slope of the hillside. It is approximately 3 m wide at the base, facing in an east-southeasterly direction with a slope of 7 degrees. The north facing wall is approximately 20 m high, with a slope of 30 degrees. This cut has exposed permafrost which is now melting and providing the unstable trench wall with large blocks of slumping soil, organic mat and water. The adjoining north wall consists primarily of overburden, a situation similar to trench R2A. The soil is a moderately well drained Cumulic Regosol with a thin litter of grass and leaves. The mineral soil is mixed with the organic material, has a sandy loam to silty loam matrix, with 40% coarse fragments, and a pH of 6.6. Abundant microfine to medium roots are present to 25+ cm depth.

This site is on a very long, densely vegetated old trench which is heavily used by moose for browsing. It has been subdivided to show the difference in vegetative cover between the bottom of the trench, with deposited material, and the permafrost slope.

The trench floor is densely vegetated, with as much as 80% of the ground being revegetated. There are no trees on this site but the tall shrub layer is well represented by two species of willow (50%), one of which reaches 6 cm diameter at the base. Both species reach a height of three metres. The low shrub layer is made up of white spruce (5%), paper birch (2%), and trembling aspen (1%), all up to 0.5 m tall. The forb layer is represented by two horsetail species (*Equisetum arvense,* 10%, *E sylvaticum,* 20%), Northern starwort (*Stellaria calycantha,* 5%) which is rare in this area, fireweed (10%), and yarrow (1%). A grass (*Calamagrostis sp*) covers 30% of the graminoid layer. Two mosses and a liverwort each add 10% to the ground cover.

The slumping trench wall is a mixture of displaced vegetation mats and incoming vegetation. The displaced vegetation blocks belong to the same community described in the undisturbed vegetation plot. The new regeneration includes willow (20%)and horsetail (20%) in the low shrub layer; fireweed (5%) and a starwort (1%) occur in the forb layer. Two grasses at 25% combine to form the graminoid layer. A large moss species (20%) and a little moss species (60%) combine to dominate the vegetation on this permafrost slump site.

R9

This trench is located at an elevation of 765 m and is characterized by well drained decomposed rock fragments with very little matrix which allows for little vegetation growth. The site has been subdivided in order to present the different regeneration patterns.

Site **R9a** is located on a north facing wall, with a rough surface and sparse revegetation (less than 10%). The dwarf shrubs at this site are white spruce (2%), balsam poplar (1%) and trembling aspen (1%); these shrubs grow between 0.3 and 0.4 m tall. Fireweed covers 2% of the forb layer, three grasses cover 7% of the graminoid layer, and one moss adds 2% to the total vegetation community of the trench.

Site **R 09b** is located on a flat area beside the trench; it is presumably made of materials deposited from the trench. Although still dominantly composed of coarse fragments, there is slightly higher proportion of matrix (possibly 10%) in the overburden. Although revegetation is still quite sparse and consists mostly of shrubs, it is still greater than at the earlier site. The low shrub layer consists of willow (10%) up to 1.5 m tall, trembling aspen (2%) up to 0.6 m tall, balsam poplar (10%) up to 1 m tall, and white spruce (10%) up to 0.6 m tall. The forb layer consists of 5% fireweed. Three grasses combining for 5% form the graminoid layer. The vegetation description is completed with an additional moss occurrence of 2%.

DRILL PADS

R 06 (Drill pad S-84-4)

This drill pad dates from 1984 and is a fairly level square surface facing west. Site **R6A** the drill pad itself, has been leveled by heavy equipment. The surface has 95% stony coverage and is fairly compacted. The soil is a moderately well draining gravel with a sandy clay loam matrix with 20% coarse fragments and a pH of 7.2. Very few fine roots are visible at shallow depths. This site is sparsely revegetated, with less than 10% vegetation coverage, 90% of the site being bare soil or rock. The low shrub layer on this sparsely vegetated site consists of white spruce (5%) which grows up to 0.4 m tall, willow (3%) which reaches 0.4 m in height, and traces (<1%) of dwarf birch and trembling aspen. Fireweed (3%) and Arctic lupine (1%) constitute the very sparse forb layer. Two common grasses combine for 15% in the

graminoid layer. A common moss contributes 1% to the moss/lichen layer. No lichens are found at this site.

Site **R6B** is an overburden pile with a loose, rough surface, beside the drill pad. The soil is the same gravelly silty loam, mixed with some organic matter from the old drill pad surface. Few micro to fine roots were present between 0 and 35 cm depth. Roots grow mainly in the organic pockets within the C horizon.

This site has good regeneration with only 10% bare ground showing. The looser surface and added organic material are probably responsible for the more productive regrowth. The low shrub layer is represented by willow (15%), white spruce (15%) reaching heights of 0.7 m, a trace (0.5%) of balsam poplar, trembling aspen, paper birch growing up to 0.7 m tall, prickly rose and Labrador tea. The dwarf shrubs crowberry and low-bush cranberry are also present. Fireweed dominates the sparse forb layer with 20% coverage. Other species found here are yarrow (1%), Arctic lupine (1%) and a trace (<1%) of spike like goldenrod (*Solidago spathulata*). A common grass covers 25% of the graminoid layer. One common moss occupies the moss/lichen layer with 20% coverage. No lichens are present.

R 06 C (undisturbed)

This undisturbed site is located at an elevation of approximately 1,000 m and has the highest elevation of all natural or undisturbed conditions described in this area. The area is on a southwest facing slope of 14 degrees. The soil is a well draining Orthic Eutric Brunisol developed from colluvial parent material. The organic mat is 7 cm thick and rests over a fine sandy ashy layer and a gravelly silt loam. Bedrock is estimated to be quite shallow and is probably present within a metre of the surface.

This area is composed of an open spruce forest with shrubs, mosses and lichens. The tree layer is represented by black and white spruce. Black spruce cover 10% of the layer at an average DBH of 12 cm and HT of 8 m. The white spruce are larger than the black spruce with a maximum DBH of 30 cm and height of 13 m, and cover 10% of the tree layer. The tall shrub layer is represented by black spruce (10%), and willow (5%) reaching 4 m in height. The dense low shrub layer is dominated by Labrador tea (50%), and augmented by blueberry (5%) and white spruce (20%). The dwarf shrub layer is well represented by crowberry and low-bush cranberry with 15% coverage each. The forb layer is very sparsely represented by bastard toad-flax (5%). Four mosses contribute sparsely (10%) to the moss/lichen layer and seven lichens combine for 65%.

R8A 1968

This drill pad is located at an elevation of 1010 metres, is approximately ten square metres in size, and is fairly level with a compacted surface. The material is a gravelly sandy loam with up to 30% coarse fragments and ashy pockets. The pH is fairly low, with value of 5.4.

This site has been divided in two, to show that the circumference of the drill pad is more vegetated than the centre. Site **R8Aa** is located at the centre of this well compacted and sparsely revegetated drill pad. The low shrub layer is sparsely occupied by white spruce reaching 0.4m in height, alder, willow, trembling aspen and Labrador tea. A trace of crowberry represents the dwarf shrub layer. The forb layer is made up of Arctic lupine (5%) and a trace of fireweed. Two common grasses combine to cover 6% of the graminoid layer. One moss and two lichens each cover 5% of the moss/lichen layer.

R8 Ab is located on the hummocky looser surface at the perimeter of the drill pad. The soil is very similar to the previous site, except that it is less compact, and shows much greater regeneration. No soil is visible here, but some exposed rock covers 2% of the site. The tall shrub layer is represented by paper birch (10%) reaching 4 m in height and 4 cm DBH, white spruce (15%) up to 3 m tall, and alder (10%) up to 2.5 m tall. Five species occupy the low shrub layer: Lodge pole pine (*Pinus contorta,* 2%) up to 1 m tall, willow (10%) up to 2 m tall, dwarf birch (2%), Labrador tea (5%), and blueberry (5%). The dwarf shrub layer is sparsely represented by crowberry (2%), low-bush cranberry (1%), and a trace of kinnikinnick. Fireweed and Arctic lupine combine to cover 5% of the forb layer. Two common grasses combine to cover 4% of the graminoid layer. Two mosses combining for 3%, and five lichens combining for 6% cover the moss/lichen layer of the site.

OTHERS

Abandoned Access Road R3a

This site is located at an elevation of 780 m, on an unused road with a north facing aspect. The level portion of the site is approximately 5 m wide at the base with a slope of 8 degrees. The adjoining south/ southwest wall is approximately 3 metres high, facing in a northeasterly direction with a slope of 14 degrees. The slumping present at this location is caused by runoff from the adjoining undisturbed areas. No permafrost was noted and yet water seepage is evident. The mineral soil has a pH of 7.0 and is a gravel with a sandy loam to silt loam matrix and 10 to 40% coarse fragments. Moisture content is 16.3%, and the surface is loose and slightly hummocky.

This site is densely revegetated. The low shrub layer is occupied by two species of willows (35%) with trembling aspen (2%) at 0.8 m in height, white spruce (2%) growing up to 0.6 m tall, and paper birch reaching 0.5 m high. The dense forb layer is dominated by two horsetails (*Equisetum arvense*, 50% and *E sylvaticum*, 30%), as well as fireweed (5%). The graminoid layer is comprised of three grasses combining for 24%, and a sedge which covers 5% of the layer. The moss *Polytricum juniperinum* (20%) and a small moss (2%) complete the vegetation picture of this site.

Undisturbed conditions R3B.

Site R3B is an undisturbed forest uphill and at a slightly higher elevation than site R3A, on a north facing slope of 8 degrees. The site has an imperfectly drained Orthic Static Cryosol. The ground shows signs of slow soil creep, which is expressed by the hummocky low ridges. The organic mat is 13 cm thick overlying 30 cm of silt loam with less than 10% coarse fragments (gravel). Permafrost exists at a depth of 30 cm, there are visible ice crystals 0.5 cm thick and 1 to at least 2 cm long and wide. Abundant, micro to coarse roots are present between 0 and 20 cm, few, micro to fine roots reached up to 50 cm deep, where the permafrost is root restricting

Natural vegetation at this site consists of black spruce open forest with low shrubs, mosses and lichens. The tree layer is entirely composed of small black spruce (5%) up to 6 m tall and an average DBH of 12 cm. Most of the black spruce is in the tall shrub layer, occupying 50% of it. The low shrub layer is dominated by Labrador tea (50%), and augmented by willow (10%) reaching 1.2 m in height, and blueberry (%). The dwarf shrub layer is represented solely by low-bush cranberry with 30% coverage. The very sparse forb layer is occupied by horsetail and coltsfoot with 2% coverage each. The graminoid layer is also very sparse with only one grass covering 5% of the layer. Four mosses, including a feathermoss (*Hylocomnium splendens* 20%) and a red spagnum moss (5%) combine for 36%. Six lichen species, combining for 52% coverage add to the dense cover of this moss/lichen layer.

NUCLEUS PROPERTY

Trenches

N2 (1984)

This trench is located at an elevation of 915 m, on an east facing slope. It was excavated in 1984 and is probably the oldest, and most accurately dated trench on this property. It is approximately 30 m long, 0.5 m wide at the base and on average 4 m deep, with a slope of 11 degrees. Again, three sample locations were chosen, one on the south facing wall (**N2a**), one on the north facing wall (**N2b**) and one on the trench bottom (**N2c**).

Site **N2a** is located on a 4.5 m high wall facing south, with a slope of 40 degrees. The upper portion of this trench wall has been undercut by runoff from the surface. In several places, the surface organic mat is overhanging the wall and contributes to wall revegetation. These walls, both north and south facing are still quite actively eroding, and trees are falling into the trench as slumping takes place. Runoff washes the fines down slope, and loosens bedrock fragments which eventually fall into the trench floor. The site has a rapidly drained Cumulic Regosol which is an undeveloped soil on a silty sandy gravel with as much as 35 to 90% coarse fragments. The moisture content is 9% and the pH value is 6.0. Plentiful micro to fine roots are present between 0 and 35 cm.

This site has 35 to 40% vegetation coverage. The shrub layer is represented by five species at this site: willow 20%, white spruce (15%) growing up to 0.4 m tall, paper birch 10%, trembling aspen 1%, and balsam poplar 1%.

Site **N2b** is located on a wall 3.5 m high, facing in a northerly direction with a slope of 36 degrees. The upper portion of this wall has a vertical face approximately 1 m high. This face remains dry and is the source of the cobble size fragments present at the toe of the slope. The soil here is very similar to the south facing wall, but has a higher moisture content of nearly 13%. The lower portion has a higher concentration of fines, the material is moist and supports some vegetation which assists in stabilizing this portion of the slope.

This north facing wall has a vegetation cover of approximately 50%. The shrub layer on this disturbed site is represented by a willow (5%), and a trace (1%) of paper birch. The dwarf shrub layer is represented by a trace (1%) of white birch which grows up to 0.1 m high. The forb layer contains only 10% fireweed. The graminoid layer is represented by two common grasses which cover 20% each. A trace (0.5%) of the common moss *Polytricum juniperinum* and 5% of another tiny moss species represent the moss/lichen community and complete the vegetation picture of this site.

Vegetation abundance increases towards bottom of disturbed slopes. Slopes which are unstable and have materials sliding down from above have less vegetation on them, especially on the upper half of the slope. It appears that the falling rock and soil prevent vegetation from getting established. Falling ash may also discourage revegetation.

The final segment of the trench (**N2c**) is 0.8 m in width, facing in a easterly direction with a slope of 11 degrees. The bottom of the trench is firm with no visible gullying. The surface has 100% stony

coverage. The soil is a well draining Cumulic Regosol on colluvial parent material. The mineral soil has a sandy loam matrix with 50 to 60% coarse fragments (gravel and cobbles), and contains few microfine to medium roots down to a depth of 30 cm. The moisture content of the mineral soil is nearly 15%.

Due to time constraints the vegetation was not described in detail, but 70 to 80% of the ground is covered by grasses, fireweed and a few shrubs.

N3 (1986)

This trench is facing in a easterly direction with a slope of 7 to 10 degrees at an elevation of 822 to 914 m. The configuration of this trench is different than most, in that it appears to have been excavated twice. The trench walls have a level, narrow bench approximately halfway up (1.4 m) that acts as support for both the upper and lower portions of the slope. The appearance of the trench and the degree of revegetation suggest that both phases of excavation of this trench were done more or less at the same time, during the 1986 exploration program. Slumping materials from the above undisturbed area provide fines and portions of organic mat that assist in stabilization of the slopes. Cobble size fragments up to 15 cm dominate the lower portion of the trench. Observations in this trench are divided into three sites to cover various aspects, the south facing wall (**N3Ba**), the north facing wall (**N3Bb**) and the trench bottom (**N3Bc**).

The south facing trench wall has a slope of 40%, and is 70% covered with volcanic ash which has been washed down from above. The soil is a well drained Cumulic Regosol, an undeveloped soil which shows active redeposition. The gravel has a loamy sand (LS) matrix and 90% coarse fragments (gravel to stones) with a pH of 6.4. The moisture content is less than 10%, and the surface is loose. Very few, very fine roots are present between 0 and 1 cm.

The low shrub layer is represented by alder (5%), paper birch (20%) and willow (5%). The dwarf shrub layer is represented by white spruce (5%) which grows up to 0.2 m tall. The forb layer is represented by 5% fireweed. The graminoid layer is represented by two common grasses which combine for 30% coverage. Two mosses combine to cover 15%, and no lichens are present on the site.

The north facing wall of the trench, site **N3Bb** has a soil and slope similar to site N3Ba. The vegetation is less prolific on this side of the trench. The dwarf shrub layer is sparse with 4% coverage and is represented by paper birch, willow, and white spruce. Fireweed represents the forb layer with 10% coverage. A grass covers 20% of the graminoid layer. A tiny moss species covers 20% of the ground and is joined by another common moss with 5%. No lichens grow on this site.

N4A (1986)

The trench is located at elevations of 820 to 880 m, on an east facing slope of 12 degrees. This trench was also part of the 1986 exploration program. It is approximately 3.3 m wide at the base and on average 3.4 m deep. Three sample locations were chosen, one on the north facing wall (site **N4Ac**), one on the south facing wall (**N4Aa**) and one on the trench bottom (**N4Ab**). An additional sample site on top of the south facing wall (**N4Ad**) documents this site.

The first segment of the trench, site **N4Ac** is approximately 4 m high, facing in a northerly direction with a slope of 32 degrees. Signs of erosion are evident; they are minor in nature and consist of movement and ponding of fines, and the movement of bedrock fragments up to 70 mm in diametre. Most of the movement has already taken place, and the slope now appears stable. As in most of the trenches there is no soil development, and the material consists of a well drained sandy gravel with traces of silt (7%). The coarse fragments of the colluviated material consist of shattered and weathered bedrock. The moisture content is low at 6.7% and the pH is 6.4. Very few micro to very fine roots are present between 0 and 21 cm.

N 04 A (c) is sparsely vegetated. The low shrub layer is made up of white spruce (5%), willow (2%), and balsam poplar (1%). The forb layer is represented by a trace (<1%) of fireweed, and three species of grass combine for 37% coverage of the graminoid layer. A trace of moss (1%) completes the vegetation picture of this site.

The second segment of the trench (**N4 A a)** is approximately 3.3 m high, facing in a southerly direction with a fairly stable slope of 30 degrees. Minor effects of erosion were noted; the runoff is channeled down a gully 0.4 m wide.

Vegetation covers approximately 25% of this site. The low shrub layer is comprised of willow (2%), paper birch (5%) and balsam poplar (5%). The two species fireweed (10%) and Arctic lupine (2%) make up the forb layer. The graminoid layer is composed of three common species (*Agrostis scabra,* 10%, a *Calamagrostis sp,* 2%, and *Festuca altaica,* 2%); also an unusual species *Festuca saximontana* (10%) is found near this site. No mosses or lichens occur at this site.

The bottom of the trench **(N4Ab)** is 3.3 m in width, facing in an easterly direction with a slope of 12 degrees. Runoff from the roadway has caused a gully to form on the north trench wall which in turn forms small incised channels in the bottom of the trench. The surface is a loosely compacted, rapidly draining, colluvial loamy sand with 90% coarse fragments, and a pH of 6.2. There are plenty microfine and fine roots in the top 5 cm.

Vegetation has taken hold in the stabilized portion of the trench bottom, this includes small spruce, and native grasses and wildflowers. The low shrub layer of this poorly vegetated site is composed of balsam poplar (2%), willow (1%), trembling aspen (1%) and white spruce (1%) which grows 0.1 m tall. The forb layer is represented by fireweed (5%), and a trace (0.5%) of tall bluebell. Three grasses, combining for 35% coverage make up the graminoid layer. No mosses or lichens are found at this site.

N4B (Undisturbed Conditions)

Site N4B is located above trench N4A at an elevation of 825 m, on an east facing 6 degree slope. The site has a rapidly draining Orthic Eutric Brunisol developed in weathered bedrock. The organic mat is 8 cm thick, the mineral soil has an ashy surface, and a B horizon as deep as 18 cm. The pH is 5.8 which is lower than the pH of the disturbed trench material. Abundant micro to coarse roots are present between 0 and 8 cm and micro to fine roots reached 16 cm deep.

The surface of this undisturbed site is completely vegetated. The tree layer is represented by black spruce (15%), with a representative DBH of 10 cm, and tree HT of 8 m. White spruce trees occupies 5% of the layer with a representative DBH 20 cm and HT 17 m. Paper birch occupies 5%, in the tree and the tall shrub layer. The tall shrub layer is represented by paper birch and 30% black spruce. The low shrub layer is dominated by Labrador tea (40%), and augmented by willow (2%), and prickly rose (1%). Low-bush cranberry (15%) represents the dwarf shrub layer. The very sparse forb layer is comprised of a trace (1%) of clubmoss. The common indigenous grass *Festuca altaica*, with 5% coverage, represents the graminoid layer. The moss and lichen layer is well represented at this site. The mosses are dominated by the feathermoss *Hylocomnium splendens* (30%), and augmented by two other forest moss species. Seven species of lichen combine for 60% coverage, 40% of which is supplied by *Cladina mitis*.

N6 1986

Site **N6** (Ashy Trenches) was excavated in 1986. It is very similar to trench N4A with the addition of a thick ash layer at the surface. The ash bed is incorporated in the overburden piles and is now washing down the walls of the trench. This thick ash bed does not seem to impact the revegetation rate.

N7 B 1986

This trench is approximately 50 m long and runs perpendicular to the hillside, at an elevation of 865 to 890 m, on a northeast facing slope. Signs of cryoturbation can be seen on the adjacent undisturbed site, and the permafrost was disturbed on this site (N7C). This site has been subdivided into three sections in order to represent different regeneration patterns: a south facing wall (**N7Ba),** a north facing wall (**N7Bc**) and the trench floor (**N7Bb**).

Site **N7Ba** is a south facing, unstable, colluviated slope of 39 degrees. At this site, fine material from an overburden pile on the crest is being washed down into the trench. The loose surface has 95% stony coverage and the soil is a very rapidly draining gravel with a sandy loam matrix and 98% coarse fragments (gravel and cobbles). The bedrock is present at a shallow depth of less than 40 cm, and is friable and highly fractured.

The vegetation on this site covers less than 30% of the ground surface, and is partially composed of fragments of surface vegetation slumping down. The low shrub layer is composed of willow (15%) which reaches up to 2 m in height, prickly rose (5%) growing up to 0.8 m tall, trembling aspen (5%) reaching 0.5 m in height, and balsam poplar (1%) up to 0.5 m tall. The shrub species Labrador tea, blueberry, and crowberry each cover 2% of the plot, and occur mostly on slumped forest soil. The dwarf shrub layer is made up of white spruce (10%) and paper birch (1%), both species reaching 0.4 m in height. The forb layer is represented with 10% coverage by fireweed, and two common grasses combine to cover 20% of the graminoid layer. Two mosses, including a tiny mat moss combine to cover 10% of the ground. No lichens are present.

The north facing wall of the trench (**N7Bc**) has a similar surface and slope. Vegetation cover is lower, with approximately 20% of the surface being revegetated. The low shrub layer is represented by 10% coverage of willow. White spruce growing up to 0.3 m tall covers 5% of the dwarf shrub layer. Fireweed represents 3% of the forb layer, and two common grasses combine to cover 12% of the graminoid layer. Seven percent coverage by two mosses completes the vegetation description for this site.

Site **N7Bb**, the trench floor, is composed of the same material as the walls, although here there is evidence of greater erosion and deposition of fine soil, pebbles, cobbles and blocks. The bedrock is partially exposed. The floor of the trench is fairly steep at 39 degrees; this accounts for the greater movement of material. This site is less revegetated than the trench walls, with 15% of the surface covered by vegetation. The regrowth is concentrated at the base of the walls where there are fairly stable surfaces.

The low shrub layer is represented by balsam poplar (5%), willow (10%), and a trace of Labrador tea (<1%). White spruce reaching a height of 0.3 m, appears as a dwarf shrub at 10%. No forbs are found

at this site, but two grasses combine to cover 10% of the graminoid layer. A tiny moss (10%) and a common larger moss (5%) complete the vegetation.

A small gully exits the trench bottom and extends for 100 m downhill, carrying runoff, where fine sediments are channeled and redeposited.

N8 B 1986

This trench referred to in assessment reports as 86 N 11 C3, is located north of trench N7B and is very similar to it. There is slightly more matrix of the parent material, with 70% coarse material. Regrowth is greater, with approximately 35 to 40% of the surface being revegetated. The low shrub layer is dominated by alder (35%), and augmented by balsam poplar (5%), paper birch (1%) and willow (3%) which grows up to 0.8 m tall. Three grasses combine to cover 25% of the graminoid layer, and a tiny moss represents 5% of the moss/lichen layer.

As in trench N7B, a gully is developing downhill from this trench, channeling surface runoff and sediments.

N1 1989

This trench referred to in exploration reports as 89N-4, was excavated in 1989 and is located at an elevation of 930 to 990 m. It is approximately 3.4 m wide at the base and on average 4 m deep, facing in an easterly direction with a slope of 5 degrees. Two sample areas were chosen in this trench, one approximately halfway up the hill (N1A) and the other at the mouth of the trench (**N1B**).

The higher portion of the trench is located at an elevation of approximately 965 m. The site is subdivided into three sections to cover various aspects, the south facing wall (**N1Aa**), the north facing wall (**N1Ac**) and the trench bottom (**N1Ab**). The trench cuts into friable bedrock of Pelly Gneiss, and gravelly loamy sand to loamy sandy gravel with 70 to 80% coarse fragments.

The south facing trench wall (**N1Aa)** is approximately 4 m high and has a slope of 36 degrees. The upper portion of this trench wall has been undercut by runoff from the undisturbed area, allowing the organic mat to overhang, and the fines to flow downwards. There is no soil development and the trench material consists of a friable, silty gravelly sand with a moisture content of 10% at the time of sampling. The slope is sparsely vegetated with a few fireweed stems and a single willow. On the lower portion some grasses are growing (7% vegetation cover) where the fines are concentrated.

The north facing trench wall (**N1Ac**) is approximately 2.5 m high, has a slope of 57 degrees, and is unstable. Erosion has exposed the underlying bedrock stratum which has activated weathering processes. This site is very sparsely vegetated (less than 1%) with willow, a mustard (*Descurainia sp*) and three grasses.

The final segment of the trench (**N1Ab**) is 3.4 m wide, facing in a easterly direction with a slope of 5 degrees. The bottom of the trench is firm and fairly well compacted, and consists of exposed bedrock and loamy sandy gravel, with traces of clay, and a moisture content of 11.3%. In some areas, fines have washed down and accumulated at the toe of slopes. This sparsely (<10%) vegetated site is dominated by four grasses and joined by a trace (<1%) of fireweed.

N 01 A (d) is located on the overburden piled beside trench N1A. The surface is very stony, friable and has a slope of 20 to 30 degrees. The soil is a rapidly draining Orthic Regosol with a sandy loam matrix and 70% coarse fragments (gravel, cobbles) and has a pH of 6.2.

This site has revegetated quite well with 60% of the ground covered by vegetation. A trace of willow (1%), and trembling aspen (5%) which grows up to 2.5 m tall comprise the shrub layer. The forb layer is composed of two species of fireweed (*Epilobium angustifolium*, 20% and *Epilobium latifolium*, 2%), and a mustard species at 5%. Four grasses complete the vegetation occurrences here with 27% coverage.

The second location **N1B,** at a lower elevation of approximately 930 m, is also subdivided into three sites: the south facing wall (**N1Ba**), the north facing wall (**N1Bb**) and the trench bottom (**N1Bb**).

The south facing trench wall (**N1Ba**) is approximately 4 m high and has a slope of 37 degrees. Several slumps were noted on the trench wall, the source of this material is the overburden pile on the top of the slope. There is no soil developing on the well drained loamy sandy gravel (40 to 60% coarse fragments). The moisture content is 7.6%.

This site has a vegetation cover of 15% to 20%. The shrub layer is composed of two species of willow (6%) and a trace of paper birch (1%). The forb layer is represented by fireweed (5%), and the graminoid layer is represented by two grasses combining for 15%.

The north facing trench wall (**N1Bc**) is approximately 1 m high and has a slope of 45 degrees. The material slumping down off the overburden piled on top of this wall contributes to the active and unstable slopes. Cracking caused by runoff and the soils dry nature is providing continual movement on the slopes surface. An ash layer, likely the White River Tephra dating from 1200 year B.P., has washed down on the slope in several locations. The soil profile here is very similar to the previous site, a gravelly sandy silt to sandy gravel, with a lower moisture content 6.4% and a coarse fragments content of 70%.

This steep site is interesting because it has a tiny moss species (5%) growing on the vertical face of the

original white volcanic ash layer. There is also a trace (<1%) of fireweed growing and two grass species at a combined 20%.

The bottom of the trench (**N1Bb**) is 2 to 3 m in width, facing in an easterly direction with a slope of 10 degrees. The bottom of the trench is full of cobbles up to 15 cm in size, and fines from the two adjoining unstable slopes, and grasses. Some gullying was noted, but these areas are well vegetated and the movement of fines remains minimal. The soil is similar to the trench material, but has a higher moisture content of 19%. This site is only vegetated by the grass *Agrostis scabra* with 25% overage.

The overburden pile (site **N1Bd)** is very similar to N1Ad, with similar morphology, soil and revegetation.

Drill Pads

N5A 1989

Site **N5A** is a drill pad associated with the 1989 drilling program and is referred to as DDH N 89/1 in assessment reports. As with other drill pads, it consists of a fairly level, square well compacted surface. The site is built on rapidly draining gravelly material with a fine sandy clay loam matrix and 60% coarse fragments with a pH 6.0. This site is sparsely vegetated; no trees or tall shrubs are present; and there is 80% open soil and rock visible. The low shrub layer consists of willow (1%) up to 0.6 m tall, and trembling aspen (2%) up to 1.5 m tall. There are no dwarf shrubs at this site. The forb layer is comprised of 1% fireweed and a trace (<1%) of Arctic lupine. Four grasses combine for 54% coverage of the graminoid layer. No mosses or lichens are present at this site.

N5B 1991

Site **N5B** was part of the 1991 drilling program and is referred to as DN91-2 in assessment reports. The surface has 100% stony coverage and no organic cover. The level surface is fairly well compacted, is comprised of well drained gravelly material with a loamy sand matrix and 90% coarse fragments, and the pH is 6.

This 4 year old site is very sparsely vegetated with 90% of the soil/rock surface showing. There are no trees, tall shrubs nor low shrubs at this site. The dwarf shrub layer is represented by willow (5%) which grows up to 0.2 m tall, and trembling aspen (5%) reaching 0.3 m tall. Three grasses combine for 37% occupation of the graminoid layer. Mosses and lichens are not present at this site.

RED RIDGE PROPERTY

Trenches

RR1B

Trench **RR1B** is located in the "O" zone, on the east facing side of Red Ridge at an elevation of approximately 1371 m. This is a shallow, 6 m by 5 m hand dug trench, with a 22 degree slope. The topography immediately above and below this site is extremely steep.

RR2A 1988

Trench **RR2A** is located at an elevation of 1500 m. It is approximately 3 m wide at the base and on average 1.5 m deep, facing in a southeasterly direction. The overburden has been stockpiled directly on top of the trench walls. During excavation, the organic and fine layers were removed and deposited first; they compose the base of the overburden piles. These piles consist primarily of bedrock fragments up to 15 cm in size, and are the source of the slumping material. Runoff is transporting the finer particles of the excavated material back into the trench. Runoff is also exposing fragmented portions of the trench walls which when loose enough will create even greater wall/slope instability. The material in the trenches and piles has a pH of 4.6, and is dominantly composed of coarse fragments of mostly angular, weathered bedrock. The matrix is mainly sand sized crushed bedrock and varies greatly within the trench wall, from 10% to 50%. The trench bottom consists nearly entirely of coarse fragments.

This trench is lacking vegetation, with a clump each of a grass (*Festuca altaica*) and a sedge (*Carex sp*) clinging to the eastern edge of the trench.

RR3 1988

The excavation is located at an elevation of 1500 m, north of Trench RR2. It is approximately 6 m wide at its midpoint and on average 3 m in height, facing a northwesterly direction with a slope of 55 degrees. Runoff is transporting the finer particles of the exposed surface onto an access road below. These fine particles play a major role in the instability of the slope. Once they are removed the friable, fragmented bedrock becomes loose and falls which in turn causes pieces of the surface organic mat to separate and slump, exposing more of the surface below. The material is similar to Trench RR2, a rapidly drained stony colluvial and residual bedrock. The pH values are low, between 4.8 and 5.0. The original soil exposed at the edges of the trench, shows a 7 cm thick organic mat, and abundant micro to medium roots to a depth of 7 cm.

The site is very sparsely revegetated. The three species found here are fireweed (2%), a starwort (5%), and a tiny moss species covering 5% of the site.

RR4 1988

This excavation is located west of Trench RR3 at a similar elevation. It is approximately 1.5 m wide at the base and on average 1.4 m in height, facing in a northerly direction with a slope of 17 degrees. The overlying organic mat is breaking off and sliding towards the bottom of the excavated area. Runoff is eroding the northwest facing trench wall transporting the fine particles downwards exposing the fragmented bedrock below. The material as in other trenches consists of fragments of bedrock gravel, well drained, with no soil development. Parts of the trench slope support slumped pieces of original organic mats.

This is also a very sparsely vegetated site. The forb layer is composed of a starwort (1%), a trace of horsetail, river beauty (1%), fireweed (2%), and a trace each of an artemesia species and prickly saxifrage (*Saxifraga tricuspidata*).

RR8 1988

This hand dug excavation is located at the crest of the ridge. It is approximately 1.2 m wide at the surface and 0.7 m deep, facing in a westerly direction on a very gently slope. Minor slumping of organic matter from the overburden pile adjacent to the excavated area is evident. Exposed bedrock fragments up to 7.5 cm in diametre are showing signs of weathering. The soil and material is similar to other trenches mentioned above.

This trench is also very sparsely vegetated, with three grass species covering 8% of the trench surface. The tailings pile beside the trench is also sparsely vegetated with less than 10% ground coverage, but supports a more varied flora: traces of mountain aven, prickly saxifrage, an Artemesia species and a Senecio species. A grass adds 5%, and a sedge joins in with 1%.

RRM10A

The trench is approximately 11 m high, facing in a southerly direction with a slope of 39 degrees. The loose, unstable material on the exposed slope consists of 70% bedrock, 20% gravel, and 10% finer particles. Large pieces of the organic mat have broken off and slumped downwards creating barriers which act as temporary supports for the sliding granular material. There is no soil development. Some rounded coarse fragments show calcium carbonate deposits.

The vegetation observations at this site have been subdivided to show differences in regeneration. The undisturbed vegetation (**RRM10C**) is a dense alpine assemblage of the following shrubs: trembling aspen (20%), prickly rose (20%), soapberry (*Sheperdia canadensis*, 10%), high-bush cranberry (*Viburnum edule*, 15%), kinnikinnick (20%), and juniper (*Juniperinum communis*). The sparse forb layer is made up of prickly saxifrage (5%), and 1% each of black-tipped groundsel (*Senecio lugens*) and fireweed. *Calamagrostis* grass occupies 10% of the graminoid layer.

The rock slope is mostly bare, adorned with slabs of organic mat from the undisturbed area above which support most of the vegetation. The low shrub layer is represented by trembling aspen (5%) and northern gooseberry (*Ribes oxyacanthoides*, 5%). Kinnikinnick covers 5% of the dwarf shrub layer. The forb layer is dominated by fireweed (20%), and augmented by an Artemesia species (3%), a little (1%) prickly saxifrage and a trace of yarrow.

At the bottom of the wall (site **RRM 10 B**), on the relatively flat part of the trench, the revegetation is slightly greater, with up to 25% of some areas revegetated in a patchy, irregular coverage. The sparse low shrub layer is composed of prickly rose (5%), willow (3%) and balsam poplar (1%). The forb layer, dominated by fireweed (20%), is also made up of yarrow (2%), tall bluebell (*Mertensia paniculata*, 4%), an Artemesia species (3%), and 1% each of sage (*Artemesia frigida*) and showy Jacob's-ladder.

Drill Pads

RR9 1988

The drill pad **RR9** also identified as SR88-02 was built in 1988. It is located below RR07, on an east facing slope at an elevation of 1465 m. The surface is composed of a compact stony gravel, with a sandy loam matrix of pH value 5.2. It is well drained and has no soil development. This site is very sparsely vegetated and more than 90% of the surface is bare.

Others

Cat Trails

Site **RR7** is at the top of a ridge that was disrupted by the movement of heavy equipment; it is partially stripped, with clumps of organic mat preserved on more than 50% of the surface. Vegetation regeneration is limited to patches which have some topsoil present. The material on site consists of 20 cm of gravelly colluvial on bedrock, is well drained and has numerous fine roots.

A touch (1%) of mountain aven is the only dwarf shrub on the site. A starwort covers 2%, and the following species cover 1% each: fireweed, tall bluebell, a saxifrage and an artemesia species. The grass *Festuca altaica* covers 10%, and a tiny moss adds 5% vegetation cover to this site.

IDAHO HILL PROPERTY

Undisturbed Conditions

IDA1B

Site **IDA1B** is a subalpine site on a moderately steep southeast facing slope, at an elevation of 1240 m. The surface is 90% covered by loose stones and appears to be actively colluviating. The soil is a rapidly draining Orthic Eutric Brunisol formed on colluvial parent material. The top 15 cm of the mineral soil is mixed with organic material and has a soft crumbly consistency. The BC horizon is a loamy coarse sand with 30% coarse fragments and contains plenty of microfine and fine roots.

The vegetation plot was selected on a densely vegetated portion of the slope. It is dominated by forbs and shrubs, and open soil covers 20% of the area. The tree layer is formed of sparse white spruce with DBH's of 10 to 15 cm and HT's 5 to 8 m. The low shrub layer is composed of willow (10%), subalpine fir (*Abies lasiocarpa*, 5%), dwarf birch (1%), and common juniper (3%). Five percent of the dwarf shrub layer is covered by kinnikinnick. The forb layer is well represented by prickly saxifrage which dominates with 25% coverage. The other species included in this layer are field locoweed (*Oxytropis campestris*, 15%), a goldenrod species (*Solidago sp*, 5%), yarrow (1%), a gentian species (*Gentiana* or *Gentianella sp*, 2%), an Artemesia species (1%), and a starwort species (5%). The graminoid layer is strongly represented by the common indigenous grass *Festuca altaica* with 50% coverage, and a sedge with 5%. No mosses are found at this site, but three lichens combine to cover 11% of this moss/lichen layer.

Trenches

IH1A

This trench is located at an elevation of 1235 m, on a southeast facing hillside, close to a collapsed adit. The excavation approximately 6 m wide and 8 m high, and the slope of the excavated wall is 32 degrees. The upper portion of the wall is active, with erosion and slumping of the original surface and organic mat occurring. The slope material is formed of coarse gravel with a loamy sand matrix and at least 90% coarse fragment content. The matrix content is lower at the base of the slope, where the coarser cobbles are rolling down. The moisture content is 11% and the pH value is 6. In places below the toe of the colluviated gravel, small fans are forming.

This slope is obviously unstable and very little revegetation has taken hold primarily due to the elevation and exposure to the elements. Up to 90% of the surface is bare. There are no trees, tall shrubs, mosses or lichens at this sparsely regenerated site. Common juniper covers 2% of the low shrub layer, and willow adds another 5%. Kinnikinnick covers 2% of the dwarf shrub layer. The forb layer is represented by a mustard species (1%), a starwort species (2%), and prickly saxifrage (5%).

IH2A

Trench **IH2A** is located on a southeast to east facing slope, at an elevation of 1161 m. The excavation is approximately 6 m high, with a 35 degrees slope. A natural runoff channel at the top of the trench drains onto its wall, and contributes to slope erosion and movement of fine and coarse grained material downslope. The original surface is also influenced by this runoff and is also breaking off in lumps and slumping down. At the base of the wall, fragments in up to 15 cm in diameter make up 40 to 50% of the material. The mineral soil has some incorporated organic material and a loamy coarse sand skeletal structure with 80% coarse fragments (gravel, cobbles), and a pH value of 6.8. Abundant fine and medium roots are present in the top 15 cm of the profile, and plenty of microfine roots are present from 15 to greater than 34 cm depth. The slope is unstable and is sparsely revegetated.

This disturbed site lacks trees, tall and low shrubs, mosses and lichens. The dwarf shrub layer is sparsely represented by a trace (<1%) of mountain aven (*Dryass sp*) and willow (*Salix sp* 3%). The forb layer is dominant with the following species: starwort (*Stellaris sp*, 10%), mustard species (2%), prickly saxifrage (*Saxifraga tricuspidata*, 2%), yarrow (*Achillea millefolia*, 2%), and a groundsel (*Senecio sp*). The graminoid layer is composed of sedge (5%) and 2% grass (*Festuca altaica*).

IH 02 B (undisturbed)

This undisturbed site is located at an elevation of 1161 m on an east facing slope of 37 degrees and has similar morphology and soil to site IH1A. This is a subalpine area with low lying plants. No trees or tall shrubs or mosses occur at this site which shows 15% open ground. The low shrub layer is composed of willow (30%), dwarf birch (10%), lodge pole pine (*Pinus contorta*, 1%), soapberry (5%), juniper (5%) and white spruce (2%). The dwarf shrub layer is limited to 20% cover by kinnikinnick. The forb layer is sparsely represented by field locoweed (*Oxytropis campestris*, 1%), a groundsel (*Senecio sp*, 5%, prickly saxifrage (10%), a gentian, twin-flower (*Linaea borealis*, 2%), and showy Jacob's-ladder (12%). Five lichens combine for 26% coverage of the moss/lichen layer.

IH 03 B (undisturbed)

Although the soil and morphology are similar to

previous undisturbed sites, this area has different vegetation. It is the lowest site examined in this area. This area is composed of a subalpine graminoid/forb community. No trees or tall shrubs are found at this site, but nearby there is a stand of trembling aspen. The sparse low shrub layer is represented by willow (2%), white spruce (1%) 1.1 m tall, and juniper (1%). Thirty percent of the dwarf shrub layer is covered by kinnikinnick. The forb layer is sparse and composed of traces of many species: mountain death camas, gentians, a groundsel, prickly saxifrage, twin-flower, yarrow, showy Jacob's-ladder (5%), and an Artemesia species. The graminoid layer is represented by the common indigenous grass *Festuca altaica* (40%), and sedge (10%). Two lichens cover 2% of the moss/lichen layer.

IH 03 A

This site represents the narrow old trail which zig-zags up the hill through the habitat described at IH 03 B (undisturbed). It is located at an elevation of 1122 m on an east facing slope. The surface has a 50% stony coverage, thus indicating some colluvial activity. The soil is a well drained Orthic Eutric Brunisol, formed on colluvial parent material. The mineral soil is mixed with organic material in the top 20 cm, and has a sandy loam matrix with 60% coarse fragments (gravel, cobbles). The pH value is 7.0. Abundant, microfine to medium roots are present in the profile.

The surrounding original vegetation is regenerating in the trail. No trees, tall shrubs, lichens or mosses are present at this site. Juniper covers 5% of the low shrub layer. Kinnikinnick covers 20% of the dwarf shrub layer. The forb layer is represented by prickly saxifrage (2%), gentians (2%), and 5% each of showy Jacob's-ladder and mountain death camas (*Zygadenus elegans*). The grass *Festuca altaica* and a sedge contribute 20%.

7 PUP PLACER OPERATION

7P 02 Undisturbed

This site is located at an elevation of 885 m on a north to northeast facing slope, and is approximately 200 m southwest of site 7P1. The surface is moderately hummocky with randomly leaning trees, evidence of slow creep. Permafrost is present at shallow depth, and the soil is classified as a Static Cryosol, or a soil with permafrost; there is no sign of cryoturbation. The soil is developed on colluvial overlying bedrock and is poorly draining with a slight seepage on top of the permafrost at depth of 47 cm. The organic is 20 cm thick; and the mineral soil has a 6 cm thick Ah horizon with a pH of 4.6, and consists of a sandy loam with occasional coarse fragments. The moisture content is high at 32%. Abundant, fine to coarse roots are present between 0 and 28 cm from the surface. The roots reached 47 cm deep, where the permafrost is a root restricting horizon.

This site is densely vegetated, with the ground predominantly covered by a typical black spruce community underlain by permafrost in a late successional stage. The forest component of this undisturbed site is composed of very sparse small black spruce (< 5%, HT 5 to 6 m, DBH of 7 to 8 cm). The tall shrub layer is sparse at 10% coverage and comprised entirely of smaller black spruce (HT is 0.3-5 m).

The low shrub layer, is composed of alder (1%), willow (2%), dwarf birch (10%), and Labrador tea (30%). The dense (80%) dwarf shrub layer consists of low-bush cranberry (40%), blueberry (25%), cloudberry (10%), and mossberry (5%). The two species in the sparse (15%) forb layer are horsetail (10%) and bastard toad-flax (5%). The graminoid community is represented by a grass (Calamagrostis spp) at 5% and a medium coverage (25%) of sedge. The remainder of the forest floor is nearly completely covered by mosses and lichen.

Tailings Piles

1912 Tailings pile 7P1

The area **7P1** has a slope of 20 degrees, is approximately 15 metres high and is northeast facing. Although the trees were hand cleared in 1990, most of the 1912 surface vegetation and soil had not been affected by this recent disturbance. The surface appears fairly stable, but sensitive to change in ground cover. Slow creep, observed through visible cracking in the mosses is probably a response to the removal of vegetation. Some water seepage was observed at the interface of the moss and the mineral soil. The overall surface is gently hummocky and densely vegetated.

The soil at this site is a well drained Orthic Regosol. Although there is no mineral soil development, a 14 cm thick surface organic mat has been forming over the last 70 years. The parent material is a gravelly silty sand with 23% coarse fragments, has a moisture content of 23% and low pH value of 4.8. Roots reach at least 36 cm deep.

Vegetation at this site is very similar to the undisturbed vegetation described at site 7P2, with the exception of the stumps (average diameter at ground level 7 cm) which remain from the 1990 clearing of trees. Tree ring counts on those stumps using hand lenses provided us with ages ranging from 78 to 65 years. The very dense (100%) low shrub layer is dominated by Labrador tea (50%), and spirea (*Spiraea* spp, 20%). Some low black spruce are regenerating in this layer (10%, they are approximately 1 m tall). Low-bush cranberry (50%) dominates the medium density dwarf shrub layer. The very sparse forb layer is represented by wild

rhubarb (*Polygonum alaskanum*, 2%). The sparse (<10%) graminoid layer is composed of a grass and a sedge. The moss community provides almost complete in coverage (>90%) and is dominated by feather moss. Unlike in the undisturbed area nearby, lichens are almost absent with the sparse occurrence of *Cladonia cornuta* (2%).

1980 to 1985? tailings piles 7P 04.

This site is located below site 7P1, on northeast facing slope of 22 degrees. The surface is hummocky and loose, and shows some signs of gullying and surface erosion, such as fine-depleted crests and fine-enriched depressions. There is no sign of permafrost nor water seepage. There is no soil development and the material consists of medium to coarse size sand, with very few coarse fragments and very low content of silt. There is a thin litter of leaves and grasses at the surface. Roots present to a depth of 22 cm.

This site is a very well regenerated dense shrub-grass thicket. There are no trees present, but the tall shrubs are very tall: the dense alder (60%) reaches four metres in height, and the willow, five metres. The low shrub layer is less obvious (17%) than the very thick (80%) tall grass (*Calamagrostis spp*). Three forbs (20%) are dominated by fireweed. A feathermoss (*Hylocomnium splendens*) and another moss (*Polytricum juniperinum*) at 5% each complete the site vegetation picture.

Cut

7P 05

This site is a seven metre long, about four metre tall cut bank, approximately 15 years old, right at the edge of undisturbed ground (see 7P 02). The site had a well drained Orthic Regosol without seepage. There was evidence of colluvial slope processes which stabilized over time by the establishment of alder. Tiny mosses were present on the soil surface, which reduced surface erosion. The mineral soil (BC 35 cm+, pH 6.2) had a sandy loam matrix and 60% coarse fragments (gravel to cobbles). Plentiful, micro to medium roots were present between 0 and at least 35 cm depth.

Aspect: N
Slope: 39°
No trees are present on this site, but the willows (10%) reach four metres in height. Four other low shrub species, including the rarely occurring spirea (spiraea spp, 10%), are dominated (50%) by alder. The sparse forb layer consists of fireweed (10%) and horsetail (5%). Three moss species, dominated by the common Polytricum juniperinum (30%), and three lichens (<10%) complete the vegetative description of this plot.

7P3 Settling pond, 1991

Aspect: ENE
Slope: 1°
This three year old settling pond has a sparse (20%) low shrub community of two willows (Salix spp) which show signs of snowshoe hare browsing. Forbs are represented (35%) by wild rhubarb (Polygonum alaskanum), horsetail (Equisetum scirpoides) and a mustard spp (Cruciferae). Graminoids are represented entirely by grasses (no sedges), very dense at 75% cover. A young tiny moss spp covers the soil very densely at 80%.

UPPER SETTLING POND: The vegetation cover is very dense (>90%). No tree nor tall shrub components are present. The low shrub layer is well (35%) represented by two willow species. The forb layer of six species (25%) is dominated by horsetail. The graminoid layer is very strong at this site with near complete coverage by a very common short grass (*Agrostis scabra*) and two tall, common grasses of the Calamagrostis genus. A very dense mat (80%) of a tiny moss spp completes the vegetation community.

ORO GRANDE PLACER OPERATION

Undisturbed

The undisturbed, original area is a typical permafrost black spruce forest of small trees, mixed with sparse small to medium sized paper birch.

The tall shrub layer includes the tree species mentioned above and locally, balsam poplar. The low shrub layer is comprised of Labrador tea, willow and blueberry.

Forbs include coltsfoot, twin flower and bluebell. The area also has a strong feathermoss and lichen (Cladina spp) component. The area is entirely vegetated and a game trail was noted.

Cuts

OG1A 1989

This north facing cut (OG1A) was excavated in 1989 and extends approximately 320 metres upcreek from the mouth of Oro Grande Gulch. When abandoned in 1989, the slope was basically vertical. The present slope is approximately 15 metres high with a slope of 45 degrees. The thawing permafrost and fine-grained nature of the material facilitates slumping and re-establishment of a stable slope. There is still active gullying caused by runoff from the above undisturbed ground, and slumping is still common, both at the surface of the receding wall and at the base of the slope. However, this slope has modified its original vertical face into a much more gentle profile (35 to 45 degrees). The high moisture

content of the material and the slumping of the original surface vegetation has allowed mosses and grasses to take hold of the more stable portions of the slope.

The site had a moderately well drained Cumulic Regosol. The soil profile showed signs of colluvial slope movement, with bands of parent material alternating with organic rich silt from the original surface. The mineral soil had a sandy loam matrix and 60% coarse fragments (gravel) with pH values ranging from 6.2 to 7.0. Very few, fine to micro roots were present between 0 and 20 cm.

This plot is densely (>90%) vegetated, mostly by forbs. The sparse (10%) low shrub layer is dominated by a willow. The dense (60%) forb layer is dominated by a very tall (1 m) mustard spp (30%). The graminoid layer is well represented (30%) by a grass (Calamagrostis spp). This plot is unusual because of the fairly substantial (40%) presence liverwort (Marchantia polymorpha). There are two moss species (45%), the dominant (40%) of which is very tiny. The mat of roots from the mosses and liverwort reduced soil surface runoff.

0G1B 1990

Site 0G1B was excavated in 1990 and also is situated approximately 300 metres up creek from OG1A; and this face was also near vertical when abandoned at the end the 1990 summer. The present slope is approximately 23 metres high and is north facing with a slope of 43 degrees. The high moisture content of the material has allowed mosses and grasses to take hold stabilizing portions of the slope. Gullying caused by runoff from the above undisturbed ground and melting permafrost is responsible for cracking and some slumping at the base of the slope; this will eventually cause further failures in areas effected.

The soil here is also a moderately well drained Cumulic Regosol. The slope is still undergoing colluvial processes such as slumping, slope wash and gullying. Evidence of such activity include the discontinuous cover of organic mat slumped from the original surface and banding of parent material and organic rich horizons, fresh, unvegetated mineral surfaces. Soil is a fine sandy loam with a very low coarse fragment content. Plentiful, fine to micro roots are present between 0 and 25 cm. The maximum rooting depth was at least 40 cm.

Vegetation, mainly a tiny moss, covers up to 70% of the surface. Other plants are very sparse, a mustard (Rorippa spp) is dominant (10%). Clumps of original surface are sliding down and carry their original ground cover species.

OG1C 1992

Site OG1C was excavated upcreek from site OG1B and was also abandoned as a near vertical wall. It is now approximately 18 metres high and as a average slope of 39 to 48 degrees, slightly steeper than the previous wall. Slope wash, slumping and gullying are noticeably more active on this slope, as evidence by large slumped blocks, recent failure cracks, and numerous colluvial fans at the toe of the slope. Abundant moisture provided by the melting permafrost contributes to the general instability of the material. Coarse material also more evident at this part of the slope; boulders and cobbles constitute up to 70% of the soil. Soil matrix is fine sandy loam to loam with pH values of 6.8 to 7.0.

This site is very sparsely vegetated, with more than 80% of the surface being bare, not counting the tiny moss which covers approximately 40% of the ground. About 50% of the site is bare. Some patches of original mat have sloughed down from above, but are not included in this site description. The dwarf shrub layer is very sparsely (1%) occupied by paper birch and alder which are both 0.1 m tall. The forbs are dominated by a mustard (Cruciferae spp) 10%. The graminoids are represented by two grasses and a rush (Luzula parviflora).

OG1F 1993

This section of the gulch is the last part to be placer mined and is a one-year old surface at the time of field work. The wall is approximately 22 metres high and is south-southwest facing. It has now a 50 degree slope on the lower portion and a near vertical upper portion. The slope is very unstable, numerous deep and long cracks at the surface will eventually cause slumps of considerable size. Gullying, slumping and slope wash are very active on this slope. Due to instability of the slope, no soil pit was dug. The wall is basically unvegetated, except for the localized slumped blocks of surface material.

Tailings Piles

OG1D 1990

Site OG1D consists of a tall pile of processed (sluiced and pushed) material approximately 15 metres tall, with a slope ranging from 22 to 28 degrees. The pile faces south and has a rough, ribbed to hummocky surface which is slightly compacted to friable. Slope seems stable, with minor gullying and slope wash. This is also supported by the well developed vegetation cover.

Soil at this site is a well drained Orthic Regosol with a thin leaf litter (less than 10 cm). The mineral soil (pH 6.8) is a fine sandy loam with 15 to 20% coarse fragments (gravel to cobbles). Plentiful, fine to microroots were present between 0 and 17 cm.

This very densely vegetated site has a high ground surface coverage (nearly 100%) and a well populated shrub layer, dominated by up to three metre tall willows (two Salix spp, 70%) and paper birch (Betula papyrifera, 20%).

The dense forb component of the site (60% of ground surface) is dominated by horsetail (35%). Graminoids are well represented (55%) by four grasses (Calamagrostis canadensis and Agrostis scabra dominating) and a sedge (Carex spp). A tiny moss covers most of the soil (60%) and is joined by a liverwort (Marchantia polymorpha 1%).

OG1E 1992

Oite **OG1E** is a tailings pile dating from the summer of 1992 located directly upcreek from site OG1D, on the south facing side of Oro Grande Gulch. The pile is approximately 17 metres high. The upper third of the pile has a slope of 28 to 31 degrees and the lower portion of the pile has a steeper slope of approximately 50 degrees. Overall surface topography is rough, hummocky and loose to friable. This slope is severely gullied and eroded, and several failure cracks and associated slumps are developing locally.

Soil at this site is also a poorly developed soil (Regosol) with no organic rich horizon. Its texture is a fine sandy loam, slightly stony (10 %) and moderately well to well drained. Roots reach a depth of 19 cm.

This is also a very densely vegetated site (more than 80% ground cover). This site has a very slight low shrub component dominated by a willow; however, raspberry (2%) is present. The forbs, as is the whole site, are strongly dominated (70%) by a mustard (Descurainia pinnata). Three grasses and a sedge represent less than 15% coverage.

OG1E 1993

This portion of the tailings is the least stable and least vegetated. Located upcreek from OG1E, the face has a steep slope, more than 50% at most places, and is severely fractured at the top for as much as 15 metres behind the pile face and at several places along the face. Piping was also observed at several places. Recent slumping is evident, and gullying is developing along some of the fractures. This pile of tailings was judged unsafe to climb around and only the back portion of its surface was investigated. The overall surface is loose, friable, very rough and hummocky.

The soil is very similar to OG1E, moderately well to well drained soil, with a fine sandy loam to loamy, micaceous texture and a low content of clasts, wood debris and occasional bones.

The surface portion of the site is densely vegetated, but less so than the previous two sites. A 0.1 m paper birch makes up the nearly non-existing dwarf shrub layer. The forb layer is strongly (70%) dominated by the pioneer fireweed, as is the whole site. The sparse (10%) graminoid layer is composed of two grasses (Agrostis scabra and Calamagrostis spp). The site is nearly entirely (90%) covered by a tiny moss spp; and the liverwort Marchantia polymorpha makes a solitary appearance.

The part of waste pile which slopes down towards creek has a lower vegetation density. The dwarf shrub component of this site only has one 0.1 m paper birch . The forb component is almost entirely composed of a mustard (60%) and fireweed (30%). The graminoid community is minuscule. A tiny moss species covers 30% of the site.

The steep portion of the wall was not surveyed in detail due to the active erosion. Most of the face is sparsely vegetated by grasses and mosses.

NUGGET GULCH PLACER OPERATION

Undisturbed

NG 01 A

This site is very similar to GG 01 D UNDISTURBED except for the following: the black spruce are a little larger and spaced further appart; the paper birch are present every 10-20 metres at an average size of DBH 12 cm and HT 7 m. Alder is also present at 10%, and horsetail is present at 5% coverage.

Cut

NG1 1988

This north facing cut dates from a 1988 mining program area and was left with a near vertical slope. It is now approximately 20 metres high with a slope of 32 degrees on the upper portion and 54 degrees on the lower portion. The slope shows signs of instability due to melting permafrost which is ice-rich with lenses up to 5 millimetres thick. The permafrost is partially covered by peat and organic matter which support the upper vegetation. Exposure of the permafrost face has caused continuous melting allowing the organic layer to overhang the underlying material and eventually slump down the slope. Some fairly stable benches have been created on the lower portion of the slope by the large slumped organic masses allowing some stable areas to form.

The soil here is imperfectly drained with slight seepage. The organic mat was form by original forest floor sliding down slope which varied in size and thickness. The mineral soil (Ahu 45 cm, pH 7.4) had a sandy loam to loam matrix and 70% coarse fragments. Fine roots were present between 0 and 25 cm.

Vegetation at this site includes patches of forest sliding down intact, bringing small original vegetation communities into disturbed area. Between original

patches (which are <50%), pioneering species colonize. The whole area is a patchwork combination of old and new vegetation. Some black spruce are still standing on sloughing patches of original mat. The sparse tall shrub layer is composed of black spruce (on original mat patches). The dense shrub layer is composed of colonizing species and indigenous species from the immediate area. Three species of willows combined for 32%, dominating the dense low shrub layer which includes paper birch (5%), dwarf birch (5%), blueberry (10%) and Labrador tea (10%). The sparse forb layer is made up of wild rhubarb (5%), horsetail (5%), traces of black-tipped groundsel, fireweed and tall bluebell. The graminoid layer is made up of four grasses, combining for 20% cover, and a sedge which adds 2%. Six mosses combine for 16% cover, and four lichens add 12%.

NG2 1988

NG2 is a south facing slope opposite to NG1 and approximately 20 metres below, at creek level. It is approximately 10 metres high with a slope of 41 degrees. The slope shows signs of instability caused by runoff. A large gully east of the sample area 1.2 metres wide at the top and 2.7 metres wide at the bottom is causing regression of the wall which will soon fail. Grass patches are present where various size slumps have fallen. The soil is a very rapidly drained sandy loam with 80% coarse fragments. Fine to micro roots were present between 0 and at least 45 cm depth.

The sparse (12%) low shrub layer is comprised of two species of willow and dwarf birch. The sparse herb layer is made up of fireweed, yarrow, and black-tipped groundsel. Three grasses, combining for 32% are in the graminoid layer.

Tailings piles

NG3 1988

The area selected NG3 is about 50 m northeast and downstream of NG 01, 02 and is a tailings pile which was levelled in 1988 and used to direct the creek flow. The nearly level pad consists of mainly a loamy sand and sand which were machine compacted during placement. Gullying at the edge of this low terrace like feature is very active.

The sandy nature and the compact surface of this feature result in a poorly revegetated surface. The shrub layer is represented by willow (3%), spruce seedlings (2%), balsam poplar seedlings (3%), and traces of alder and paper birch. A very sparse forb layer shows traces of Arctic lupine. Two pioneer grass species cover 15% of the gramminoid layer.

NG4

NG4 consists of a flat area composed of gravel and sand which were machine compacted during placement, directly down creek from NG3. This area shows faint signs of revegetation. The sparse low shrub layer is represented by up to 1 m tall willow, a trace of 0.4 m tall trembling aspen, balsam poplar and paper birch. No dwarf shrubs are found at this site. The forb layer is comprised of fireweed (5%), a senecio species (5%) and yarrow (1%). The graminoid layer is represented by three common grasses with a combined coverage of 13%.

NG5

Site NG5 is a 1988 tailings pile located at the intersection of Nugget and Eldorado Creeks. Slopes face northwest and are variable, between 10 and 35 degrees. The soil is a rapidly drained fine sandy loam with 40% coarse fragments. Medium to fine roots were present between 0 and at least 27 cm depth.

This site has revegetated nicely with good representation from most vegetation layers. The tall shrub layer is well represented (50%) by up to 4 m tall willow. The low shrub layer is represented by wild raspberry (5%), and 0.6 m tall paper birch (2%). The herb layer has great variety. It is dominated by fireweed (50%), and joined by the following species: wild rhubarb (10%), a cinquefoil species (15%), and traces of bedstraw, black-tipped groundsell, horsetail and tall bluebell. Two grasses combine for 50%, and a tiny moss species adds another 30% coverage.

ELDORADO CREEK

Settling Pond

ED1A is a large settling pond located slightly above creek level on Eldorado creek. This two level pond is probably two seasons old and is pleasing to the eye because of the dense vegetation cover. The low shrub layer is sparsely (20%) represented by a willow. The forb component of the site is overwhelmingly (80%) dominated by horsetail. The graminoid layer is very sparse (10%), but a grass species (Alopecurus aequalis) rarely seen in this study occurs here at 5% coverage.

The soil is an imperfectly drained silty loam and fine sandy loam matrix, respectively, with slight seepage. Few, fine roots were present between 0 and 15 cm depth. Tiny mosses formed a root mat at the soil surface reducing possible wind erosion. The side of the settling pond was undercut by the stream.

DISCOVERY CLAIM

DC 01

Old workings on Parks Canada claim.

This area is a rocky hillside (slope is 20 degrees) with medium density vegetation from tall

shrubs down to lichen and moss. An island of medium sized trees (birch and spruce) and push piles of old logs indicate de-forestation. No trees are present on the representative plot. The tall shrub layer is well (35%) represented by two tree species, paper birch and trembling aspen which are up to three metres tall. The dense (50%) low shrub layer is dominated by alder. Forbs are very sparse (<5%) on this site. The dwarf shrub layer is almost non-existent except for the occasional (1%) low-bush cranberry plant. Graminoids are sparsely (20%) represented by the common grass Festuca altaica. The two mosses (35%) at the site are dominated (30%) by Polytricum juniperinum. Three lichens are found at the site at a very sparse 3% coverage.

DC 02

DC 02 is located on a bedrock bench on top of hill, aproximately 200 m uphill and west of DC 01. Aspect is variable and slope is 2%. There is a thin discontinuous veneer of gravelly loamy sand over the bedrock which is fractured and friable in places.

This plot is sparsely vegetated mostly by shrubs, grass and moss. Tall shrubs are well represented (45%) by balsam poplar and alder. Low and dwarf shrubs are very sparse (12%), as are forbs (7%), and the graminoid layer is only represented by a grass (Calamagrostis spp) at 20%. Two lichens (<5%) and a moss (Polytricum juniperinum, 30%) round out the low vegetation component of this site.

REVENUE CREEK PLACER PROPERTY

RC1

This site is a settling pond with side berms to 4.8 metres in height, having slopes of 38 degrees on average. These berms are cracking and sloughing due to the low moisture content of the soils. Exposure to the elements, i.e., wind and rain, are primary causes of the surface erosion present. On the floor of the settling pond considerable cracking on the surface is evident due to its exposure to the sun. The insitu condition of the soils used to make the berms can be classified as hard with a cohesive value of 1.6 ton foot^2 at a depth of 14 to 18 centimetres below the effected surface material. On the floor of the pond the insitu condition of the soil is classified as stiff with a cohesive value of 0.9 ton foot^2. **RC1A** is located on the upper settling pond in Big Creek valley at base of Revenue Creek hills. **RC1B** is located in the same settling pond as RC 01 A. It was included to show the different vegetation present. In the adjoining pond **(RC2)**, the insitu condition of the soil was also tested giving values of stiff material, i.e., 0.5 ton foot^2 between 0 to 14 centimetres; stiff material, i.e., 0.9 tons foot^2 between 15 to 20 centimetres; and hard material, i.e., 1.2 tons foot^2 between 20 to 30 centimetres.

Site **RC1A** is a moderately well drained Cumulic Regosol. Runoff channels were present near the soil pit. The mineral soil is a fine sand without coarse fragments in the C1 horizon, whereas the C2 horizon was gravelly. The pH value is 7.8. Plentiful, micro to fine roots were present between 0 and 12 cm depth. Few roots reached at least 23 cm deep.

Willow, growing up to 0.4 m in height is the only shrub on this site. The herb layer consists of two mustards (mustard sp, 23%, and *Descurainia* sp, <1%), a horsetail (10%), yarrow (1%), and a trace of fireweed. Grasses are very strong at this site. *Beckmannia syzigachne* dominates with 70% coverage. Two common pioneering species combine to add 25%. No mosses nor lichens are found at this site.

RC1B is a silty clay loam with 10% coarse fragments over a coarse sand with 90% coarse fragments. Very few, micro to very fine roots were present between 0 and at least 12 cm depth. Willow represents the dwarf shrub layer of this sparsely vegetated site. The herb layer is composed of two mustards combining for 4%, and a horsetail (5%). The grasses agrostis scabra (10%), Beckmannia syzigachne (10%) and foxtail barley (Hordeum jubatum, 1%) represent the graminoid layer.

The settling pond walls are vegetated variously, depending on wall stability and height from bottom (various water levels).

Site **RC2** is a silt loam, silty fine sand, and coarse sand with coarse fragments and has a pH value of 4.6. Plentiful, micro to medium roots were present between 0 and 18 cm. This settling pond has two islands with 0.5m tall 2.5 m willow (Salix sp) on them. Vegetation density is very low, therefore percent coverage was not determined. See species list for occurrences in pond and on pond wall.

RC3

This cut slope at creek level is approximately 10 metres in height, facing in a westerly direction with a slope of 40 degrees. The slope is unstable; major cracking exists at the top which is discharging slumps of material. The primary cause of cracking is likely related to presence of dry impermeable silts with volcanic ash seams up to 25 millimetres thick. Below this silty material gravel and cobbles were noted. Some undercutting south of the sample area was observed. In this area, the material is more of a sandy gravel with traces dry silt. The effects of wind, rain and some runoff on this area have caused failures allowing the upper portion to eventually fail and slide. A road existed at the top of the slope with a 1 metre berm separating it from the edge of the cliff. This berm directs runoff back onto the road and over the cliff.

This site is well revegetated. The site is situated on a cut bank about 300 m long which is in various stages of erosion. A berm (push pile) at the top of the bank is breaking off and falling down. This berm is caused from the building of a trail (1958-64) about 2 m from the top of, and adjacent to, the bank. About 30 m uphill another road was built between 1975 and 1977.

The tall shrub layer is represented by willow (25%) which grows up to 3 m tall. The low shrub layer is very sparsely represented by white spruce. The herb layer is occupied by a 1.3 m tall mustard (25%), fireweed (10%), a cinquefoil (5%), traces of a starwort, a mustard and yarrow. The graminoid layer is represented by four grasses, combining for 45% coverage. A tiny moss species (5%) completes the vegetation picture of this site.

APPENDIX THREE

VEGETATION SURVEY

SITE 11 TR 01 A	ASPECT: SSE SLOPE: 47 deg
SPECIES	%
Picea mariana	1
Picea glauca	1
Betula papyrifera	10
Betula glandulosa	5
Alnus crispa	10
Salix sp.	5
Vaccinium uliginosum	10
Lupinus arcticus	5
Pedicularis labradorica	0.5
Ledum groenlandica	5
Cornus canadensis	1
Vaccinium vitis-idaea	5
Epilobium angustifolium	1
Calamagrostis sp.	1
Festuca altaica	1
Salix planifolia	10
Empetrum nigrum	1
Achillea millefolium	1
Senecio lugens	1
Peltigera apthosa	5
Stereocaulon sp.	20
Cladonia borealis	20
Cladonia cornuta	1
Cladonia pyxidata	1
Cladonia coccyfera	1
Polytricum juniperinum	15
Tomenthypnum nitens	1
Dicranum scoparium	5

SITE 11 TR 01 B	ASPECT: E SLOPE: WALL
SPECIES	%
Polytrichum juniperinum	15
Stereocaulon sp.	2
Betula glandulosa	2
Cladonia borealis	2
Yellow powder lichen	1

SITE 11 TR O1 E	ASPECT: NE SLOPE: 42 deg
SPECIES	%
Betula glandulosa	50
Alnus crispa	35
Salix sp.	20
Ledum groenlandicum	10
Empetrum nigrum	15
Vaccinium uliginosum	10
Vaccinium vitis-idaea	10
Lupinus arcticus	15
Senecio lugens	5
Picea mariana	1
Epilobium angustifolium	5
Festuca altaica	10
Calamagrostis sp.	5
Lycopodium clavatum	0.5
Tomenthypnum nitens	15
Polytricum juniperinum	20
Liverwort sp.	30
Hylocomium splendens	40
Cladonia sp.	0.5
Cladonia borealis	20
Cladonia gracillis	5
Cladonia cornuta	5
Cladonia pyxidata	5
Parmelia sulcata	1
Cetreria pinastri	1
Peltigera apthosa	5
Stereocaulon sp.	2
TRENCH BOTTOM	
Picea glauca	dbh's: 4cm, 5cm
Betula papyrifera	dbh's: 20cm, 14cm

SITE 61 TR 01 F **UNDISTURBED**	ASPECT: E SLOPE: 10 deg.
SPECIES	%
Picea mariana (trees)	30
Picea mariana (shrubs)	30
Vaccinium uliginosum	20
Empetrum nigrum	5
Vaccinium vitis-idaea	25
Geocaulon lividum	15
Festuca altaica	5
Cladonia gracillis	20
Cladonia uncialis	5
Nepthroma arcticum	5
Pleurozium schreberii	5
Cladina stellaris	10
Dicranum scoparum	5
Hylocomium splendens	10
Peltigera apthosa	10
Cladina mitis	30
Stereocaulon sp.	40
Arctostaphylos uva-ursi	1

SITE 61 TR 01 A

ASPECT: N
SLOPE: 0 deg (site)
11deg (area)

SPECIES	%
Stereocaulon sp.	5
Cladina mitis	2
Equisetum arvense	2
Alnus crispa	70
Empetrum nigrum	2
Picea mariana	10
Agrostis scabra	10
Vaccinium vitis-idaea	2
Vaccinium uliginosa	5
Salix sp.	2
Epilobium angustifolium	1
Betula papyrifera	0.5
Calamagrostis sp.	2
Polytricum juniperinum	20
Cladonia borealis	5

SITE 61 TR 01 D

ASPECT: ESE
SLOPE: 28 deg

SPECIES	%
Alnus crispa	50
Picea mariana (shrubs)	10
Ledum groenlandicum	10
Salix sp.	5
Vaccinium uliginosum	10
Vaccinium vitis-idaea	5
Empetrum nigrum	5
AT SLOPE BASE:	
Agrostis scabra	n.d.
Epilobium angustifolium	n.d.
grass sp.	n.d.
Peltigera apthosa	1
Polytricum juniperinum	5
Cladina mitis	10
Cladonia pyxidata	5
Stereocaulon sp.	20

SITE 61 TR 01 E

ASPECT: E
SLOPE: 8 deg.

SPECIES	%
Picea mariana (shrubs)	25
Salix sp.	5
Alnus crispa	2
Vaccinium uliginosum	50
Ledum groenlandicum	30
Geocaulon lividum	15
Vaccinium vitis-idaea	10
Empetrum nigrum	1
Calamagrostis sp.	5
Agrostis scabra	2
tiny moss	30

SITE 88 TR 20-UNDISTURBED

ASPECT: NNE
SLOPE: 7 deg

SPECIES	%
Picea glauca	15; dbh 13cm
Picea mariana	15; dbh 16cm
Betula glandulosa	40
Salix commutata	10
Vaccinium uliginosum	30
Ledum groenlandicum	25
Empetrum nigrum	25
Festuca altaica	5
Vaccinium vitis-idaea	15
Carex podocarpa	10
Cladonia cornuta	5
Peltigera apthosa	20
Cladina mitis	30
Cladonia stellaris	10
Cladonia uncialis	5
Cladonia gonecha	1
Cetreria islandica	5
Cladina rangiferina	15
Nepthroma arcticum	20
Stereocaulon sp.	5
Pleurozium schreberii	60
Dicranum scoparium	15
Polytricum juniperinum	15

SITE 88 TR 20-1 TRENCH FLOOR

ASPECT: N
SLOPE: 1 deg

SPECIES	%
Agrostis scabra	25
Calamagrostis sp.	5
Luzula parviflora	5
Alopecurus aequalis	1
Salix drummondiana	0.5
Ledum groenlandicum	1

SITE 88 TR 20-1 COLLUVIUM

ASPECT: W
SLOPE: N.D.

SPECIES	%
Calamagrostis sp.	15
Agrostis scabra	20
Agrostis scabra (clumps)	5
Calamagrostis canadensis	5
Epilobium angustifolium	1
Polytricum juniperinum	1
Lupinus arcticus	0.5

SITE 88 TR 20-2 TRENCH FLOOR

ASPECT: N
SLOPE: 1 deg

SPECIES	%
Agrostis scabra	5
Salix myrtillifolia	0.5
Polytricum juniperinum	5
Calamagrostis canadensis	1

SITE 88 TR 20-2 COLLUVIUM	ASPECT: W SLOPE: N.D.
SPECIES	%
Picea glauca	0.5; 3 year old seedling
Polytricum juniperinum	20
Salix sp. A	0.5
Calamagrostis canadensis	10
Epilobium angustifolium	2
Liverwort sp.	5

SITE 88 TR 20-3	ASPECT: E SLOPE: 0 - 50 deg
SPECIES	%
Agrostis scabra	30
Agrostis scabra (clumps)	20
Calamagrostis canadensis	25
Luzula parviflora	2
Polytricum juniperinum	15
Liverwort sp.	15
Salix sp.	1
Epilobium angustifolium	1
Salix drummondiana	0.5
tiny moss sp.	20
ON CLUMPS OF FALLEN ORIGINAL MATERIAL	
Pleurozium schreberii	1
Cladina mitis	0.5

SITE LS 03 B	ASPECT: NE SLOPE: 23 deg
SPECIES	%
Lazula parviflora	15
Agrostis scabra	20
Epilobium angustifolium	5
Alnus crispa	2
Polytricum juniperinum	1
Calamagrostis	0.5
Polygonum alaskanum	0.5
Lupinus arcticus	0.5

SITE LS 03 A-a	ASPECT: S SLOPE: base of wall.
SPECIES	%
Polygonum alaskanum	5
Epilobium angustifolium	5
Luzula parviflora	2
Calamagrostis sp.	2
Salix sp. A	2
Agrostis scabra	5
Agrostis scabra (clumps)	1

SITE LS 03 A-b	ASPECT: NE SLOPE: 0 deg
SPECIES	%
Agrostis scabra	40
Calamagrostis canadensis	15
Calamagrostis sp.	2
Polygonum alaskanum	2
Salix sp. A	1

SITE LS 03 A-c	ASPECT: S SLOPE: 45 deg
SPECIES	%
Luzula parviflora	5
Calamagrostis sp.	3
Agrostis scabra	15
Salix sp. A	2
Epilobium angustifolium	5
Galium trifidum	2
Liverwort sp.	30
Polytricum juniperinum	5

SITE VR 01 793 A	ASPECT: N SLOPE: 12 deg.
SPECIES	%
Calamagrostis canadensis	90
Salix sp.	5
Epilobium angustifolium	5
Polytricum juniperinum	20
Equisetum sylvaticum	5
Equisetum pratense	2
Carex sp.	n.d.

SITE LS 07 OLD TRENCH D UNDISTURBED EAST ELDORADO CREEK	ASPECT: SW SLOPE: 9 deg.
SPECIES	%
Picea mariana (trees)	40
Picea mariana (shrubs)	15
Salix sp.	10
Ledum groenlandicum	25
Rosa accicularis	5
Vaccinium vitis-idaea	15
Lupinus arcticus	5
Geocaulon lividum	2
Empetrum nigrum	5
Mertensia paniculata	2
Betula papyrifera	5
Picea glauca	5
Hylocomium splendens	50
Pleurozium schreberii	10
Dicranum scoparium	5
Ptilium crista-castrensis	1
Cladonia uncialis	1
Peltigera aphthosa	15
Peltigera scabrosa	5
Cladina mitis	20
Cladonia cornuta	5

SITE LS 07 OLD TRENCH B **EAST ELDORADO CREEK** SPECIES	ASPECT: N SLOPE: 50 deg %
Picea mariana	10
Ledum groenlandicum	20
Geocaulon lividum	0.5
Betula papyrifera	20
Lupinus arcticus	5
Mertensia paniculata	0.5
Epilobium angustifolium	1
Festuca altaica	2
Alnus crispa	5
Vaccinium vitis-idaea	5
Pyrola secunda	1
Peltigera scabrosa	2
Peltigera apthhosa	5
Cladina mitis	2
Cladonia borealis	2
Hylocomium splendens	10
tiny moss	10
Polytricum juniperinum	5

SITE LS 07 OLD TRENCH C **EAST ELDORADO CREEK** SPECIES	ASPECT: S SLOPE: 35 deg. %
Betula papyrifera	one tree, dbh 5 cm
Populus balsamifera	2
Alnus crispa	5
Epilobium angustifolium	10
Geocaulon lividum	1
Festuca altaica	5
Arctostaphylos uva-ursi	10
Lupinus arcticus	2
Picea mariana	5
Linaea borealis	5
Achillea millefolium	1
Senecio lugens	1
Mertensia paniculata	1
Sheperdia canadensis	1
Rosa accicularis	1
grass sp. (oat hair)	2
Vaccinium vitis-idaea	2
tiny moss	5
Peltigera aphthosa	5
Polytricum juniperinum	10
Stereocaulon sp.	5
Cladonia borealis	10

SITE LS 07 OLD TRENCH A **EAST ELDORADO CREEK** SPECIES	ASPECT: N SLOPE: <50 deg. %
Picea mariana	20
Betula papyrifera	40
Alnus crispa	40
Populus balsamifera	5
Salix sp.	1
Ledum groenlandicum	5
Vaccinium vitis-idaea	3
Epilobium angustifolium	5
Danthonia intermedia	2
Empetrum nigrum	5
Festuca altaica	2
Arctostaphylos uva-ursi	2
Mertensia paniculata	2
Sheperdia canadensis	0.5

SITE LS 07 OVERBURDEN **EAST ELDORADO CREEK** SPECIES	ASPECT: SW SLOPE: 0 deg. %
Alnus crispa	40
Picea mariana	5
Populus balsamifera	5
grass (oat hair)	5
Betula papyrifera	5
Arctostaphylos uva-ursi	0.5
Salix sp.	0.5
Stereocaulon sp.	30
Cladonia Borealis	15
Polytricum juniperinum	5
Cladonia cornuta	5
Cladonia coccifera	0.5
Umbilicaria hyperborea	1
Rhizocarpon geographicum	5
Cetreria pinastri	3

SITE 91 TR 20 **TOP OF COLLUVIUM** SPECIES	ASPECT: SW (TRENCH) SLOPE: 1 - 12 deg. %
Salix sp.	0.5
Calamagrostis sp.	0.5
Epilobium angusifolium	5
Rubus idaeus	0.5
Senecio lugens	0.5
Agrostis scabra	5
Polytricum juniperinum	15
tiny moss	5
Populus tremuloides	0.5
Betula papyrifera	1
Lupinus arcticus	0.5
Vaccinium vitis-idaea	0.5

SITE LS FIELD 05
UNDISTURBED

ASPECT: NE
SLOPE: 11 deg.

SPECIES	%
Betula glandulosa	60
Picea mariana (trees)	5
Picea mariana (shrubs)	10
Salix sp.	5
Ledum groenlandicum	40
Vaccinium vitis-idaea	20
Vaccinium uliginosum	15
Polytricum juniperinum	2
Empetrum nigrum	2
Hylocomium splendens	30
Nephroma arcticum	5
Pleurozium schreberii	50
Cetreria cucculata	5
Cladonia cornuta	2
Cladonia gongcha	2
Cetreria islandica	1
Peltigera apthosa	5
Cladina mitis	10
Cladina rangiforina	10

SITE LS FIELD 04
STRIPPED SURFACE

ASPECT: NNE
SLOPE: 14 deg.

SPECIES	%
Lupinus arcticus	0.5
Epilobium angustifolium	2
Calamagrostis sp.	1
Polytricum juniperinum	5
Agrostis scabra	5
Salix sp.	Found in a groove along the floor; slightly higher abundance than species above.
Populus tremuloides	
Polygonum alaskanum	
tiny moss	

SITE LS FIELD 01
NATURAL REVEGETATION

ASPECT: NNE
SLOPE: 2 deg.

SPECIES	%
Salix sp.	60
Epilobium angustifolium	50
Calamagrostis sp.	20
Polytricum juniperinum	20
Agrostis scabra	10
Lupinus arcticus	5
Betula papyrifera	0.5
Senecio lugens	0.5
Populus tremuloides	0.5

SITE LS FIELD 06
PARTIAL DISTURBANCE

ASPECT: NE
SLOPE: 6 deg.

SPECIES	%
Ledum groenlandicum	5
Betula glandulosa	15
Salix sp.	5
Calamagrostis sp.	10
Lupinus arcticus	0.5
Epilobium angustifolium	2
Vaccinium vitis-idaea	2
Vaccinium uliginosum	5
Luzula parviflora	2
Empetrum nigrum	1
Festuca altaica	1
Agrostis scabra	5
Picea mariana	0.5
Dicranum scoparium	5
Hylocomium splendens	5
tiny moss	10
Pleurozium schreberii	5
Polytricum juniperinum	5
Cladina mitis	2
Nephroma arcticum	5
Cetreria cucculata	2

SITE LS 04 UNDISTURBED

ASPECT: NE
SLOPE: 10 deg.

SPECIES	%
Picea mariana	5
Betula glandulosa	70
Salix sp.	10
Ledum groenlandicum	30
Vaccinium uliginosum	30
Vaccinium vitis-idaea	10
Festuca altaica	10
Petasites frigidus	2
Empetrum nigrum	5
Stereocaulon sp.	5
Peltigera apthosa	2
Cladina mitis	15
Cladina rangiferina	20
Nephroma arcticum	10
Polytricum juniperinum	5
Pleurozium schreberii	20
Hylocomium splendens	40

SITE 61 TR 01 C
DRILL PAD

ASPECT: WNW
SLOPE: 0 deg.

SPECIES	%
Alnus crispa	20
Salix sp.	25
Agrostis scabra	20
Picea glauca	1
tiny moss sp. (mat)	60
Calamagrostis sp.	1

SITE 61 TR 01 B-a UPPER EXCAVATED WALL	ASPECT: WNW SLOPE: 20 deg.
SPECIES	%
Vaccinium vitis-idaea	1
Calamagrostis sp.	5
Polygonum alaskanum	10
Ledum groenlandicum	20
Vaccinium uliginosum	5
Picea glauca	2
Epilobium angustifolium	2
Salix sp.	2
Alnus crispa	10
Agrostis scabra	20
Cladina mitis	5
Polytricum juniperinum	20
Betula papyrifera	5
Populus tremuloides	2
Rubus idaeus	1
Cetreria islandica	0.5
Carex sp.	5
Spiraea sp.	2
tiny moss sp. (mat)	10

SITE 61 TR 01 B-b LOWER EXCAVATED WALL	ASPECT: WNW SLOPE: 39 deg.
SPECIES	%
Alnus crispa	10
Salix sp. 1	5
Salix sp. 2	5
Agrostis scabra	15
Polygonum alaskanum	15
Betula papyrifera	1
Calamagrostis sp.	2
Populus tremuloides	1
Epilobium angustifolium	1

SITE 90 R 12 DRILL PAD (HARD)	ASPECT: ENE SLOPE: 0 deg.
SPECIES	%
Agrostis scabra	10
Salix sp.	0.5
tiny moss sp. (mat)	30

SITE 90 R 12 DRILL PAD PERIMETER	ASPECT: ENE SLOPE: O deg.
SPECIES	%
Calamagrostis sp.	30
Salix sp.	15
Agrostis scabra	60
Epilobium angustifolium	10
Petasites frigidus	0.5
Polygonum alaskanum	5
Betula glandulosa	2

SITE 92 LS 12 DRILL PAD	ASPECT: ENE SLOPE: 1 deg.
SPECIES	%
Calamagrostis canadensis	20
Calamagrostis sp.	5
Epilobium angustifolium	25
Agrostis scabra	60
Polygonum alaskanum	5
Betula glandulosa	2
Salix sp.	1
mustard sp.	2
Lupinus arcticus	0.5
tiny moss sp (mat)	5

SITE 92 LS 15 DRILL PAD (HARD)	ASPECT: ENE SLOPE: 1%
SPECIES	%
Salix sp.	2
Agrostis scabra	30
Epilobium angustifolium	5
Polyganum alaskanum	2
Lupinus arcticus	0.5
Vaccinium uliginosum	2
Calamagrostis canadensis	2
Rubus idaeus	0.5

SITE 92 LS 15 DRILL PAD PERIMETER	ASPECT: ENE SLOPE: 1%
SPECIES	%
Calamagrostis canadensis	15
Epilobium angustifolium	25
Salix sp.	15
Agrostis scabra	80
Polygonum alaskanum	10
Betula glandulosa	5
Rubus idaeus	10
tiny moss	10

SITE 93 LS 24 D UNDISTURBED	ASPECT: NNE SLOPE: 12 deg.
SPECIES	%
Picea mariana	50
Betula glandulosa	25
Salix sp.	2
Ledum groenlandicum	25
Equisetum sylvaticum	15
Vaccinium uliginosum	15
Vaccinium vitis-idaea	20
Calamagrostis sp.	10
Carex sp.	2
Empetrum nigrum	20
Polytricum juniperinum	15
Rubus chamaemorus	15
Sphagnum (red,green,brown)	20
Pleurozium schreberii	10
Hylocomium splendens	30
Nephroma arcticum	10
Peltigera apthosa	2
Cladina rangiferina	10
Cladina mitis	20
Cladonia cornuta	10
Petasites frigidus	5

SITE 93 LS 24 A	ASPECT: N
DRILL PAD	SLOPE: 8 deg.
SPECIES	%
Agrostis scabra	2
Equisetum sylvaticum	1
Polytricum juniperinum	1
Salix sp.	0.5
tiny moss sp.	5
Epilobiium angustifolium	1

SITE 93 LS 24 B	ASPECT: N
BLACK MUCK DELTA	SLOPE: 9 deg.
SPECIES	%
Salix sp.	5
tiny moss sp.	80
Calamagrostis sp.	5
Agrostis scabra	2
Equisetum sylvaticum	30
Polytricum juniperinum	5

SITE 93 LS 24 C	ASPECT: N
PERMAFROST SLOUGH	SLOPE: 20 deg.
SPECIES	%
Calamagrostis sp.	20
Salix sp.	5
Polytricum juniperinum	25
tiny moss sp.	30
Equisetum sylvaticum	2

SITE 93 LS 04	ASPECT: E
DRILL PAD	SLOPE: 2 deg.
SPECIES	%
Agrostis scabra	30
Calamagrostis sp.	5
Epilobium angustifolium	10
Matricaria sp.	5
Salix sp.	1
Luzula parviflora	1
Calamagrostis canadensis	10
Polygonum alaskanum	1
Festuca altaica	0.5

SITE DC 01	ASPECT: ENE
STRIPPED SURFACE	SLOPE: 20 deg.
SPECIES	%
site	
Betula papyrifera	25
Populus tremuloides	10
Picea glauca	2
Alnus crispa	40
Salix sp.	10
Festuca altaica	20
Lupinus arcticus	2
Rubus idaeus	0.5
Epilobium angustifolium	1
Vaccinium vitis-idaea	1
Polemonium pulcherrimum	0.5
Polytricum juniperinum	30
Hylocomium splendens	5
Cladonia borealis	1
Cladonia cornuta	1
Peltigera apthosa	1

SITE LS 01	ASPECT: N
BUNKHOUSE NORTH	SLOPE: 5 deg.
SPECIES	%
Picea mariana	5
Alnus crispa	20
Salix sp.1	15
Betula glandulosa	5
Epilobium angustifolium	10
Betula papyrifera	2
Rubus idaeus	5
Calamagrostis sp.	5
Luzula parviflora	2
Cornus canadensis	10
Linaea borealis	2
Vaccinium uliginosum	5
Ledum groenlandicum	5
Empetrum nigrum	5
Senecio sp.	2
Petasites frigidus	10
Vaccinium vitis-idaea	5
Equisetum sylvaticum	2
Festuca altaica	5
Agrostis scabra	2
Picea glauca	5
Salix sp.2	10
Peltigera apthosa	5
Pleurozium schreberii	25
Polytricum juniperinum	25
Lycopodium annotinum	2
Cladonia sp.	2
Salix sp.3	5
Salix sp.4	5

SITE LS 02	ASPECT: SE
BUNKHOUSE SOUTHEAST	SLOPE: 12 deg.
SPECIES	%
Salix sp.1	10
Salix sp.2	40
Artemesia sp.	5
Rosa accicularis	5
Senecio sp.	5
Petasites frigidus	5
Rubus idaeus	5
Epilobium angustifolium	10
Calamagrostis sp.	40
Achillea millefolium	5
Cornus canadensis	5
Erigeron sp.	2
Geum aleppicum	2
Gallium borealis	2
Festuca altaica	5
Ledum groenlandicum	2
Betula glandulosa	5
Betula papyrifera	5
Polygonum alaskanum	5
Pleurozium schreberii	15
Hylocomium splendens	2
Cladina pyxidata	2
Polytricum juniperinum	10
Peltigera apthosa	5
Cladina gracillis	5
Cladina cornuta	2

SITE GG 01 A	ASPECT: S
SLOPE BELOW FOREST	SLOPE: 43 deg.
SPECIES	%
Alnus crispa	30
Polygonum alaskanum	5
Rubus idaeus	10
Agropyron trachycaulum	15
Jacob's ladder	5
Calamagrostis sp.	10
Salix sp.	5
Picea glauca	1
Festuca altaica	0.5
Betula Papyrifera	10
Epilobium angustifolium	15
Arctostaphylos uva-ursi	5
Galium trifidum	1
Potentilla hookeriana	2
Rosa accicularis	1
Salix sp.	5
Populus tremuloides	1
Salix sp. (long leaf)	2
tiny moss	0.5

SITE GG 01 C	SLOPE: 40 deg.
UNDISTURBED	ASPECT: S
SPECIES	%
Populus tremuloides (trees)	40
Populus tremuloides (shrubs)	40
Shepherdia canadensis	25
Rosa accicularis	5
Arctostaphylos uva-ursi	70
Linaea borealis	10
Epilobium angustifolium	5
Festuca altaica	2
Mertensia paniculata	5
Vaccinium uliginosum	2
Vaccinium vitis-idaea	2
Carex sp.	0.5
Hylocomium splendens	2
Dicranum scoparium	1
Senecio pauperculus	0.5
Cetreria pinastri	5
Cladonia cornuta	1
Peltigera apthosa	2
Cladonia borealis	2
Parmalia sulcata	2
Cladonia pyxidata	0.5

SITE GG 01 B	ASPECT: N
EXPOSED BEDROCK	SLOPE: 42 deg.
SPECIES	%
Alnus crispa	100
Betula papyrifera	2
Salix sp.	5
Epilobium angustifolium	5
Calamagrostis sp.	10
Festuca altaica	2
liverwort sp.	2
Polytricum juniperinum	5
crusty lichen on rock	1
Cladonia cornuta	1
Cladonia borealis	2

SITE GG 01 D	ASPECT: N
UNDISTURBED	SLOPE: 40 deg.
SPECIES	%
Picea mariana	45
Betula papyrifera	5
Betula glandulosa	2
Salix sp.	5
Spiraea	10
Ledum groenlandicum	25
Petasites frigidus	2
Festuca altaica	20
Festuca altaica litter	20
Vaccinium vitis-idaea	10
Hylocomium splendens	65
Polytricum juniperinum	10
Lycopodium clavatum	1
big light moss	2
Sphagnum sp. (red)	15
liverwort sp.	5
Pleurozium schreberii	5
Cladonia sp.	1
Cladonia cornuta	3
Cetreria islandica	0.5
Cladonia gracillis	5
Cladina rangiferina	5
Cetreria cucculata	20
Cladina mitis	25
Cetreria pinastri	10
Parmelia sulcata	10
Peltigera apthosa	5

ITE GG 02 (1978)	ASPECT: S
	SLOPE: 27 deg.
SPECIES	%
Betula papyrifera	10
Rubus idaeus	30
Calamagrostis sp.	10
Salix sp.	10
Epilobium angustifolium	5
Populus tremuloides	10
Salix sp.	10
Linaea borealis	5
Polygonum alaskanum	5
Festuca sp.	15
Galium trifidum	1
Potentilla sp.	0.5
Achillea millefolium	0.5
tiny moss	0.5

SITE NG 01 A	ASPECT: NNW
UNDISTURBED	SLOPE: 31 deg.
SPECIES	%
Alnus crispa	10
Equisetum scirpoides	5

The vegetation at this site is very similar to GG 01 undisturbed site; Picea mariana and Betula papyrifera are larger here.

SITE NG 01
PATCHY PERMAFROST

ASPECT: NW
SLOPE: 26 deg.

SPECIES	%
Salix sp.	
Betula papyrifera	30
Picea mariana	5
Betula glandulosa	5
Calamagrostis canadensis	5
Vaccinium uliginosum	20
Festuca altaica	10
Vaccinium vitis-idaea	5
Ledum groenlandicum	5
Agrostis scabra	10
Epilobium angustifolium	15
Senecio lugens	2
Mertensia paniculata	2
Carex sp.	1
Equisetum pratense	2
Polygonum alaskanum	5
Salix sp. (thin)	15
Salix myrtillifolia	1
Galium sp.	1
Hordeum jubatum	0.5
Sphagnum sp. (red)	1
moss sp.	2
Hylocomium splendens	5
Polytricum juniperinum	5
Dicranum scoparium	2
Marchantia polymorpha	1
Cladina stellaris	2
Cladina mitis	0.5
Cetreria cucculata	5
Cladina rangiferina	1
	5

SITE NG 02
CREEK SLOPE

ASPECT: SE
SLOPE: N.D.

SPECIES	%
Hordeum jubatum	2
Salix sp.	5
Calamagrostis sp.	10
Epilobium angustifolium	5
Achilaea millefolium	5
Senecio lugens	2
Agrostis scabra	20
Salix myrtillifolia	2
Betula papyrifera	5

E NG 02 A
UNDISTURBED

ASPECT: SE
SLOPE: 30 deg.

SPECIES	%
Picea glauca (trees)	30
Picea glauca (shrubs)	5
Betula papyrifera	5
Salix sp. (tall)	10
Rosa accicularis	5
Ledum glandulosum	10
Vaccinium vitis-idaea	15
Geocaulon lividum	5
Festuca altaica	10
Picea mariana (trees)	10
Picea mariana (shrubs)	5
Shepherdia canadensis	2
Epilobium angustifolium	2
Lupinus arcticus	2
Mertensia paniculata	2
Arctostaphylos uva-ursi	2
Peltigera scabrosa	2
Cladina mitis	5
Cladonia sp.	2
Cladina stellaris	2
Hylocomium splendens	30
Tomenthyptum nitens	5

SITE NG 03

ASPECT: SW
SLOPE: 3 deg.

SPECIES	%
Salix sp.	1
Achillea millefolium	2
Picea sp. (seedlings)	2
Populus balsamifera	3
Alnus crispa	1
Agrostis scabra	10
Hordeum jubatum	5
Lupinus arcticus	1
Salix sp. (thin)	2
Potentilla sp.	1
Betula papyrifera	0.5

SITE NG 04
SANDPILE

ASPECT: SW
SLOPE: 3 deg.

SPECIES	%
Salix sp.	5
Hordeum jubatum	1
Populus tremuloides	0.5
Populus balsamifera	1
Epilobium angustifolium	5
Senecio sp.	5
Agrostis scabra	10
Calamagrostis sp.	2
Achillea millefolium	1
Betula papyrifera	1

SITE NG-5	
Picea mariana	10
Alnus crispa	10
Calamagrostis sp.	5
Betula glandulosa	5
Spiraea betulifolia	20
Ledum groenlandicum	50
Vaccinium vitis-idaea	40
Salix sp.	5
Vaccinum uliginosum	15
Carex sp.	2
Empetrum nigrum	1
Polygonum alaskanum	2
Festuca altaica	2
Sphagnum sp. (green)	10
Polytricum juniperinum	20
Hylocomium splendens	60
Tomenthyptum nitens	5
Sphagnum sp. (red)	2
Cladonia cornuta	2

SITE N 01 A-a	ASPECT: S
TRENCH WALL	SLOPE: 35 deg.
SPECIES	%
Salix sp.	1
Agrostis scabra	5
Calamagrostis sp.	0.5
Epilobium angustifolium	1

SITE N 01 A-b	ASPECT: E
TRENCH FLOOR	SLOPE: 5 deg.
SPECIES	%
Calamagrostis sp.	2
Agrostis scabra	5
Festuca sp.	0.5
Epilobium angustifolium	0.5
Festuca altaica	0.5

SITE N 01 A-c	ASPECT: N
TRENCH WALL	SLOPE: 35 deg.
SPECIES	%
Salix sp.	0.5
Calamagrostis sp.	1
Descurainia	0.5
Agrostis scabra	1
Festuca sp.	0.5

SITE N 01 A-d	ASPECT: E
PUSH PILE	SLOPE: 5 deg.
SPECIES	%
Mustard type	5
Epilobium angustifolium	20
Calamagrostis sp.	5
Epilobium latifolium	2
Populus tremuloides	5
Agrostis scabra	10
Festuca altaica	10
Festuca sp.	2
Salix sp.	1

SITE N 01 B-a	ASPECT: S
	SLOPE: 37 deg.
SPECIES	%
Betula papyrifera	1
Festuca altaica	10
Salix sp.	1
Epilobium angustifolium	5
Calamagrostis sp.	5
Salix sp. 2	5

SITE N 01 B-b	ASPECT:
	SLOPE:
SPECIES	%
Agrostis scabra	25

SITE N 01 B-c	ASPECT: N
	SLOPE: 45 deg.
SPECIES	%
Agrostis scabra	15
Calamagrostis sp.	5
Epilobium angustifolium	1
tiny moss	5

SITE N 01 B-e	ASPECT: S
	SLOPE: 10 deg.
SPECIES	%
Salix sp.	
Populus balsamifera	0.5
Vaccinium uliginosum	1
Ledum groenlandicum	3
Populus tremuloides	0.5
Betula glandulosa	1
Picea glauca	25
Vaccinium vitis-idaea	1
tiny moss	30
Peltigera apthosa	2
Cladonia sp.	0.5
Carex sp.	5
Tomenthyptum nitens	1
open rock	50

SITE N 02 A	ASPECT: S
	SLOPE: 40 deg.
SPECIES	%
Populus balsamifera	1
Betula papyrifera	10
Calamagrostis sp.	30
Agrostis scabra	10
Picea glauca	15
Salix sp.	20
Epilobium angustifolium	5
Populus tremuloides	1
open rock	60

SITE N 02 B

ASPECT: N
SLOPE: 36 deg.

SPECIES	%
Agrostis scabra	20
Salix sp.	5
Epilobium angustifolium	10
Calamagrostis sp.	20
Betula papyrifera	1
Picea glauca	1
tiny moss	5
Polytricum juniperinum	0.5
open rock	50

SITE N 02 B
UNDISTURBED

ASPECT: SE
SLOPE: 14 deg.

SPECIES	%
Populus tremuloides	25
Picea glauca (trees)	20
Picea glauca (shrubs)	5
Picea mariana (trees)	5
Picea mariana (shrub)	5
Salix sp.	5
Ledum groenlandicum	50
Empetrum nigrum	10
Vaccinium vitis-idaea	20
Rosa accicularis	1
Geocaulon lividum	5
Festuca altaica	3
Hylocomium splendens	10
Cladonia gracilis	5
Cladina mitis	5
Cetreria cucculata	5
Peltigera scabrosa	5
Cladonia sp.	5
Stereocaulon sp.	1
Tomenthyptum nitens	1
Calamagrostis sp.	1

SITE N 03 A-a

ASPECT: E
SLOPE: 2 deg.

SPECIES	%
Salix sp.	2
Epilobium angustifolium	15
Salix sp.	15
Picea glauca	15
Alnus crispa	5
Senecio lugens	5
Equisetum scirpoides	2
Equisetum arvense	2
Betula papyrifera	2
Calamagrostis canadensis	5
Festuca saximontana	2
Rosa accicularis	2
Solidago spathulata	1

SITE N 03 A-b

ASPECT: S
SLOPE: 40 deg.

SPECIES	%
Agrostis scabra	50
Populus balsamifera	2
Calamagrostis sp.	2
Senecio lugens	2
Carex sp.	5
Epilobium latifolium	1
tiny moss	5
Betula papyrifera	2
Epilobium angustifolium	5

SITE N 03 A-c

ASPECT: E
SLOPE: 2 deg.

SPECIES	%
Agrostis scabra	25
Equisetum scirpoides	25
Salix sp.	5
tiny moss	5
sand and rock	70

SITE N 03 A-d

ASPECT: N.D.
SLOPE: N.D.

SPECIES	%
Epilobium angustifolium	20
Agrostis scabra	5
Salix sp.	10
Picea glauca	5
Betula papyrifera	2
Senecio lugens	5
Calamagrostis sp.	20

SITE N 03 B-a

ASPECT: S
SLOPE: 40 deg.

SPECIES	%
Alnus crispa	5
tiny moss	10
Salix sp.	5
Betula papyrifera	20
Epilobium angustifolium	5
Calamagrostis sp.	10
Picea glauca	5
Agrostis scabra	20
Polytricum juniperinum	5

SITE N 03 B-c
TRENCH FLOOR

ASPECT: S
SLOPE: 40 deg.

SPECIES	%
Salix sp.	30
Agrostis scabra	30
Calamagrostis sp.	20
Festuca altaica	20

SITE N 03 B-b

ASPECT: N
SLOPE: 41 deg.

SPECIES	%
Epilobium angustifolium	10
Calamagrostis sp.	20
Betula papyrifera	1
Salix sp.	1
Picea glauca	2
tiny moss	20
Polytricum juniperinum	5

SITE N 04 A-a
TRENCH WALL

ASPECT: S
SLOPE: 30 deg.

SPECIES	%
Salix sp.	2
Betula papyrifera	5
Agrostis scabra	10
Calamagrostis sp.	2
Epilobium angustifolium	10
Festuca altaica	2
Populus balsamifera	5
Lupinus arcticus	2
Festuca saximontana	10

SITE N 04 A-b
TRENCH FLOOR

ASPECT: E
SLOPE: 12 deg.

SPECIES	%
Calamagrostis sp.	10
Festuca saximontana	5
Epilobium angustifolium	5
Picea glauca	0.5
Agrostis scabra	20
Populus tremuloides	1
Salix sp.	1
Populus balsamifera	2
Mertensia paniculata	0.5

SITE N 04 A-c
TRENCH WALL

ASPECT: N
SLOPE: 30 deg.

SPECIES	%
Populus balsamifera	1
Calamagrostis sp.	10
Agrostis scabra	25
Picea glauca	5
Epilobium angustifolium	1
Salix sp.	2
Polytricum juniperinum	1
Poa sp.	2

SITE N 04 B
UNDISTURBED

ASPECT: E
SLOPE: 6 deg.

SPECIES	%
Picea mariana (trees)	15
Picea mariana (shrubs)	30
Picea glauca	5
Salix sp.	2
Rosa accicularis	1
Ledum groenlandicum	40
Vaccinium vitis-idaea	15
Festuca altaica	5
Lycopodium alpinum	1
Dicranum scoparium	10
Hylocomium splendens	30
Cladina mitis	40
Stereocaulon sp.	1
Cladonia sp.	5
Peltigera apthosa	10
Cetreria islandica	1
Cladonia gracillis	1
Cladonia uncialis	1
Pleurozium schreberii	1
Betula papyrifera	5

SITE R 01

ASPECT: E
SLOPE: 1 deg.

SPECIES	%
Picea glauca	2
Calamagrostis sp.	2
Epilobium angustifolium	2
Agrostis scabra	2
Salix sp.	2
Polytricum juniperinum	5
Betula papyrifera	1
tiny moss	5

SITE R 02 A-a
SLOUGHING AREA

ASPECT: N
SLOPE: 26 deg.

SPECIES	%
Salix sp.	15
Equisetum arvense	40
Equisetum sylvaticum	40
Populus tremuloides	2
Vaccinium vitis-idaea	1
Ledum groenlandicum	1
Carex sp.	5
Picea glauca	1
Calamagrostis sp.	1
Polytricum juniperinum	10
Luzula parviflora	2
Epilobium angustifolium	2
Salix sp.	2

SITE R 02 A-b
WET TRENCH FLOOR

ASPECT: W
SLOPE: 5 deg

SPECIES	%
Salix sp.	60
Equisetum arvense	70
moss sp.	50
water plant sp.	5
Equisetum sylvaticum	30
Aulacomnium palustre	0.5
Epilobium angustifolium	1

SITE R 02 A-c

ASPECT: S
SLOPE: N.D.

SPECIES	%
Salix sp.	50
Epilobium angustifolium	10
Picea glauca	10
Polytricum juniperinum	10
tiny moss	1
Equisetum arvense	40
Equisetum sylvaticum	40
Agrostis scabra	5
Betula papyrifera	1
Populus tremuloides	10
Salix sp.	10
Populus balsamifera	5

SITE R 02 C
UNDISTURBED

ASPECT: N
SLOPE: 11 deg.

SPECIES	%
Picea mariana (trees)	20
Picea mariana (shrubs)	30
Salix sp.	10
Ledum groenlandicum	60
Petasites frigidus	1
Vaccinium vitis-idaea	20
Betula glandulosa	1
Vaccinium uliginosum	1
Equisetum sylvaticum	1
Carex sp.	1
big moss	2
Dicranum scoparium	10
Polytricum juniperinum	10
Hylocomium splendens	30
Cladonia sp.	10
Cladina mitis	20
Cladonia cornuta	5
Cetreria cucculata	10
Cladina rangiferina	5
Peltigera apthosa	20
Festuca altaica	2
Pleurozium schreberii	5

SITE R 02 B-a

ASPECT: N
SLOPE: 38 deg.

SPECIES	%
Calamagrostis sp.	0.5
Epilobium angustifolium	2
Alnus crispa	1
Salix sp.	0.5
Polytricum juniperinum	1

SITE R 02 B-b

ASPECT: N
SLOPE: 85 deg.

SPECIES	%
Epilobium angustifolium	0.5
tiny moss	1
Polytricum juniperinum	1
liverwort sp.	1
Agrostis scabra	10
grass sp.	0.5

SITE R 02 B-c

ASPECT: S
SLOPE: N.D

SPECIES	%
Populus balsamifera	5
Epilobium angustifolium	10
Salix sp.	10
Populus tremuloides	5
Alnus crispa	10
Agrostis scabra	1
Polytricum juniperinum	5
Lupinus arcticus	2
Picea glauca	10
Betula papyrifera	2

SITE R 02 E

ASPECT: ESE
SLOPE: 7 deg.

SPECIES	%
Salix sp. 1	30
Salix sp. 2	20
Calamagrostis sp.	30
Equisetum arvense	10
Marchantia polymorpha	10
Equisetum sylvaticum	20
Polytricum juniperinum	10
tiny moss	10
Stellaria calycantha	5
Achillea millefolium	1
Epilobium angustifolium	10
Picea glauca	5
Betula papyrifera	2
Senecio lugens	1
Populus tremuloides	1

SITE R 02 E-a
UNDISTURBED

ASPECT: NE
SLOPE: 26 deg.

SPECIES	%
VERY SIMILAR TO R 02 C, MORE SPHAGNUM	

SITE R 02 E-b ASPECT: NNE
SLOPE: 36 deg., VARIABLE

SPECIES	%
Salix sp. 1 and 2	20
Calamagrostis sp.	20
Equisetum sylvaticum	20
big moss	20
little moss	60
Agrostis scabra	5
Epilobium angustifolium	5
Stellaris sp.	1

SITE R 02 D ASPECT: N AND E
INTERSECTION SLOPE: N.D.

SPECIES	%
Populus tremuloides	5
Salix sp.	5
Betula papyrifera	2
Epilobium angustifolium	5
Picea glauca	5
Polytricum juniperinum	15
tiny moss	10
Calamagrostis sp.	2

R 03 A ASPECT: N
OLD ROADWAY SLOPE: 10 deg.

SPECIES	%
Salix sp.	25
Equisetum arvense	50
Agrostis scabra	20
Equisetum sylvaticum	30
Calamagrostis canadensis	2
Epilobium angustifolium	5
Populus tremuloides	2
Picea glauca	2
small moss	2
Carex sp.	5
Polytricum juniperinum	20
Betula papyrifera	1
Salix (thin leaf)	10
Calamagrostis sp.	2

SITE R 03 B ASPECT: N
UNDISTURBED SLOPE: 8 deg.

SPECIES	%
Picea mariana (trees)	5
Picea mariana (shrubs)	50
Ledum groenlandicum	50
Salix sp.	10
Vaccinium vitis-idaea	30
Vaccinium uliginosum	5
grass sp.	5
Equisetum sylvaticum	2
Petasites frigidus	2
Polytricum juniperinum	10
Hylocomnium splendens	20
Cetreria cucculata	20
Cladina rangiferina	10
Cladina mitis	10
Cladonia sp.	10
Peltigera apthosa	1
Sphagnum red	1
Calamagrostis sp.	1
Dicranum scoparium	5
Betula glandulosa	1
Cladonia cornuta	1

SITE RC 01 A ASPECT: N
SETTLING POND SLOPE: 1 deg.

SPECIES	%
Agrostis scabra	20
Salix sp.	5
Hordeum jubatum	5
Beckmannia zigachne	70
Potentilla sp.	20
mustard sp. 1	3
Achillea millefolium	1
Descurainia sp.	0.5
Equisetum sp.	10
Epilobium angustifolium	0.5

SITE RC 01 B ASPECT: N
SETTLING POND SLOPE: 1 deg.

SPECIES	%
Agrostis scabra	10
mustard sp. 1	1
Beckmannia syzigachne	10
Equisetum sp.	5
Salix sp. 1	5
Potentilla sp.	3
Hordeum jubatum	0.5

SITE RC 01
SETTLING POND WALL

SPECIES	%
Hordeum jubatum	no numbers
Potentilla sp.	
Festuca altaica	
Agropyron trachycaulum	
Equisetum arvense	
Equisetum scirpoides	
Agrostis scabra	
Picea glauca	
Achillea millefolium	
Stellaris sp.	
Beckmannia syzigachne	
Descurainia richardsonii	
mustard sp.	
Epilobium angustifolium	
Calamagrostis canadensis	
Salix sp.	

ASPECT: N.D.
SLOPE: N.D.

SITE RC 02
SETTLING POND

SPECIES	%
Equisetum arvense	no numbers
Salix sp.	
Beckmannia syzigachne	
Hordeum jubatum	
Potentilla sp.	
Calamagrostis canadensis	
Achillea millefolium	
Potentilla norvegica	
Equisetum flluviatile	
POND WALL:	
Carex sp.	
Polemonium caeruleum	
dandelion	
Betula papyrifera	
Populus balsamifera	

ASPECT: N.D.
SLOPE: N.D.

SITE RC 03
CREEKBED CUT

SPECIES	%
Salix sp.	25
Calamagrostis canadensis	15
Descurainia sp. 1	25
Epilobium angustifolium	10
Agrostis scabra	10
Achillea millefolium	1
Festuca altaica	10
Potentilla sp.	5
tiny moss	5
Picea glauca	5
Stellaria sp.	2
Beckmannia syzigachne	10
Descurania sp. 2	2

ASPECT: W
SLOPE: 40 deg.

SITE R 06 A
DRILL PAD

SPECIES	%
Picea glauca	5
Salix sp.	3
Calamagrostis sp.	5
Lupinus arcticus	1
Agrostis scabra	10
Epilobium angustifolium	3
Polytricum juniperinum	1
Betula glandulosa	0.5
Populus tremuloides	0.5

ASPECT: W
SLOPE: 3 deg.

SITE R 06 B
DRILL PAD

SPECIES	%
Populus balsamifera	0.5
Salix sp.	15
Picea glauca	15
Populus tremuloides	1
Achillea millefolium	1
Lupinus arcticus	1
Ledum groenlandicum	2
Epilobium angustifolium	20
Vaccinium vitis-idaea	1
Polytricum juniperinum	20
Calamagrostis sp.	25
Rosa accicularis	1
Empetrum nigrum	3
Betula papyrifera	1
Solidago spathulata	

ASPECT: W
SLOPE: 3 deg.

SITE R 06 C
UNDISTURBED

SPECIES	%
Picea mariana (trees)	10
Picea mariana (shrubs)	10
Picea glauca (trees)	10
Picea glauca (shrubs)	20
Salix sp.	5
Ledum groenlandicum	50
Vaccinium uliginosum	15
Empetrum nigrum	15
Vaccinium vitis-idaea	25
Geocaulon lividum	5
Dicranum scoparium	5
Cladina mitis	10
Cetreria cucculata	10
Tomenthyptum nitens	1
Hylocomium splendens	2
Cladonia spp. (3 kinds)	20
Polytricum juniperinum	1
Cladonia graciltis	1
Peltigera apthosa	5
Stereocaulon sp.	15
Festuca altaica	5
Cladonia uncialis	5

ASPECT: SW
SLOPE: 14 deg.

SITE R 07 A

ASPECT: NW
SLOPE: 3 deg.

SPECIES	%
Salix sp.	60
Betula glandulosa	5
Picea glauca	20
Alnus crispa	1
Betula papyrifera	5
Epilobium angustifolium	10
Equisetum arvense	30
Agrostis scabra	10
Polytricum juniperinum	1
Petasites frigidus	0.5
Ledum groenlandicum	1
Populus tremuloides	1
Calamagrostis canadensis	20
grass sp.	1

SITE R 07 B

ASPECT: N
SLOPE: 2 deg.

SPECIES	%
Salix sp.	1
Picea glauca	2
Betula glandulosa	1
Betula papyrifera	1
Agrostis scabra	5

SITE R 08 A
DRILL PAD CENTRE

ASPECT: E
SLOPE: 0 deg.

SPECIES	%
Picea glauca	5
Alnus crispa	1
Salix sp.	10
Lupinus arcticus	5
Populus tremuloides	0.5
Agrostis scabra	1
Polytricum juniperinum	5
Calamagrostis sp.	5
Empetrum nigrum	1
Ledum groenlandicum	1
Cladonia borealis	5
Epilobium angustifolium	0.5
Stereocaulon sp.	5

SITE R 08 A-b
DRILL PAD PERIMETER

ASPECT: E
SLOPE: 0 deg.

SPECIES	%
Pinus contorta	2
Salix sp.	10
Betula papyrifera	10
Picea glauca	15
Betula glandulosa	2
Ledum groenlandicum	5
Festuca altaica	2
Vaccinium uliginosum	5
Empetrum nigrum	2
Vaccinium vitis-idaea	1
Polytricum piliferum	0.5
Polytricum juniperinum	2
Epilobium angustifolium	3
Peltigera apthosa	1
Cladonia borealis	1
Cladina mitis	1
Cladonia cornuta	0.5
Alnus crispa	10
Arctostaphylos uva-ursi	0.5
Stereocaulon sp.	2
Lupinus arcticus	2
Calamagrostis sp.	2

SITE R 08 B
CLEARED AREA

ASPECT: E
SLOPE: 5 deg.

SPECIES	%
Picea mariana	15
Betula papyrifera	2
Salix sp.	5
Ledum groenlandicum	50
Vaccinium uliginosum	15
Festuca altaica	25
Empetrum nigrum	5
Vaccinium vitis-idaea	5
Petasites frigidus	10
Tomenthyptum nitens	15
Dicranum scoparium	5
Cladina mitis	10
Cladonia pyxidata	2
Cladonia sp.	2
Lupinus arcticus	1
Peltigera apthosa	1
Polytricum juniperinum	20

SITE R 08 C	ASPECT: E
UNDISTURBED	SLOPE: 13 deg.
SPECIES	%
Picea glauca	5
Picea mariana (trees)	10
Picea mariana (shrubs)	35
Salix sp.	2
Ledum groenlandicum	50
Vaccinium uliginosum	20
Vaccinium vitis-idaea	15
Festuca altaica	20
Calamagrostis sp.	2
Geocaulon lividum	5
Tomenthyptum nitens	5
Hylocomium splendens	50
Polytricum juniperinum	20
Cladina rangiferina	10
Cladina mitis	20
Cladonia sp.	10
Peltigera apthosa	20
Pleurozium schreberii	20
Nepthroma arcticum	1
Petasites frigidus	3
Stereocaulon sp.	3

SITE R 09-a	ASPECT: NE
	SLOPE: 4 deg.
SPECIES	%
Agrostis scabra	5
Epilobium angustifolium	2
Polytricum juniperinum	2
Picea glauca	2
Festuca altaica	1
Calamagrostis sp.	1
Populus balsamifera	1
Populus tremuloides	1

SITE R 09-b	ASPECT: NE
	SLOPE: 4 deg.
SPECIES	%
Salix sp.	10
Epilobium angustifolium	5
Festuca altaica	1
Agrostis scabra	2
Populus tremuloides	2
Polytricum juniperinum	2
Populus balsamifera	10
Picea glauca	10
Calamagrostis sp.	2

SITE R 09 B	ASPECT: N
UNDISTURBED	SLOPE: 19 deg.
SPECIES	%
Picea mariana (trees)	5
Picea mariana (shrubs)	40
Ledum groenlandicum	25
Vaccinium vitis-idaea	20
Festuca altaica	5
Dicranum scoparium	10
Hylocomium splendens	20
Polytricum juniiperinum	5
Pleurozium schreberii	5
Cladina rangiferina	20
Cladina mitis	20
Lycopodium clavatum	1
Cladonia cornuta	1
Cetreria cucculata	20
Cetreria islandica	5
Peltigera apthosa	15

SITE N 05 A	ASPECT: E
DRILL PAD	SLOPE: 0 deg.
SPECIES	%
Salix sp.	1
Festuca altaica	1
Agrostis scabra	50
Calamagrostis canadensis	2
Populus tremuloides	2
Hordeum jubatum	0.5
Lupinus arcticus	0.5
Epilobium angustifolium	1

SITE N 05 B	ASPECT: E
DRILL PAD	SLOPE: 0 deg.
SPECIES	%
Calamagrostis sp.	5
Agrostis scabra	30
Salix sp.	5
Populus tremuloides	5
Hordeum jubatum	2

SITE N 07 B-a	ASPECT: S
TRENCH WALL	SLOPE: 39 deg.
SPECIES	%
Picea glauca	10
Salix sp.	15
Epilobium angustifolium	10
Agrostis scabra	5
Calamagrostis sp.	15
Populus tremuloides	5
Rosa accicularis	5
tiny moss	5
Polytricum juniperinum	5
Ledum groenlandicum	2
Vaccinium uliginosum	2
Empetrum nigrum	2
Betula papyrifera	1
Populus balsamifera	1

SITE N 07 B-b	ASPECT: E
TRENCH FLOOR	SLOPE: 39
SPECIES	%
Picea glauca	10
Salix sp.	10
Populus balsamifera	5
Agrostis scabra	5
Ledum groenlandicum	0.5
Polytricum juniperinum	5
tiny moss	10
Calamagrostis sp.	5

SITE N 07 B-c	ASPECT: N
TRENCH WALL	SLOPE: 32 deg.
SPECIES	%
Calamagrostis sp.	10
Picea glauca	5
Salix sp.	10
tiny moss	5
Polytricum juniperinum	2
Agrostis scabra	2
Epilobium angustifolium	3

SITE N 07 C	ASPECT: NE
UNDISTURBED	SLOPE: 15 deg.
SPECIES	%
Picea mariana (trees)	10
Picea mariana (shrubs)	50
Salix sp.	3
Ledum groenlandicum	50
Petasites frigidus	2
Vaccinium uliginosum	15
Vaccinium vitis-idaea	20
Hylocomium splendens	30
Lycopodium annotinum	1
Pleurozium schreberii	25
Sphagnum (brown)	2
Peltigera apthosa	10
Cladina mitis	30
Cladonia pyxidata	1
Cetreria islandica	1
Cetreria cucculata	2
Polytricum juniperinum	2
Cladonia uncialis	2
Cladonia cornuta	1
Cladonia sp.	3
Rosa accicularis	1
Calamagrostis sp.	2

SITE N 08 B-a	ASPECT: S
TRENCH WALL	SLOPE: 35 deg.
SPECIES	%
Alnus crispa	25
Populus balsamifera	5
Calamagrostis sp.	5
Epilobium angustifolium	2
Salix sp.	10
Agrostis scabra	5
Betula papyrifera	1
Polytricum juniperinum	5
tiny moss	5

SITE N 08 B-b	ASPECT: N
TRENCH WALL	SLOPE: 30
SPECIES	%
Alnus crispa	35
Picea glauca	2
Epilobium angustifolium	10
Populus balsamifera	5
Calamagrostis sp.	5
Hordeum jubatum	10
Betula papyrifera	1
Salix sp.	3
Agrostis scabra	10
tiny moss	5

SITE N 08 C	ASPECT: E
	SLOPE: 14 deg.
SPECIES	%
Salix sp.	20
Alnus crispa	5
Picea glauca	5
Vaccinium ulignosum	1
Ledum groenlandicum	2
Populus balsamifera	2
Epilobium angustifolium	5
Agrostis scabra	5
Polytricum juniperinum	1
Calamagrostis sp.	5
Populus tremuloides	1

SITE BCV 01	ASPECT: N-E
VALLEY BOTTOM	SLOPE: 0 deg.
SPECIES	%
Populus balsamifera	60
Picea glauca	15
Salix sp. (thin leaves)	20
Rosa acciccularis	50
Viburnum edule	40
Delphinium glaucum	5
Calamagrostis canadensis	25
Mertensiana paniculata	10
Linaea borealis	5
Pyrola chloranthia	2
Equisetum pratense	70
Stellaria calycantha	2
Hylocomium splendens	2

SITE BCV 02 ASPECT:
FLOODPLAIN SLOPE: 0 deg.

SPECIES	%
Alnus crispa	no numbers
Salix spp. 1 and 2	
Picea glauca	
Epilobium angustifolium	
Festuca altaica	
Agropyron trachycaulum	
Agrostis scabra	
Descurainia sp.	
Calamagrostis canadensis	
Epilobium latifolium	
Androsace septentriovalis	
Achillea millefolium	
Polemonium sp.	
Senecio lugens	
Arabis cardamines	
gardenweed	
Artemesia sp.	
Rosa accicularis	
Equisetum arvense	
Carex sp.	
Calamagrostis canadensis	
Hedysarum sp.	
Stellaris sp.	

SITE BCV 03 ASPECT:
FOREST SLOPE: 0 deg.

SPECIES	%
Picea glauca	60
Viburnum edule	10
Populus balsamifera	2
Equisetum pratense	60
Mertensia paniculata	1
Calamagrostis sp.	5
Hylocomium splendens	70
Polytricum juniperinum	2
Peltigera apthosa	5
Festuca altaica	2
Epilobium angustifolium	1
Hedysarum alpinum	1
Linaea borealis	2
Rosa accicularis	2
Pleurozium schreberii	1
Ptillium crista-castrensis	1

SITE BCV 04 ASPECT:
RUNWAY CLEARING SLOPE: 0 deg.

SPECIES	%
Salix sp.	60
Populus balsamifera	30
Ribes hudsonianum	2
Epilobium angustifolium	2
Calamagrostis canadensis	20
Picea glauca,	10
Artemesia sp.	1
Rosa accicularis	2
Equisetum arvense	20
Equisetum pratense	20
tiny tall moss	20
Mertensia paniculata	2
Carex sp.	10

SITE RR 01 ASPECT: E
SMALL TRENCH SLOPE: 22 deg.

SPECIES	%
Festuca altaica	no numbers
wild oat grass	
Epilobium angustifolium	
Artemesia sp.	
Epilobium latifolium	
Stellaria sp.	

SITE RR 01 ASPECT: E
UNDISTURBED SLOPE: 22 deg.

SPECIES	%
Juniperinum horizontalis	no numbers
Salix sp.	
Saxifraga tricuspidata	
Oxytropis sp.	
grass sp.	
Epilobium angustifolium	
Mertensia paniculata	
Artemesia sp.	
Festuca altaica	
Vaccinium vitis-idaea	
Senecio lugens	
Dryas sp.	
Cetreria cucculata	
Cladonia sp.	
Thamnolia vernicularis	
Rhizocarpon geographicum	
Xanthoria elegans	
Potentilla fruticosa	
Hedysarum alpinum	
Epilobium latifolium	
chickweed	
moss	
Tomenthytum nitens	
grass sp.	

SITE IH 01 A ASPECT: E
UNDISTURBED SLOPE: 32 deg.

SPECIES	%
Picea glauca	5
Salix sp.	10
Festuca altaica	50
Carex sp.	5
Saxifraga tricuspidata	25
Abies lasiocarpa	5
Oxytropis campestris	15
Solidago sp.	5
Achillea millefolium	1
Gentian sp.	2
Betula glandulosa	1
Artemesia sp.	1
Stellaris sp.	5
Juniperus communis	3
Cetreria nivalis	5
Cladonia sp.	5
Cladonia pyxidata	1
Arctostaphylos uva-ursi	5

SITE IH 01 B ASPECT: N.D.
ADIT SLOPE: N.D.

SPECIES	%
Juniperus communis	2
Festuca altaica	5
Salix sp.	5
mustard sp.	1
Stellaria sp.	2
Carex sp.	1
Arctostaphylos uva-ursi	2
Saxifraga tricuspidata	5

SITE IH 02 A ASPECT: E
TOP OF ROAD SLOPE: 35 deg.

SPECIES	%
Carex sp.	5
mustard sp.	2
Stellaris sp.	10
Salix sp.	3
Saxifraga tricuspidata	2
Achillea millefolium	2
Senecio sp.	2
Festuca altaica	2
Dryas sp.	0.5

SITE IH 02 B ASPECT: E
UNDISTURBED SLOPE: 37 deg.

SPECIES	%
Salix sp.	30
Betula glandulosa	10
Pinus contorta	1
Shepherdia canadensis	5
Potentilla fruticosa	5
Oxytropis campestris	1
Arctostaphylos uva-ursi	20
Juniperinum communis	5
Senecio sp.	5
Xanthoria elegans	1
Rhizocarpon geographicum	5
Cetreria nivalis	5
Cladonia sp.	5
Saxifraga tricuspidata	10
Picea glauca	2
Gentian sp.	2
Linaea borealis	2
grey rock lichen	10
Polemonium pulcherrimum	12

SITE IH 03 B ASPECT: E
UNDISTURBED SLOPE: 28 deg.

SPECIES	%
Festuca altaica	40
Salix sp.	2
Populus tremuloides	nearby site
Arctostaphylos uva-ursi	30
Carex sp.	10
Juniiperum communis	1
Zygadenas elegans	3
gentian sp.	1
Senecio lugens	2
Saxifraga tricuspidata	2
Linaea borealis	2
Achillea millefolium	1
Polemonium pulcherrimum	5
Picea glauca	1
Artemesia sp.	1
Rhizocarpon geographicum	1
Cladonia sp.	1

SITE IH 03 A ASPECT: E
OLD FOOT TRAIL SLOPE: 28 deg.

SPECIES	%
Senecio sp.	50
Juniperinum communis	5
Saxifraga tricuspidata	2
Carex sp.	20
Festuca altaica	20
Arctostaphylos uva-ursi	20
gentian sp.	2
Polemonium pulcherrimum	5
Zygadenus elegans	5

SITE RR 05 ASPECT: N
UNDISTURBED SLOPE: 2 deg.

SPECIES	%
Festuca altaica	50
Salix sp.	5
Silene acaulis	2
Dryas sp.	20
grass sp.	5
Polemonium pulcherrimum	1
Cetreria cucculata	25
Calamagrostis sp.	5
Carex sp.	2
Saxifraga lyallii	1
Stellaria sp.	2
Polytricum juniperinum	2
Vaccinium vitis-idaea	1
Thamnolia vermicularis	1
Salix reticulata	10
tiny moss	5
Cladonia pyxidata	1

SITE RR 04 ASPECT: N
TRENCH SLOPE: 17 deg.

SPECIES	%
Calamagrostis canadensis	2
Stellaris sp.	1
Equisetum scirpoides	0.5
Epilobium latifolium	1
wild oat grass	1
Epilobium angustifolium	2
Festuca sp.	1
grass sp.	1
tiny moss	5
Artemesia sp.	0.5
Saxifraga tricuspidata	0.5

SITE RR 03 ASPECT: NW
SMALL EXCAVATION SLOPE: 5 deg.

SPECIES	%
Epilobium latifolium	2
tiny moss	5
Stellaris sp.	5

SITE RR 06 ASPECT: WNW
UNDISTURBED SLOPE: 22 deg.

SPECIES	%
Alectoria ochraleuca	3
Salix sp.	15
Betula glandulosa	10
Vaccinium vitis-idaea	10
Vaccinium uliginosum	5
Festuca altaica	10
Saxifraga tricuspidata	5
Tomenthyptum nitens	5
Polytricum juniperinum	5
Peltigera apthosa	3
Cladonia cornuta	2
Pyrola sp.	3
Cetreria cucculata	20
tiny moss	10
Cetreria islandica	3
Cladina mitis	1
Cladina rangiferina	1
Dicranum scoparium	2
Peltigera scabrosa	2
Dryas sp.	20
grass sp.	15
Senecio lugens	0.5
Lupinus arcticus	1
Silene acaulis	1
Potentilla fruticosa	0.5
Umbilicaria hypoborea	1

SITE RR 07 ASPECT: N.D.
SCRAPED GROUND SLOPE: N.D.

SPECIES	%
Epilobium latifolium	1
Festuca altaica	10
Stellaris sp.	2
Mertensia paniculata	1
Saxifraga sp.	1
Artemesia sp.	1
tiny moss	5
Dryas sp.	1

SITE RR 08 ASPECT: E-W
HANDTRENCH SLOPE: 0 deg.

SPECIES	%
grass sp. (short)	1
grass sp. (wheat)	5
Festuca sp. (blue)	2
ON DIRT PILE:	
Carex sp.	1
Dryas sp.	2
grass sp. (wheat)	5
Saxifraga tricuspidata	3
Artemesia sp.	2
Senecio sp.	1

SITE RR 09 ASPECT: NW
DRILL PAD SLOPE: 1 deg.

SPECIES	%
Festuca altaica	no numbers
Agrostis scabra	
Carex sp.	
Stellaris sp.	
Artemesia sp.	
Hierochloe alpina	
grass sp.	
tiny moss	
grass sp.	
Poa sp.	

SITE RRM 10 (A) ASPECT: S
SHALE SLOUGH SLOPE: 39 deg.

SPECIES	%
Populus tremuloides	5
Epilobium angustifolium	20
Arctostaphylos uva-ursi	5
Artemesia sp.	3
Ribes oxycanthoides	5
Calamagrostis sp.	2
Viburnum edule	1
Saxifraga tricuspidata	1
Achillea millefolium	0.5

SITE RRM 10 (B)	ASPECT: E
FLAT BOTTOM PART	SLOPE: 8 deg.
SPECIES	%
Epilobium angustifolium	20
Calamagrostis sp.	5
Achillea millefolium	2
Mertensia paniculata	4
Rosa accicularis	5
Artemesia frigida	1
Carex sp.	0.5
Polemonium pulcherrimum	1
grass sp.	1
Artemesia sp.	3
Salix sp.	3
Populus balsamifera	1

SITE RRM 10	ASPECT: S
UNDISTURBED	SLOPE: 38 deg.
SPECIES	%
Populus tremuloides	20
Rosa accicularis	20
Shepherdia canadensis	10
Viburnum edule	15
Arctostaphylos uva-ursi	20
Calamagrostis sp.	10
Saxifraga tricuspidata	5
Juniperinum communis	10
Senecio lugens	1
Epilobium angustifolium	1

SOIL ANALYSIS

J. R. Paine & Associates Ltd.
CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 80 TR 2 Depth: 0-20cm
Location: Trench Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/11

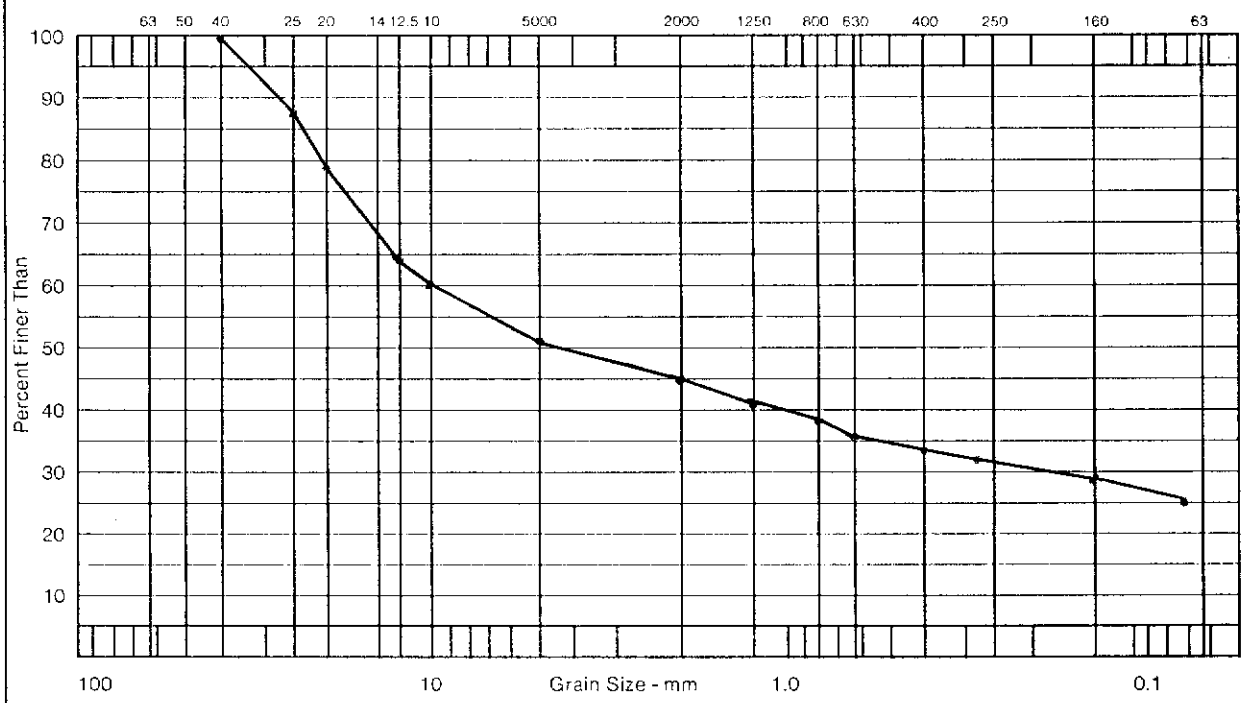
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63.000	63.0					
50.000	50.0					
40.000	40.0					100.0
25.000	25.0					87.1
20.000	20.0					78.9
12.500	12.5					64.1
10.000	10.0					60.2
5.000	5.0					51.8
2.000	2.0					44.5
1.250	1.25					40.5
800	0.800					37.9
630	0.630					36.2
400	0.400					33.7
315	0.315					32.2
160	0.160					28.9
80	0.080					24.4

Description of Sample
Silty Sandy Gravel, bM
Subangular and Subround Shapes
fractured and weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 13.9 %
Gravel: 48.2 %
Sand: 29.4 %
Silt: 24.4 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/05

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Trench Floor		0-20cm		88 TR 2	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.060	68	0.005	10
				0.043	64	0.003	8
				0.031	61	0.002	6
				0.023	53	0.001	1
				0.017	42		
				0.012	33		
		0.080	100	0.009	21		
		0.063	100	0.007	15		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

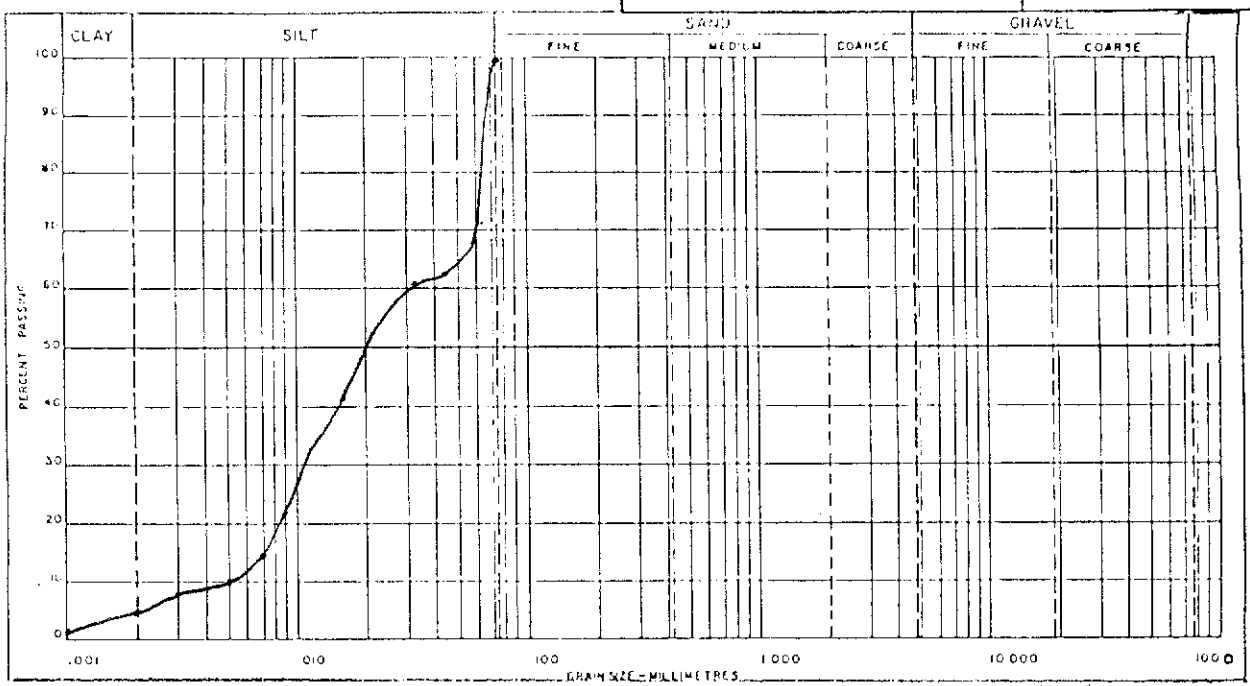
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt Trace of Clay, ML	
	Moisture 8.4%
Insitu Condition	
Loose	
Fine Portion of Sand:	
Sandy Basalt, GW	
Fractured & Weathered	
Bedrock	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect -

- Trench Bottom / Width - 1.5m

DATE SAMPLED 9-1/09/01

DATE RECEIVED 9-1/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: EE TK2 Depth: 0-20cm Client: GEO-ANALYSIS & ASSOCIATES

Location: Trench Bottom Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: Date: 1994/10/04

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					92.5
20,000	20.0					86.0
12,500	12.5					68.9
10,000	10.0					58.7
5,000	5.0					42.1
2,000	2.0					28.6
1,250	1.25					21.7
800	0.800					17.3
630	0.630					14.7
400	0.400					10.9
315	0.315					8.8
160	0.160					5.2
80	0.080					1.3

Description of Sample

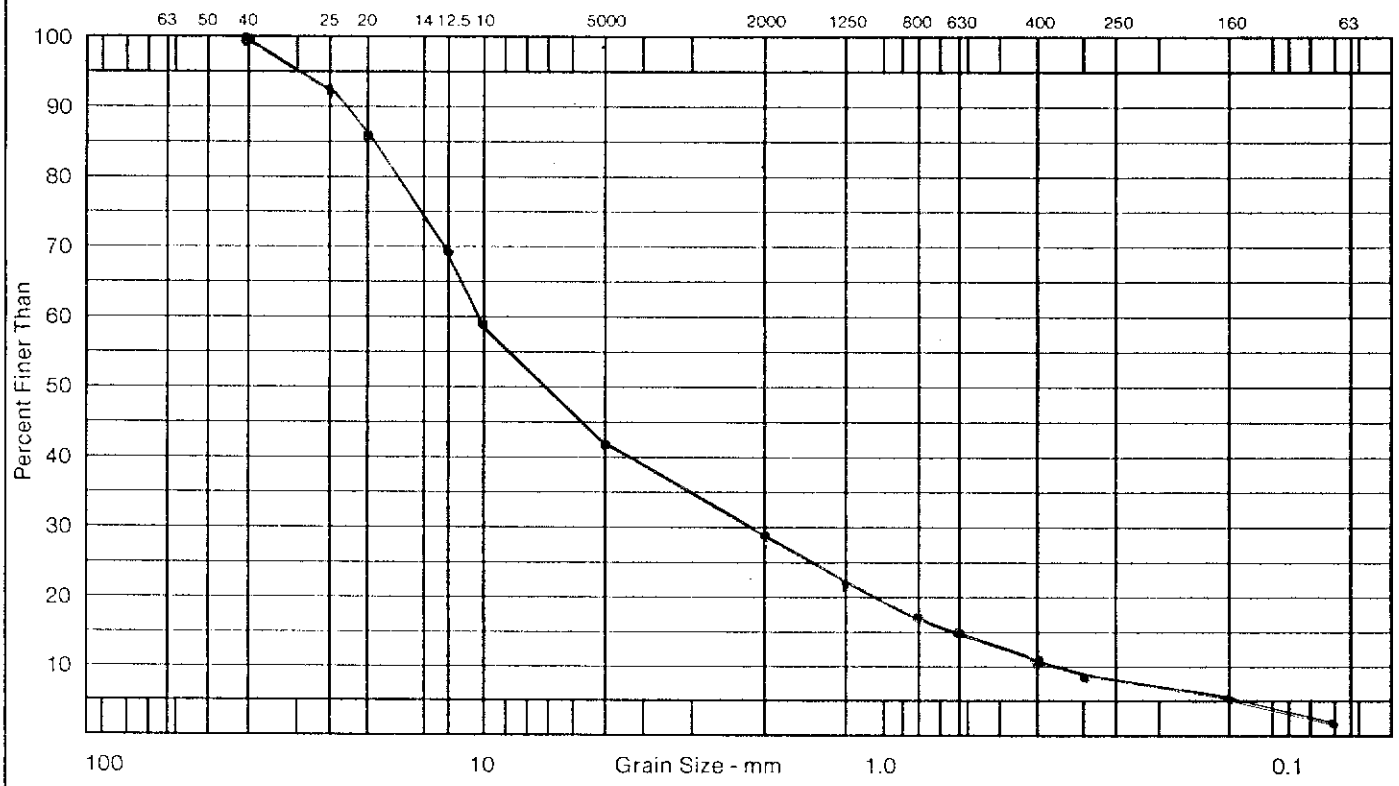
Sandy Gravel, GW
Subangular and Subround Shapes
Fractured and weathered bedrock

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks

Moisture: 8.1%
Gravel: 57.9 %
Sand: 40.8 %
Silt: 1.3 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 61TR1A Depth: 0-30cm
Location: LONESTAR 1961 TRENCH Slope/North Face

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/05

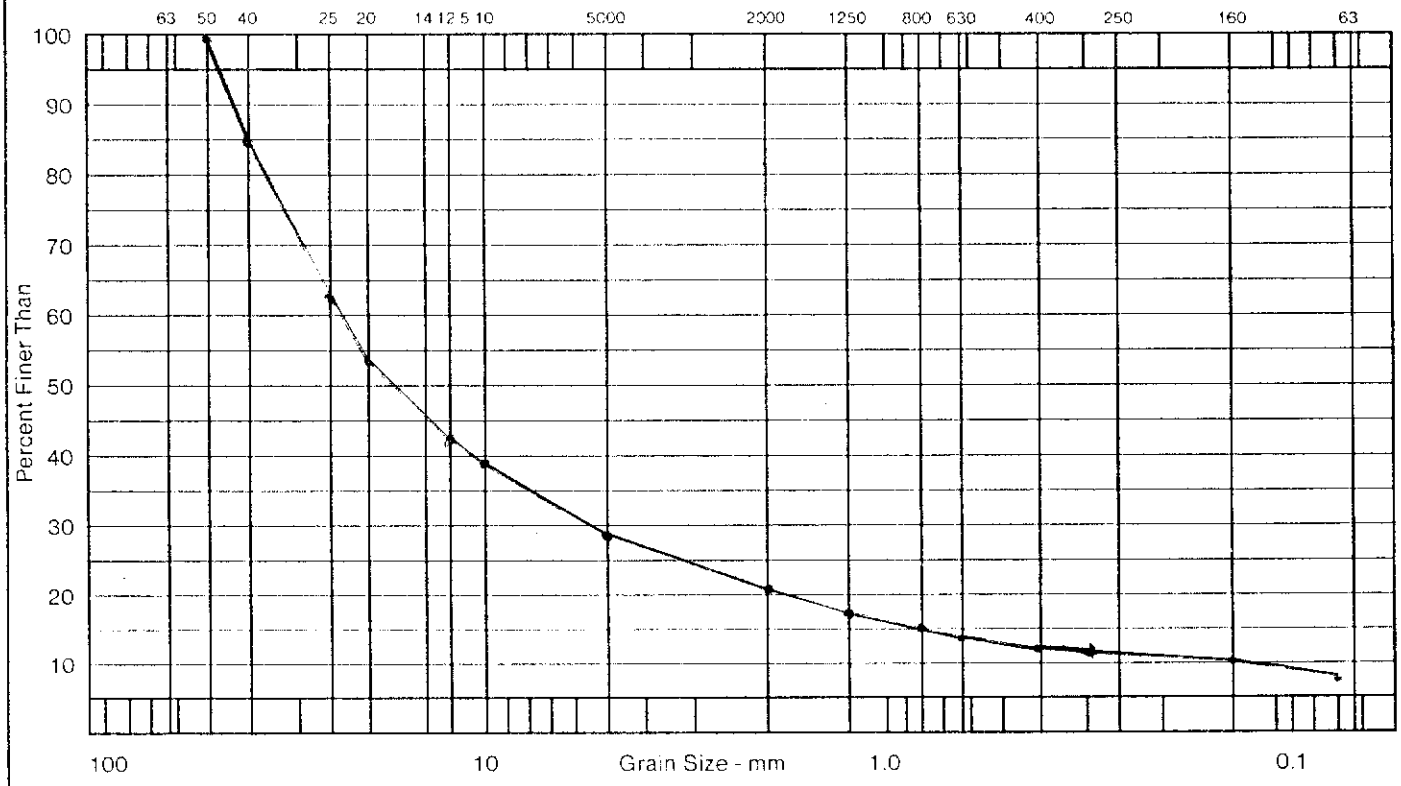
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					84.9
25,000	25.0					62.5
20,000	20.0					53.8
12,500	12.5					42.8
10,000	10.0					38.9
5,000	5.0					27.9
2,000	2.0					20.5
1,250	1.25					17.0
800	0.800					15.2
630	0.630					14.1
400	0.400					12.7
315	0.315					11.9
160	0.160					10.1
80	0.080					7.6

Description of Sample
Sandy Gravel trace of silt, GW
S-angular i s-rounded shapes
Fractured and weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 7.7 %
Gravel: 72.1 %
Sand: 20.3 %
Silt: 7.6 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 61 TR/B6 Depth: 0-20cm

Location: Slope West / Northwest

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/04

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					94.1
12,500	12.5					75.2
10,000	10.0					67.2
5,000	5.0					55.2
2,000	2.0					45.3
1,250	1.25					39.8
800	0.800					36.8
630	0.630					33.7
400	0.400					30.0
315	0.315					27.9
160	0.160					22.8
80	0.080					15.9

Description of Sample

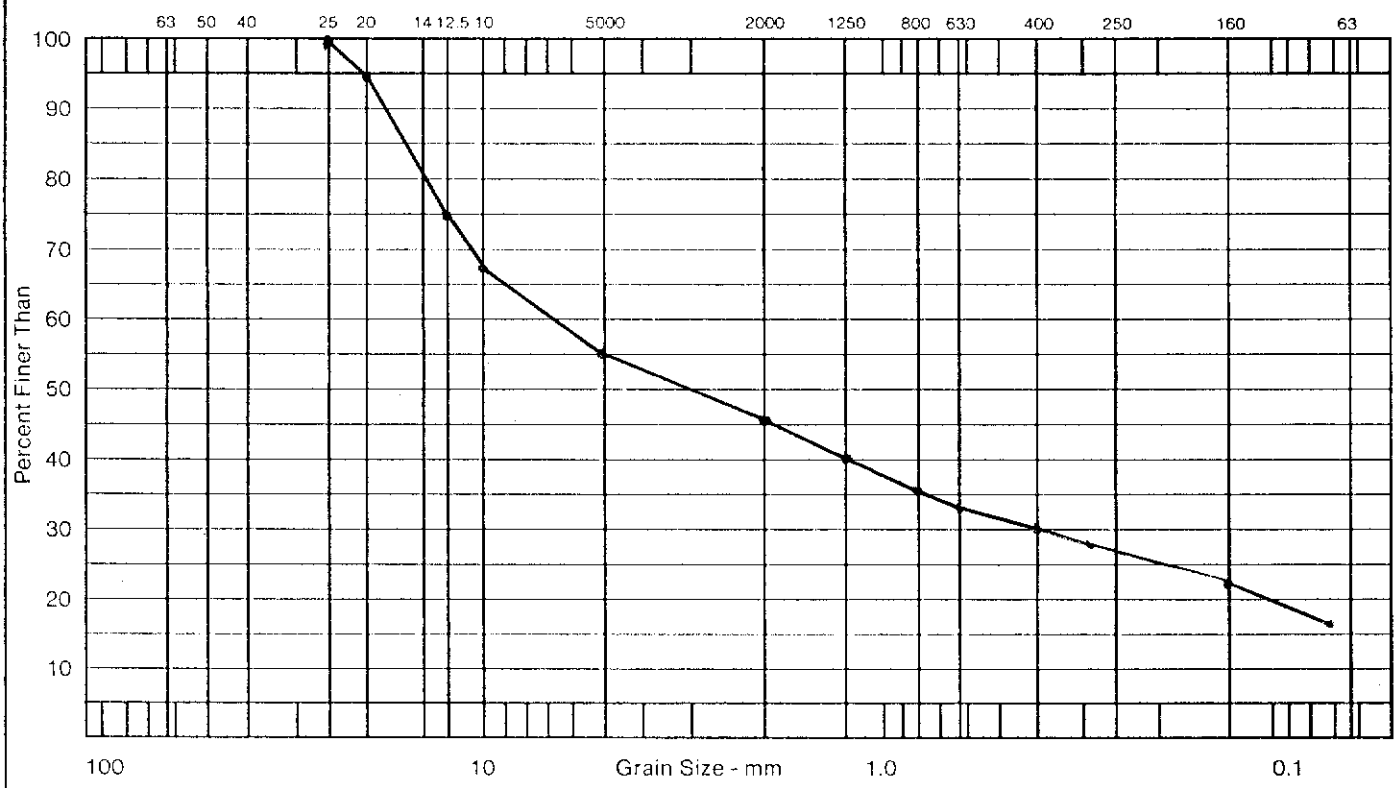
Silty Sandy Gravel, GW-GM
Subangular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 11.5%
Gravel: 44.8 %
Sand: 39.3 %
Silt: 15.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
				61 TR 136	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.039	74	0.005	9
				0.043	70	0.003	8
				0.031	65	0.002	6
				0.022	61	0.001	3
				0.016	45		
				0.013	27		
				0.009	18		
		0.063	100.0	0.007	13		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.S.

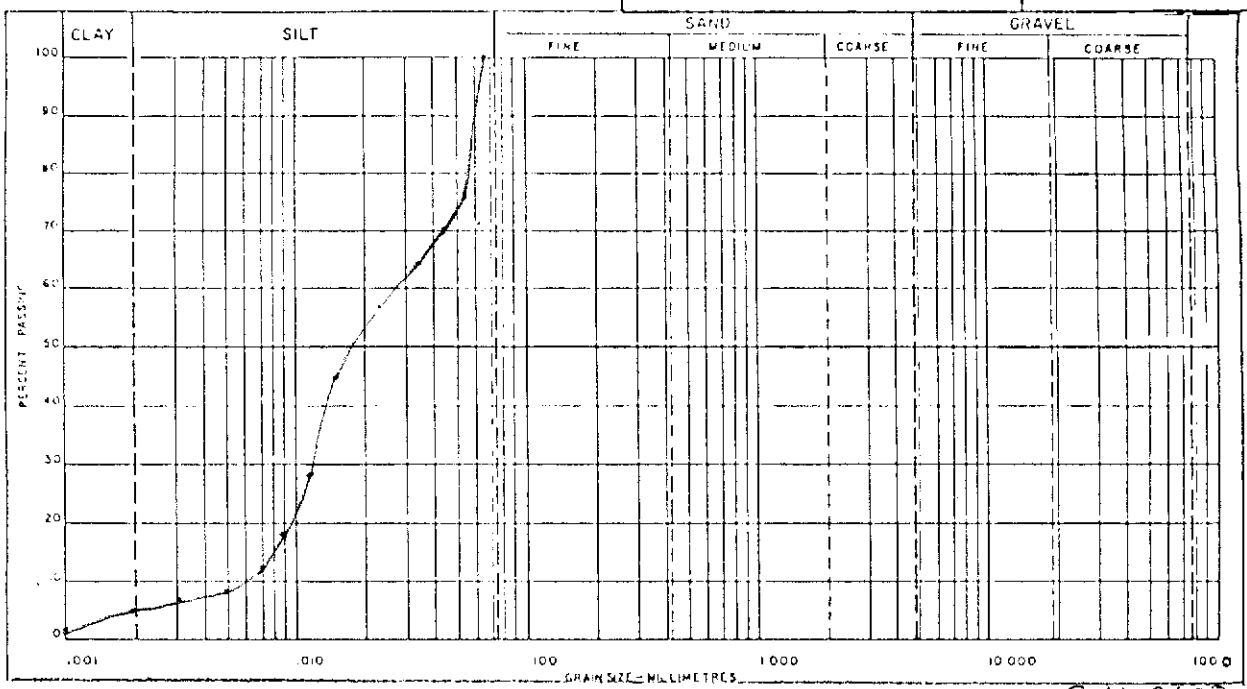
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Fine Portion of Sieve	
is Silty Sandy Gravel	Moisture 7.5%
6W-6M	
Silt, ML	
Trace Cementation	
Loose	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - West / North West

Slope - 39° / Height - 50m

DATE SAMPLED 94/09/02

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N1Aa Depth: 0-30 cm

Location: Nucleus Property
Aspect - East / North Wall

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					99.6
12,500	12.5					93.9
10,000	10.0					86.9
5,000	5.0					77.0
2,000	2.0					56.8
1,250	1.25					52.1
800	0.800					48.3
630	0.630					45.9
400	0.400					42.4
315	0.315					40.6
160	0.160					36.5
80	0.080					29.4

Description of Sample

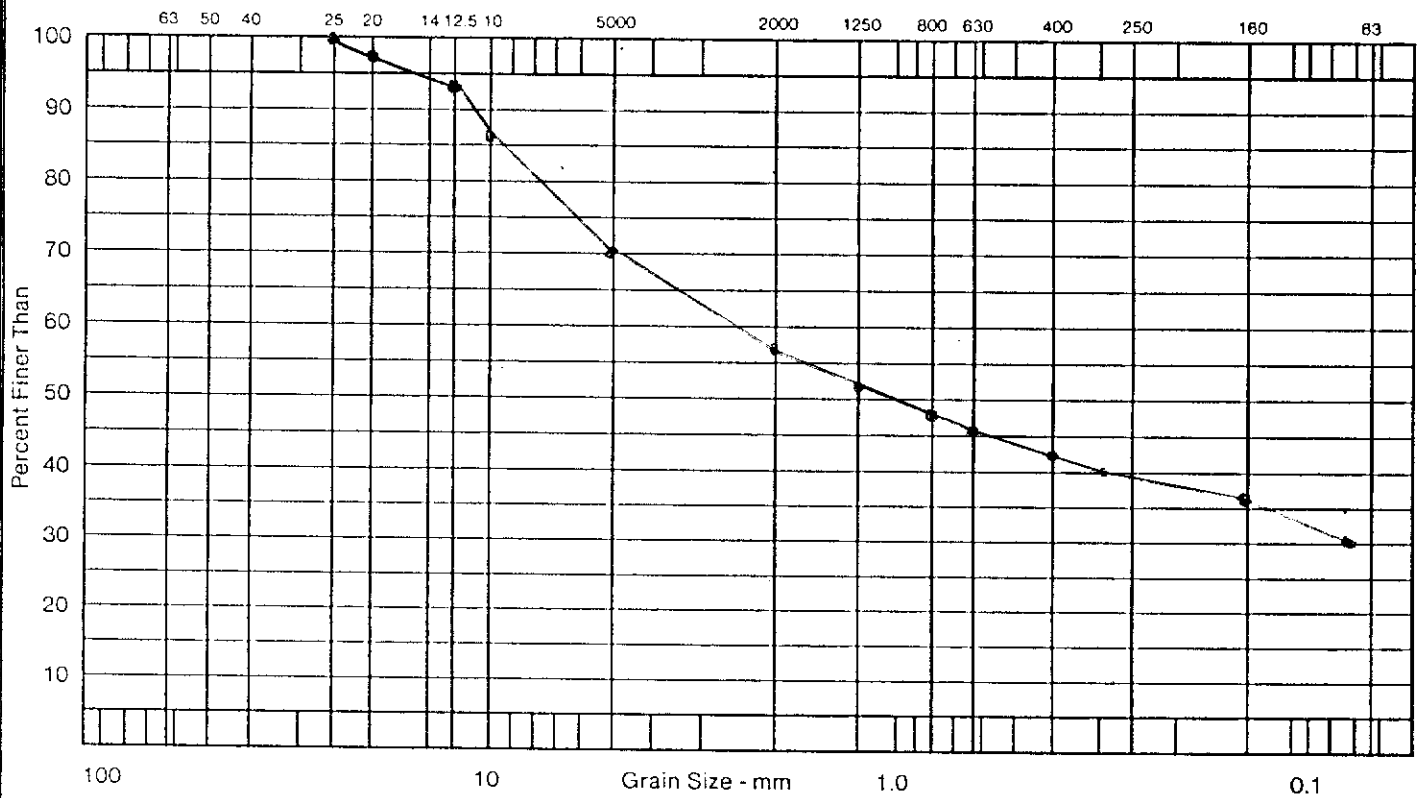
Silty Gravelly Sand, SM
Subangular and Subrounded shapes
Shattered, weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 9.1 %
Gravel: 30.0 %
Sand: 40.6 %
Silt: 29.4 %



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CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 1A Depth: 0-20cm

Location: Trench Wall

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/06

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					76.0
12,500	12.5					53.6
10,000	10.0					48.1
5,000	5.0					36.8
2,000	2.0					28.7
1,250	1.25					25.1
800	0.800					23.0
630	0.630					21.6
400	0.400					19.6
315	0.315					18.5
160	0.160					16.1
80	0.080					12.9

Description of Sample

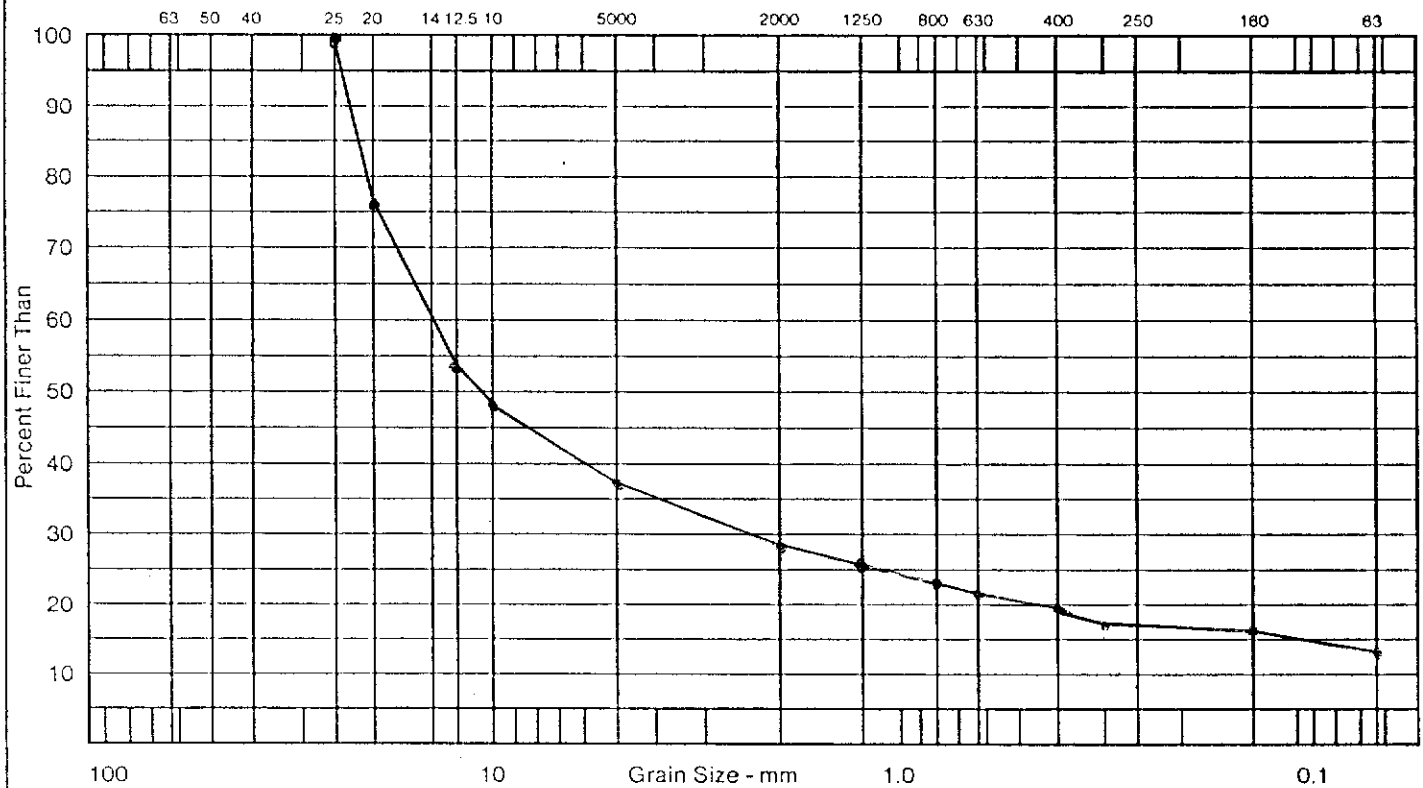
Sandy Gravel, some silt (SW-GM)
Subangular and Subround Shapes
Fractured and weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 6.2 %
Gravel: 63.2 %
Sand: 23.9 %
Silt: 12.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 3A Depth: 0-20cm

Location: Trench Wall

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/06

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					77.6
20,000	20.0					70.5
12,500	12.5					64.5
10,000	10.0					59.1
5,000	5.0					48.3
2,000	2.0					39.9
1,250	1.25					35.7
800	0.800					33.0
630	0.630					31.7
400	0.400					29.5
315	0.315					28.3
160	0.160					25.3
80	0.080					20.7

Description of Sample

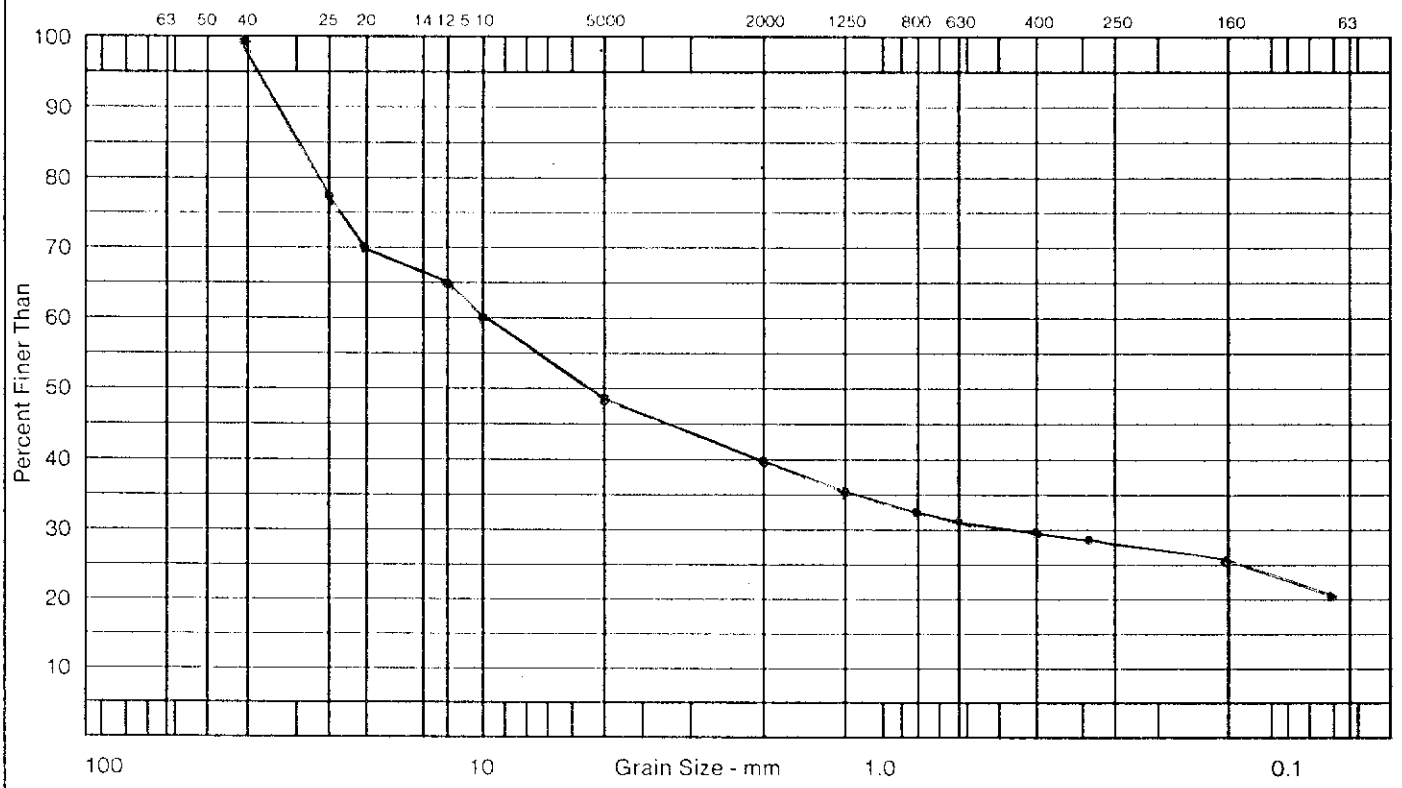
Silty Sandy Gravel, GM
Subangular and Subrounded Stones
fractured and weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 14.1 %
Gravel: 51.7 %
Sand: 27.6 %
Silt: 20.7 %



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CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94 09 08

STA.	SAMPLE TYPE	DEPTH	HOLE NO	FIELD NO.	LAB NO
				SA	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.059	75	0.005	12
				0.043	67	0.003	6
				0.032	57	0.002	4
				0.023	46	0.001	3
				0.017	35		
				0.013	24		
		0.560	100	0.009	18		
		0.063	81	0.007	16		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	PL	PI	NATURAL % H2O	SG

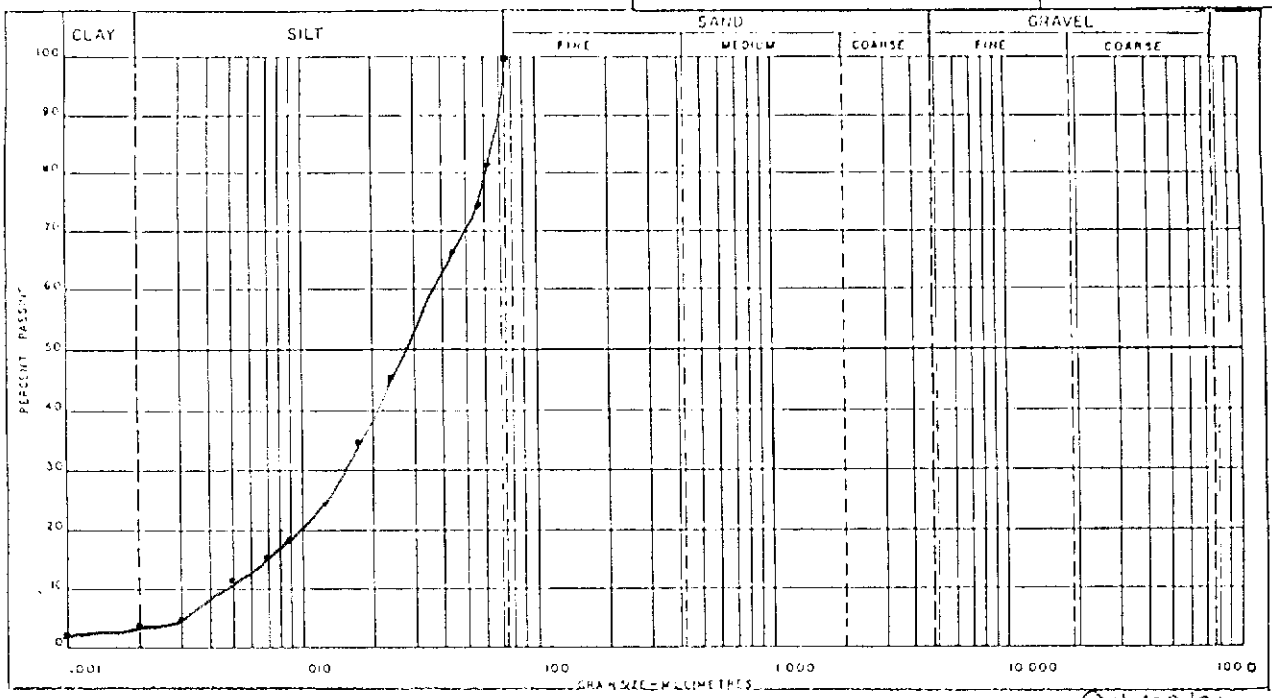
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Fine portion of the sieve is Sandy Gravelly Silt	Moisture 29.3%
Silt, ML	
Insitu Condition	
Loose	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Bottom of Gully

DATE SAMPLED 94/09/01

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY

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CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 5A Depth: 0-20cm

Location: Bottom of Gully

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/07

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					96.2
20,000	20.0					92.3
12,500	12.5					80.8
10,000	10.0					74.4
5,000	5.0					65.3
2,000	2.0					58.3
1,250	1.25					54.9
800	0.800					52.7
630	0.630					51.6
400	0.400					49.5
315	0.315					48.3
160	0.160					45.1
80	0.080					39.9

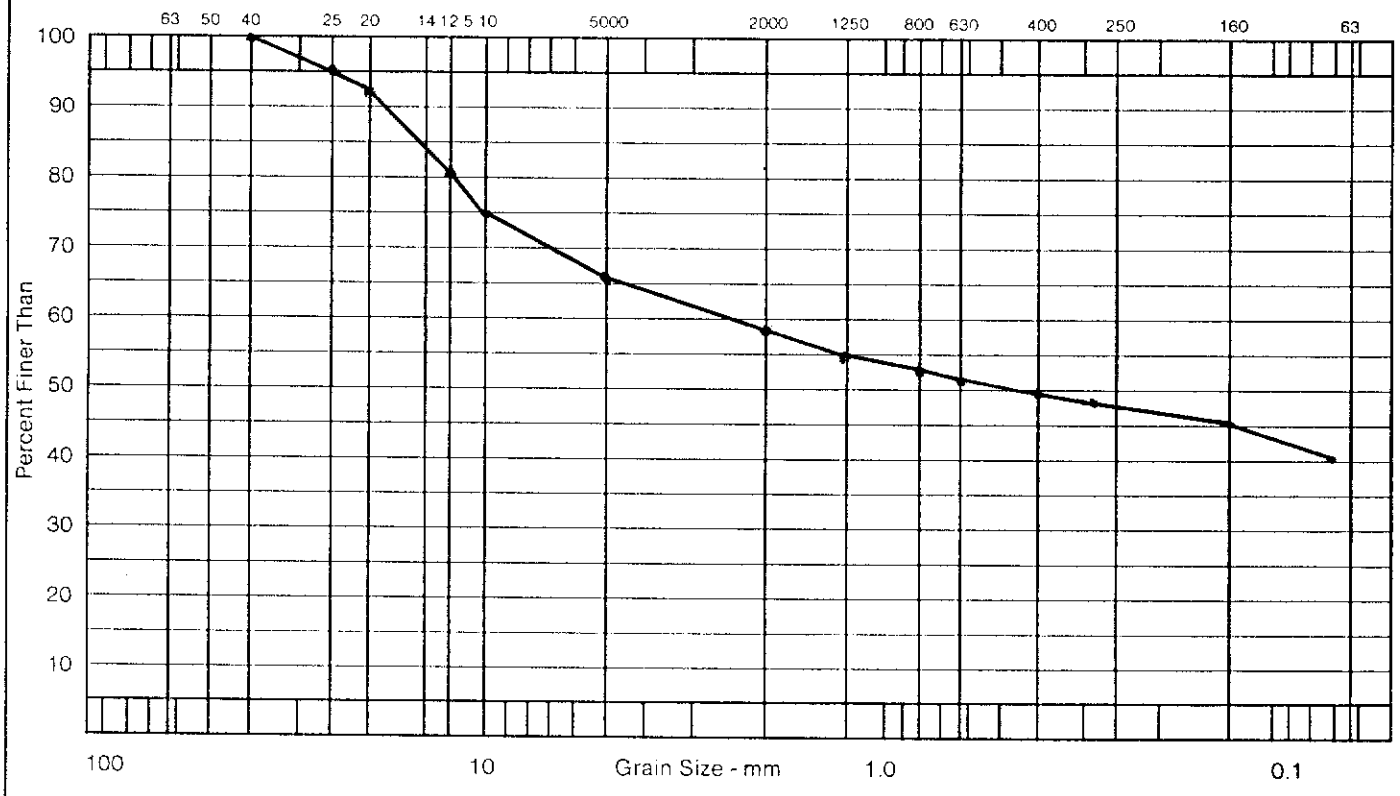
Description of Sample: Sandy Gravelly Silt, ML
Subrounded and Rounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 29.3 %
Gravel: 34.9 %
Sand: 25.9 %
Silt: 39.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 5B Depth: 0-20cm

Location: Trench Wall

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: Date: 1994/10/07

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					92.8
20,000	20.0					88.4
12,500	12.5					84.2
10,000	10.0					75.1
5,000	5.0					69.1
2,000	2.0					53.2
1,250	1.25					40.0
800	0.800					33.3
630	0.630					29.0
400	0.400					27.0
315	0.315					23.7
160	0.160					17.1
80	0.080					9.9

Description of Sample: Savoy Gravel, trace of silt, brown-grey, Subangular and Subrounded Shapes

Time of Sieving: Min. 15

Method of Preparation: Dry ____ Washed X

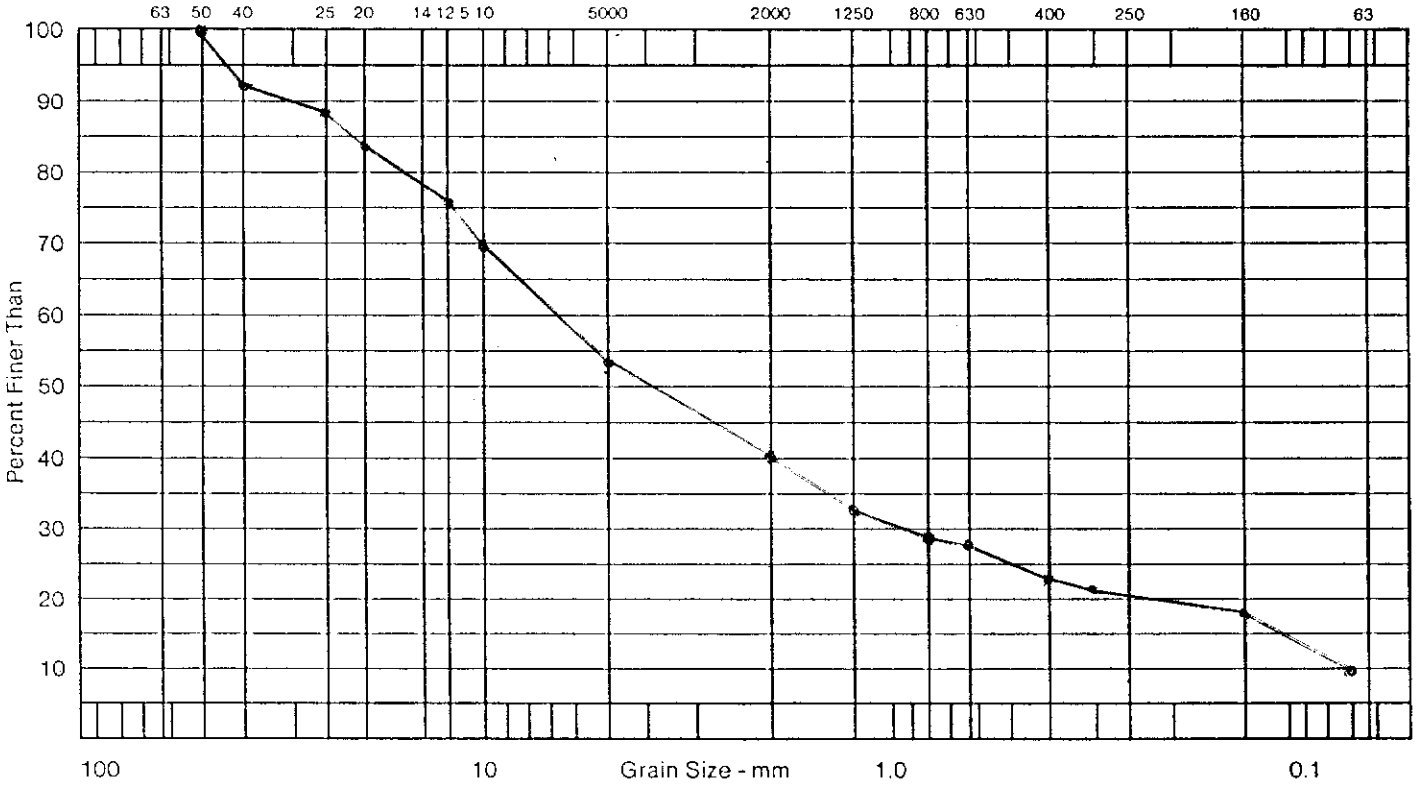
Remarks:

Moisture: 5.5 %

Gravel: 46.8 %

Sand: 43.3 %

Silt: 9.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
		0-15cm		1C	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.055	93	0.005	16
				0.039	88	0.003	8
				0.029	80	0.002	5
				0.021	73	0.001	4
				0.016	44		
				0.012	37		
		0.080	100	0.009	27		
		0.063	99	0.000	19		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

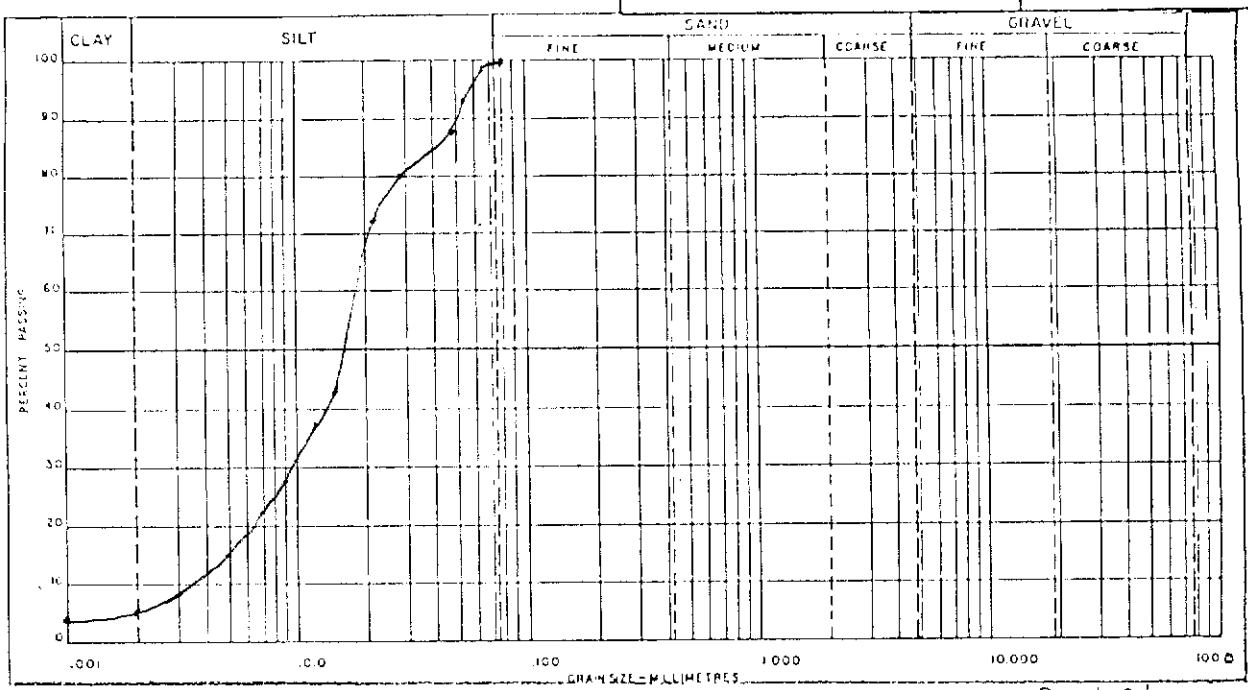
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt Trace of Clay, ML	Moisture: 42.5%
Triple Condition	
Soft IC ≤ 0.125-0.25 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect -

- Trench Bottom / Width - 4.7m

DATE SAMPLED 94/09/01

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT			CLIENT		DATE RECORDED
Land Claim Reclamation Project			Geo-Analysis & Associates		94/10/08
STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO. 6A	LAB NO.

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT		DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
					0.059	72	0.005	12
					0.043	66	0.003	9
					0.031	62	0.002	5
					0.022	56	0.001	2
					0.017	40		
					0.013	31		
					0.009	21		
		0.063	100		0.007	16		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

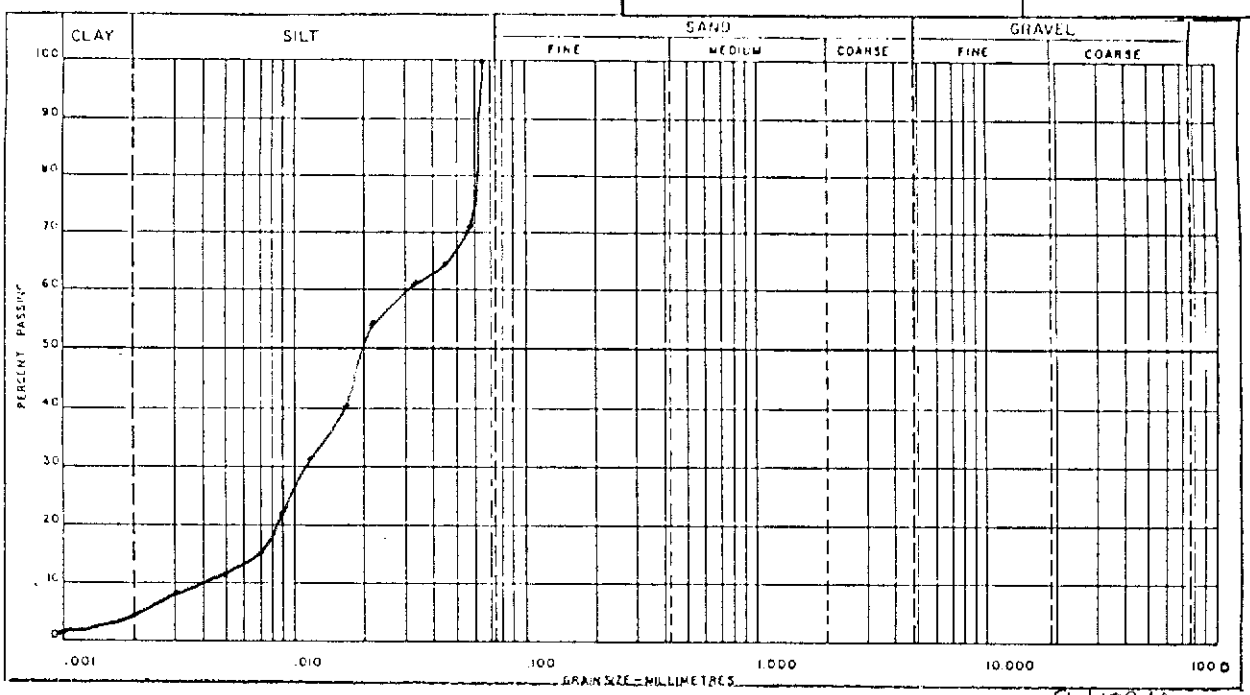
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Fine portion of the Sieve	
is Sandy Gravel, trace of	Moisture 7.7%
Silt, GW	
Silt, ML	
Insitu Condition	
Medium Dense to	
Dense.	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - West / Slope 3° / Trench

Bottom / Width - 4.0m

DATE SAMPLED 94/09/01

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Nucleus Property	N/A a	0-30 cm		A2	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				.054	98	0.005	20
				0.041	88	0.003	16
				0.029	80	0.002	13
				0.022	66	0.001	12
				0.016	52		
				0.012	43		
				0.009	34		
	0.080	100		0.007	26		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

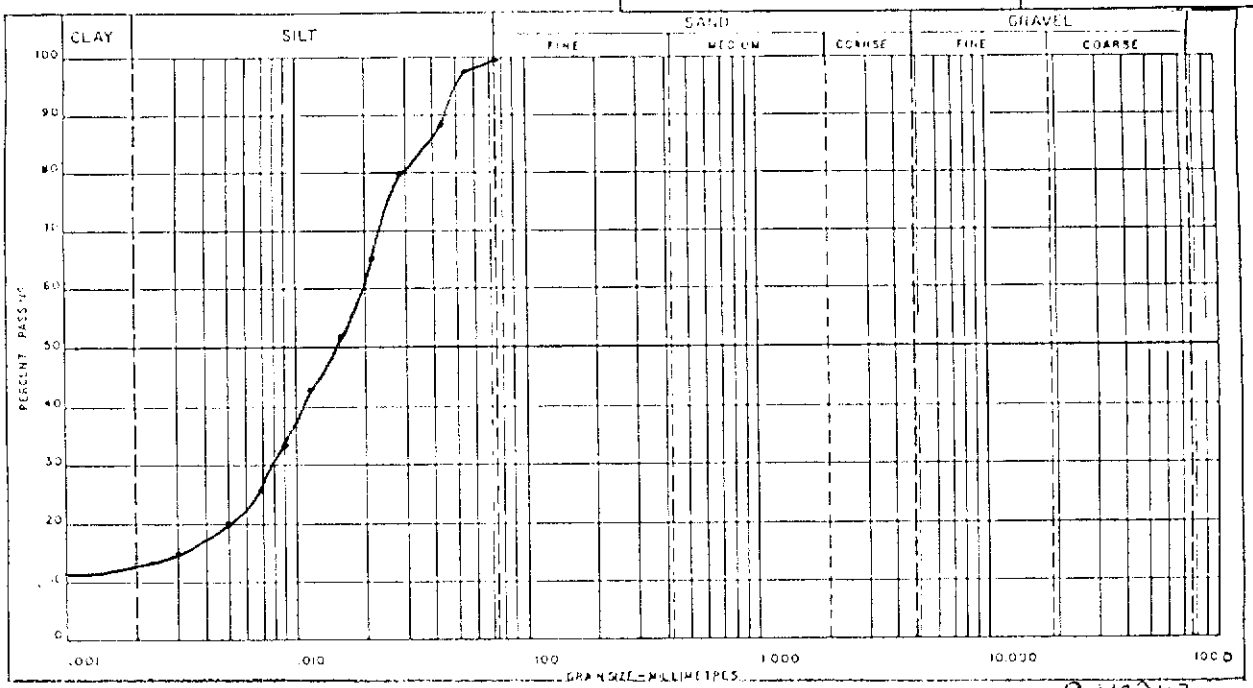
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Fine portion of the Sand is Silty Gravelly Sand, SM	Moisture 9.1%
Silt, some clay ML-CL	
In-situ Condition Very Soft c = less than 0.125 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East - North Wall
Slope - 36° / Height 39m

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT			CLIENT		DATE RECORDED
Land Claim Reclamation Project			Geo-Analysis & Associates		9-1/10/09
STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Nuclear Property		0-30cm		1B	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.059	76	0.005	5
				0.043	67	0.003	2
				0.031	59		
				0.023	56		
				0.017	37		
				0.013	24		
		0.080	100	0.009	15		
		0.063	80	0.006	10		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

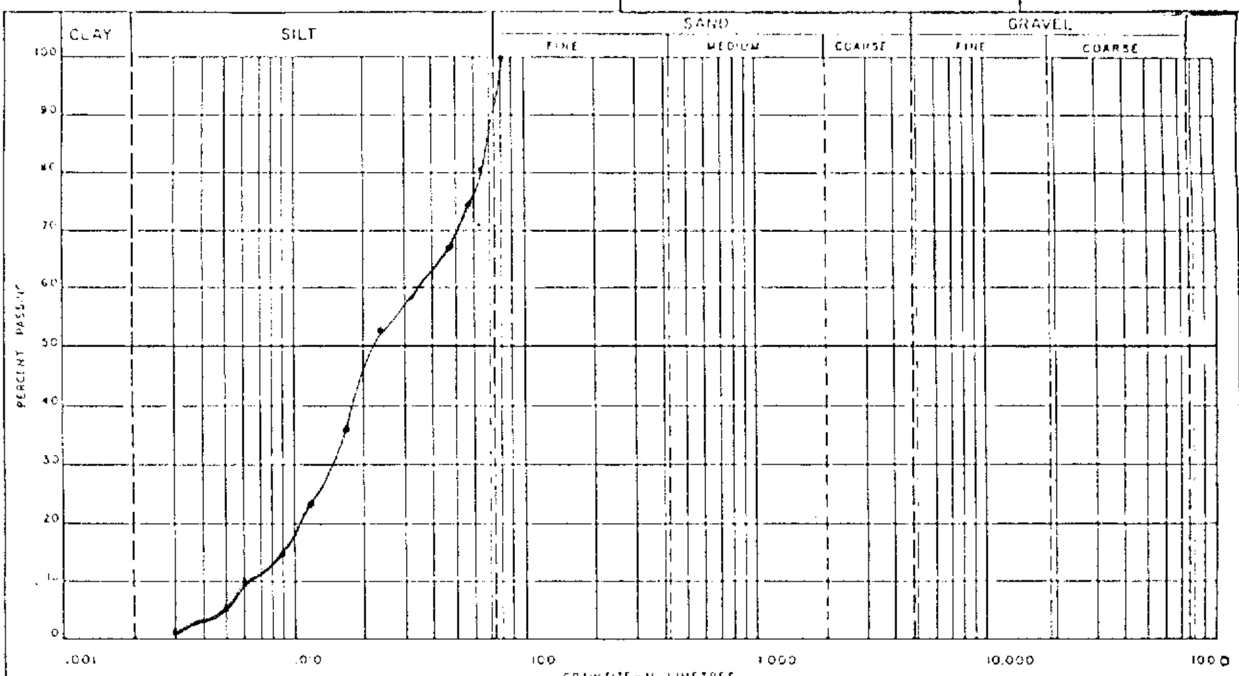
CRUSH COUNT ________ %

PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
fine portion of sieve is	
Gravelly Sand some silt	Moisture : [illegible]
SW-SM	
Silt ML	
Insitu Condition	
Loose ie. Volume of	
[illegible] can be reduced	by vibration

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	



LABORATORY'S REMARKS ________
Aspect - East / North Wall
Slope 40° Height 1.6m

DATE SAMPLED 94/09/13
DATE RECEIVED 9-4/09/18
TECHNICIAN(S) MK
CHECKED BY ________

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	9-1/10/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Nadeau Property	N1Aa	0-20cm		A1	

N1Ab - trench bottom

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.077	94	0.004	24
				0.055	86	0.003	20
				0.040	80	0.003	16
				0.029	75	0.002	12
				0.022	62	0.001	12
				0.016	53		
				0.012	41		
		0.080	100	0.009	35		

SAMPLE NO	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

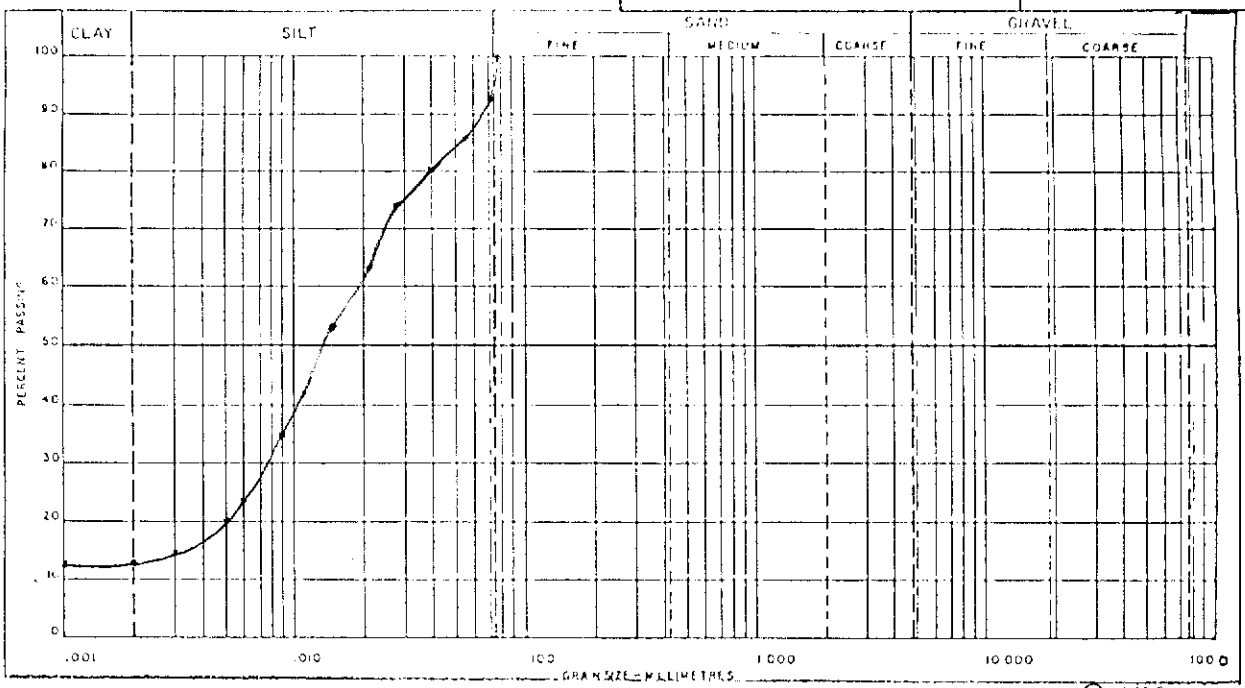
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, some clay, ML-CL	
	Moisture: 11.3%
In-situ condition	
Medium stiff or firm	
c = 0.25 - 0.5 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aged - East
- Trench Bottom / Width 3.4m

DATE SAMPLED 9-1/09/13

DATE RECEIVED 9-1/09/18

TECHNICIAN(S) MK

CHECKED BY

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N1Ba Depth: 0-30 cm
Location: Nucleus Property
Aspect - East / North Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: Date: 1994/10/05

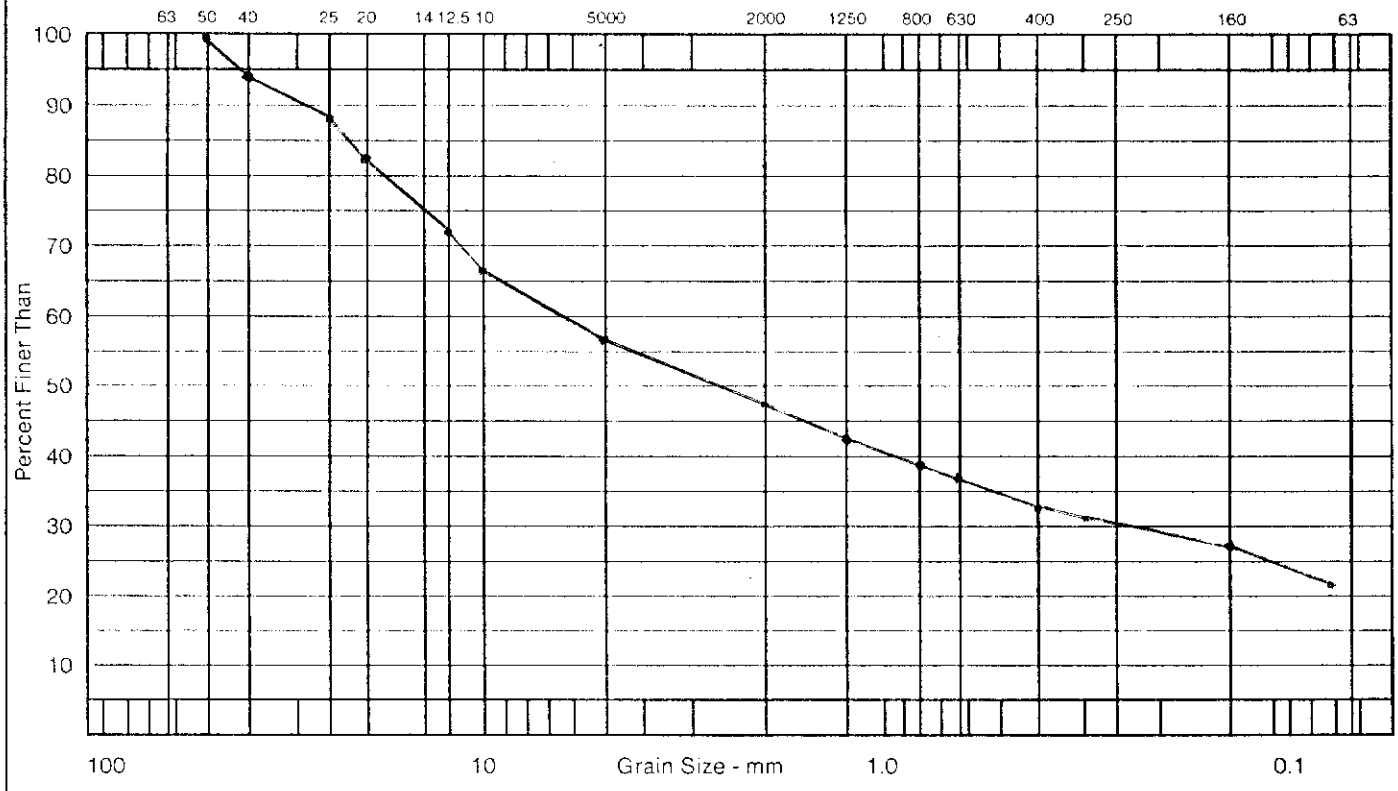
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					93.9
25,000	25.0					88.0
20,000	20.0					82.5
12,500	12.5					72.1
10,000	10.0					66.8
5,000	5.0					56.9
2,000	2.0					47.6
1,250	1.25					42.8
800	0.800					38.9
630	0.630					36.9
400	0.400					33.1
315	0.315					31.0
160	0.160					27.3
80	0.080					21.6

Description of Sample
Silty Sandy Gravel, GM
Subangular and Subrounded shapes
Shattered and weathered bedrock

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks
Moisture: 6.4 %
Gravel: 43.1 %
Sand: 35.3 %
Silt: 21.6 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO	FIELD NO.	LAB NO
Nucleus Property	M1BB	0 - 20cm		P1	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.055	96	0.005	19
				0.040	90	0.003	13
				0.029	86	0.002	9
				0.021	78	0.001	8
				0.015	68		
				0.012	56		
		0.063	100.0	0.009	40		
		0.063	100.0	0.006	29		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

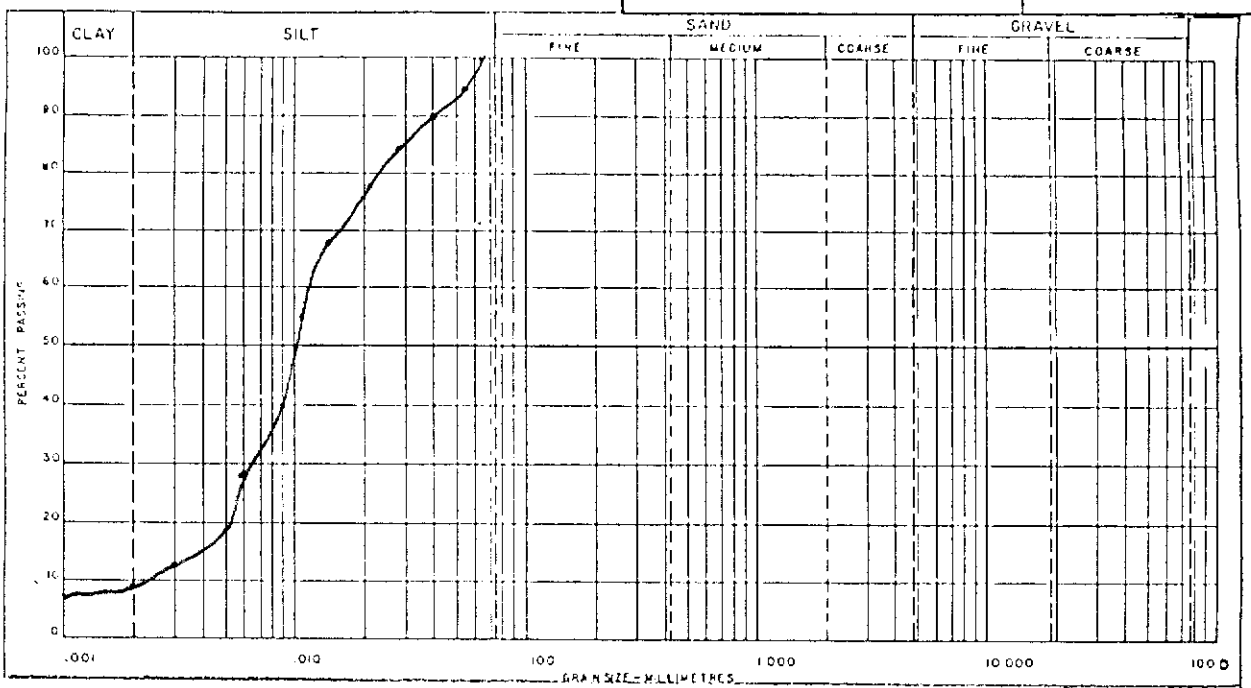
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of Clay, ML	
	Moisture 19.1%
Insitu Condition	
Very Soft ie: less than	
0.125 tons per	
ft2	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East

Trench Bottom / Width 2.3m

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: W1Bc Depth: 0-30cm
Location: Nucleus Property
Aspect - East / South Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: Date: 1994/10/05

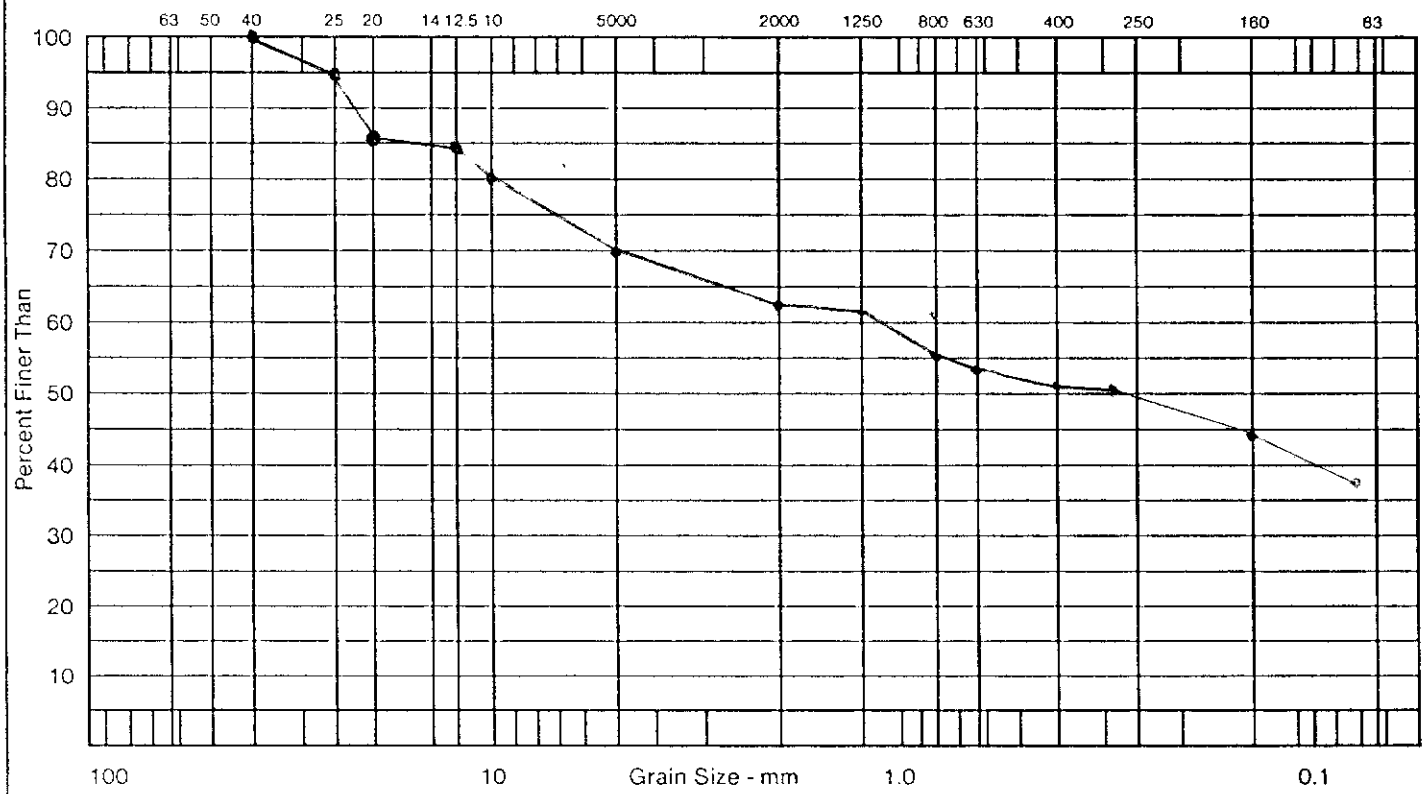
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					94.9
20,000	20.0					86.2
12,500	12.5					84.2
10,000	10.0					79.8
5,000	5.0					69.8
2,000	2.0					62.0
1,250	1.25					58.4
800	0.800					55.6
630	0.630					54.1
400	0.400					51.1
315	0.315					49.1
160	0.160					44.4
80	0.080					36.6

Description of Sample
Gravelly Sandy Silt, SM-ML
Subangular and Subrounded shapes
Shattered and weathered bedrock

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks
Moisture: 7.6%
Gravel: 30.2%
Sand: 33.2%
Silt: 36.6%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N2a Depth: 0-30cm
Location: Nucleus Property
Aspect - East / North Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/06

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					92.7
20,000	20.0					90.8
12,500	12.5					79.6
10,000	10.0					72.9
5,000	5.0					64.7
2,000	2.0					57.9
1,250	1.25					54.0
800	0.800					51.1
630	0.630					49.5
400	0.400					46.8
315	0.315					44.8
160	0.160					38.0
80	0.080					30.3

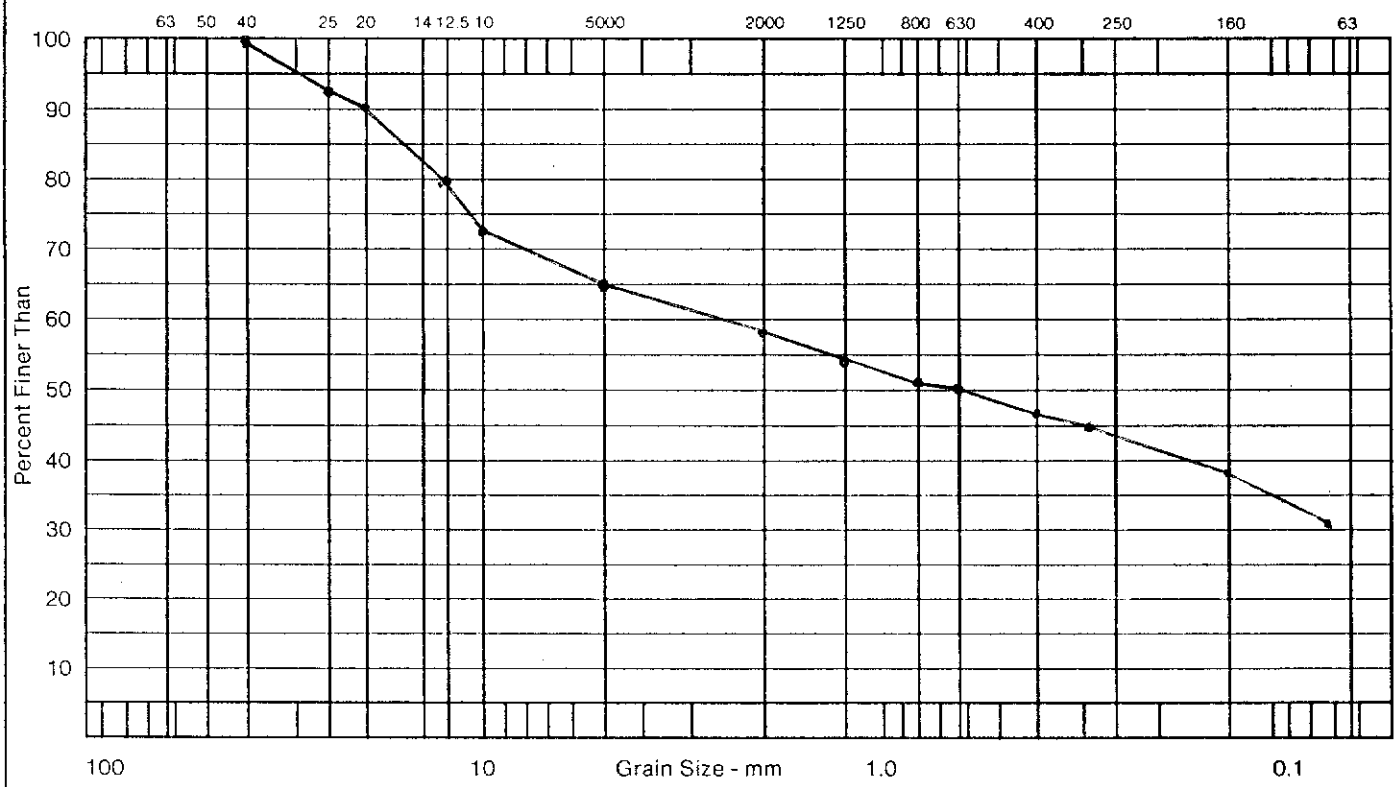
Description of Sample
Silty Sandy Gravel, GM
Subangular and Subrounded Shapes
Shattered and Weathered Bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 9.6
Gravel: 35.3
Sand: 34.4
Silt: 30.3



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N26 Depth: 0-30cm
Location: Nadeau Property
Aspect - East / Trench Bottom

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/06

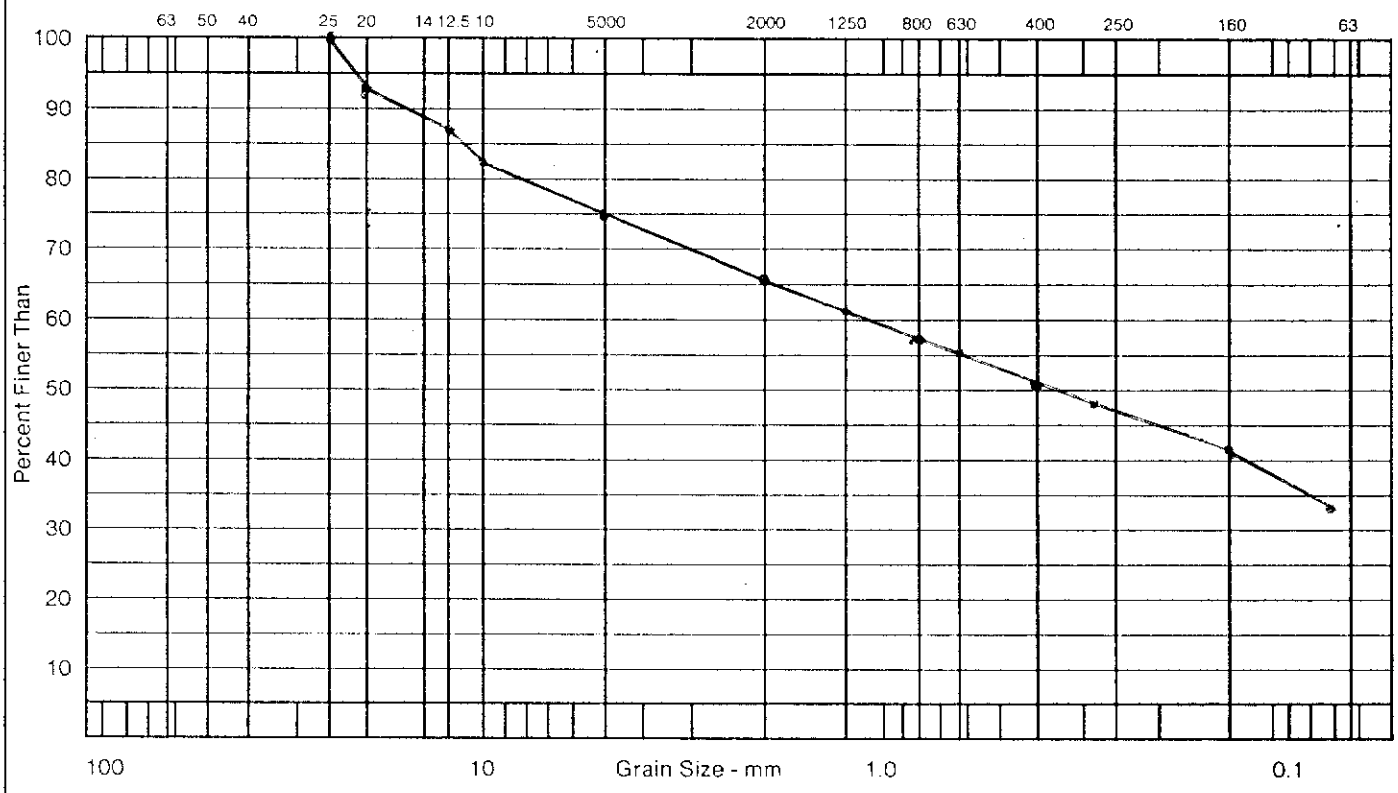
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					93.8
12,500	12.5					86.9
10,000	10.0					82.4
5,000	5.0					74.5
2,000	2.0					65.7
1,250	1.25					61.2
800	0.800					57.3
630	0.630					55.2
400	0.400					51.3
315	0.315					48.7
160	0.160					41.8
80	0.080					38.7

Description of Sample
Gravelly Silty Sand, SM
Subangular and Subrounded shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 12.7 %
Gravel: 25.5 %
Sand: 40.8 %
Silt: 33.7 %



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CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/04

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Nodwell Property	N2c	0-20cm		3	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT		DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
					0.055	96	0.005	25
					0.040	90	0.003	16
					0.029	84	0.002	15
					0.021	77	0.001	14
					0.011	66		
					0.012	54		
		0.080	100		0.009	44		
		0.063	100		0.006	33		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

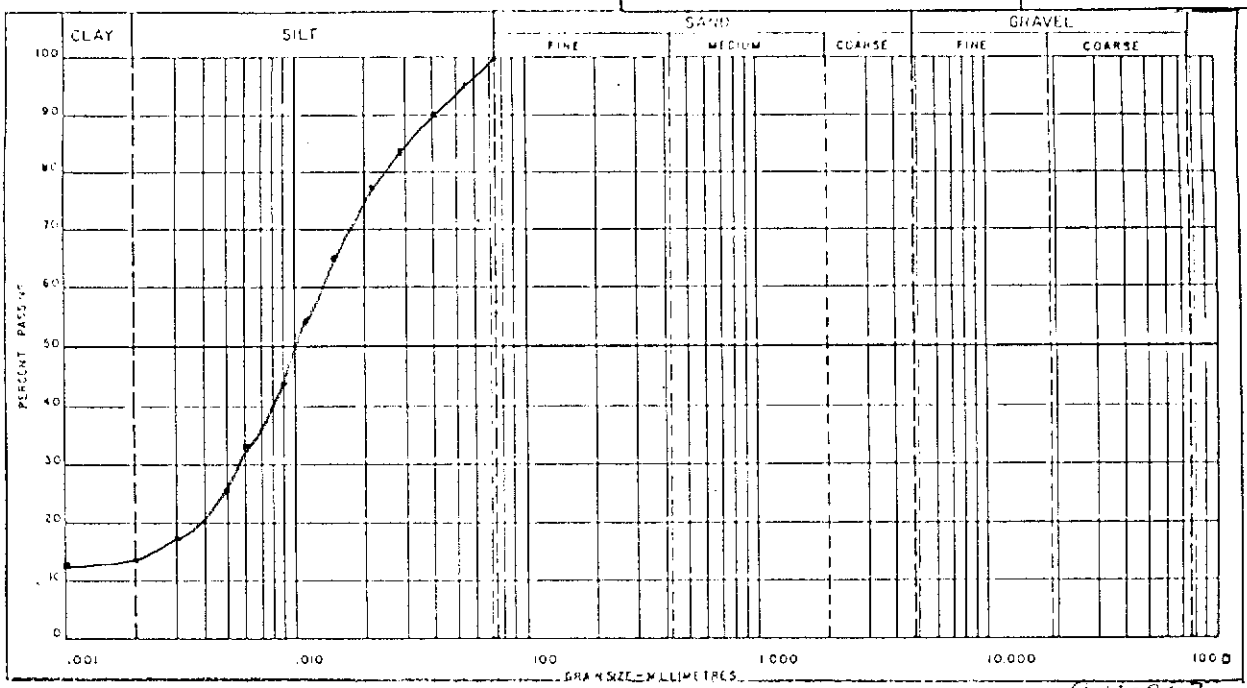
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, Some Clay ML-CL	
	Moisture: w 5%
Tensile Condition	
Medium Stiff as From	
cf: 0.25 - 0.5 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East

- Trench Bottom / Width 0.8m

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N4Ab Depth: 0-30cm

Location: Nucleus Property
Aspect - East / Trench Bottom

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/07

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					100.0
50,000	50.0					82.4
40,000	40.0					65.2
25,000	25.0					65.2
20,000	20.0					63.0
12,500	12.5					53.2
10,000	10.0					45.7
5,000	5.0					35.8
2,000	2.0					28.3
1,250	1.25					24.4
800	0.800					21.6
630	0.630					20.0
400	0.400					17.1
315	0.315					15.3
160	0.160					10.8
80	0.080					7.1

Description of Sample

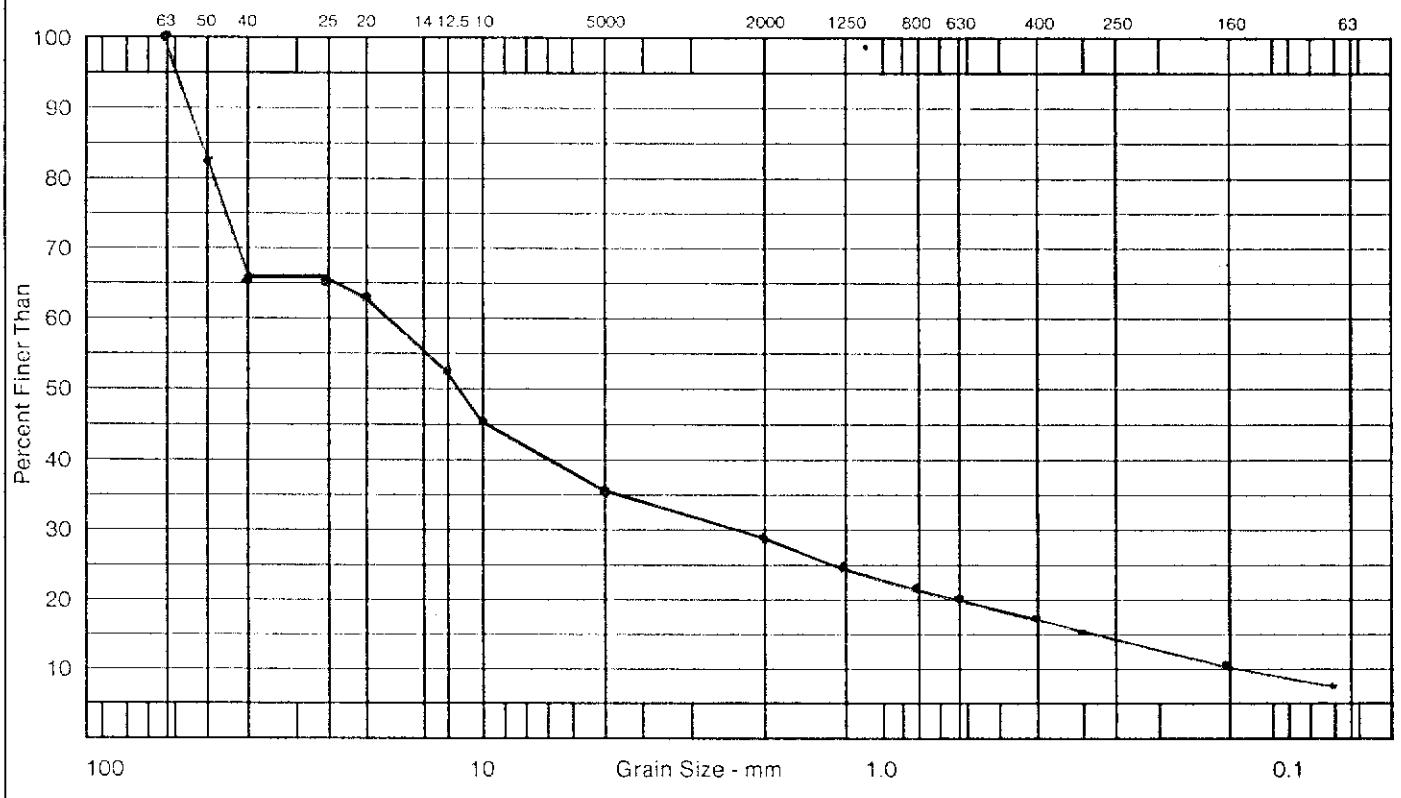
Sandy Gravel, trace of silt, GW
Subangular and subrounded stones
Shattered, weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 6.7 %
Gravel: 64.2 %
Sand: 28.7 %
Silt: 7.1 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: N4Ac Depth: 0-30cm
Location: Nucleus Property
Aspect - East / South Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/07

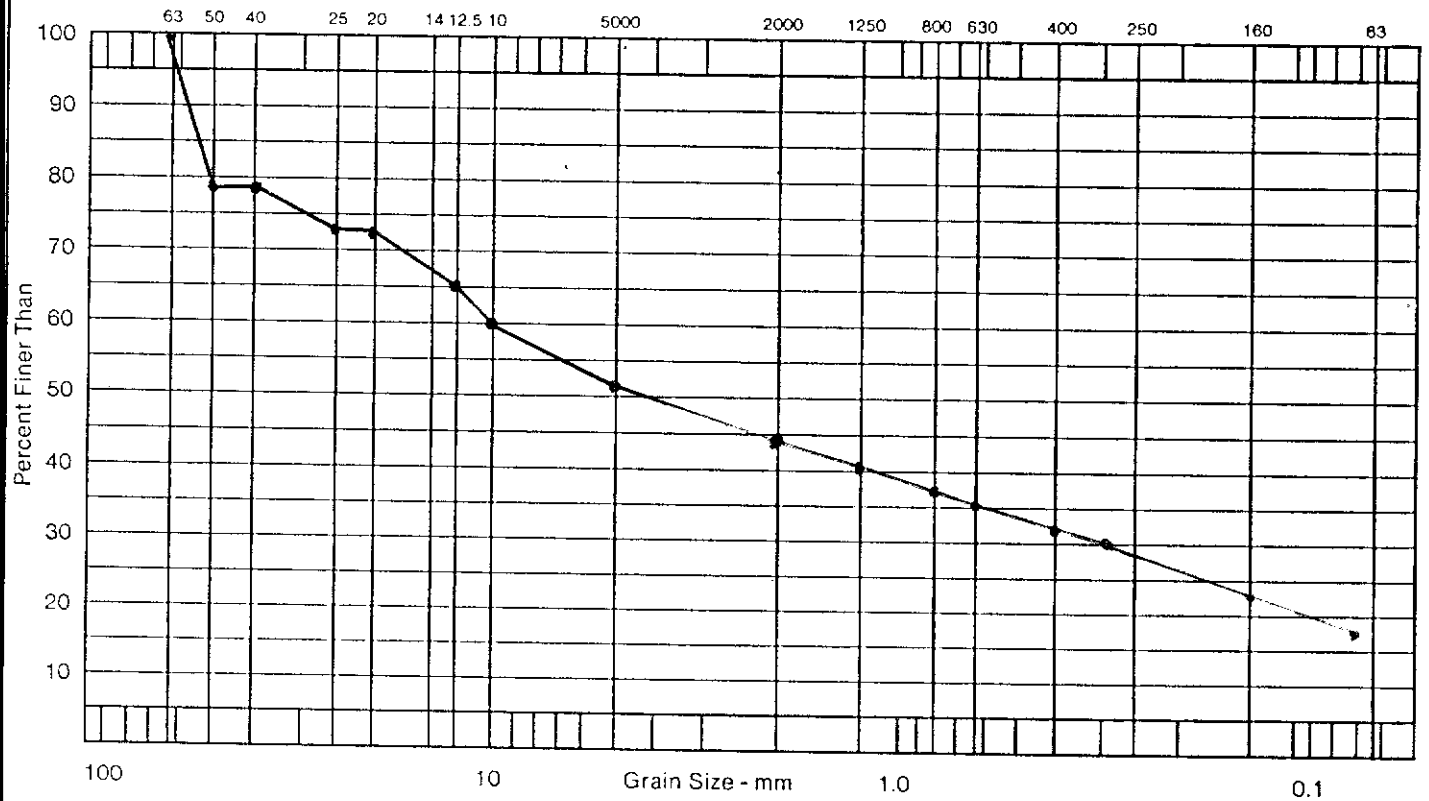
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					100.0
50,000	50.0					78.4
40,000	40.0					78.4
25,000	25.0					73.0
20,000	20.0					73.0
12,500	12.5					65.0
10,000	10.0					59.8
5,000	5.0					51.4
2,000	2.0					44.5
1,250	1.25					40.3
800	0.800					39.0
630	0.630					35.2
400	0.400					31.8
315	0.315					29.5
160	0.160					23.4
80	0.080					17.2

Description of Sample
Silty Sandy Gravel, GM
Subangular and Subrounded Shapes
Shattered, weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 9.9 %
Gravel: 48.6 %
Sand: 34.2 %
Silt: 17.2 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 1B Depth: 0-30cm

Location: Nucleus Property
Aspect - East / North Wall

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					96.2
20,000	20.0					90.0
12,500	12.5					75.0
10,000	10.0					69.7
5,000	5.0					58.2
2,000	2.0					47.9
1,250	1.25					42.1
800	0.800					37.4
630	0.630					34.7
400	0.400					29.6
315	0.315					26.4
160	0.160					19.6
80	0.080					14.2

Description of Sample

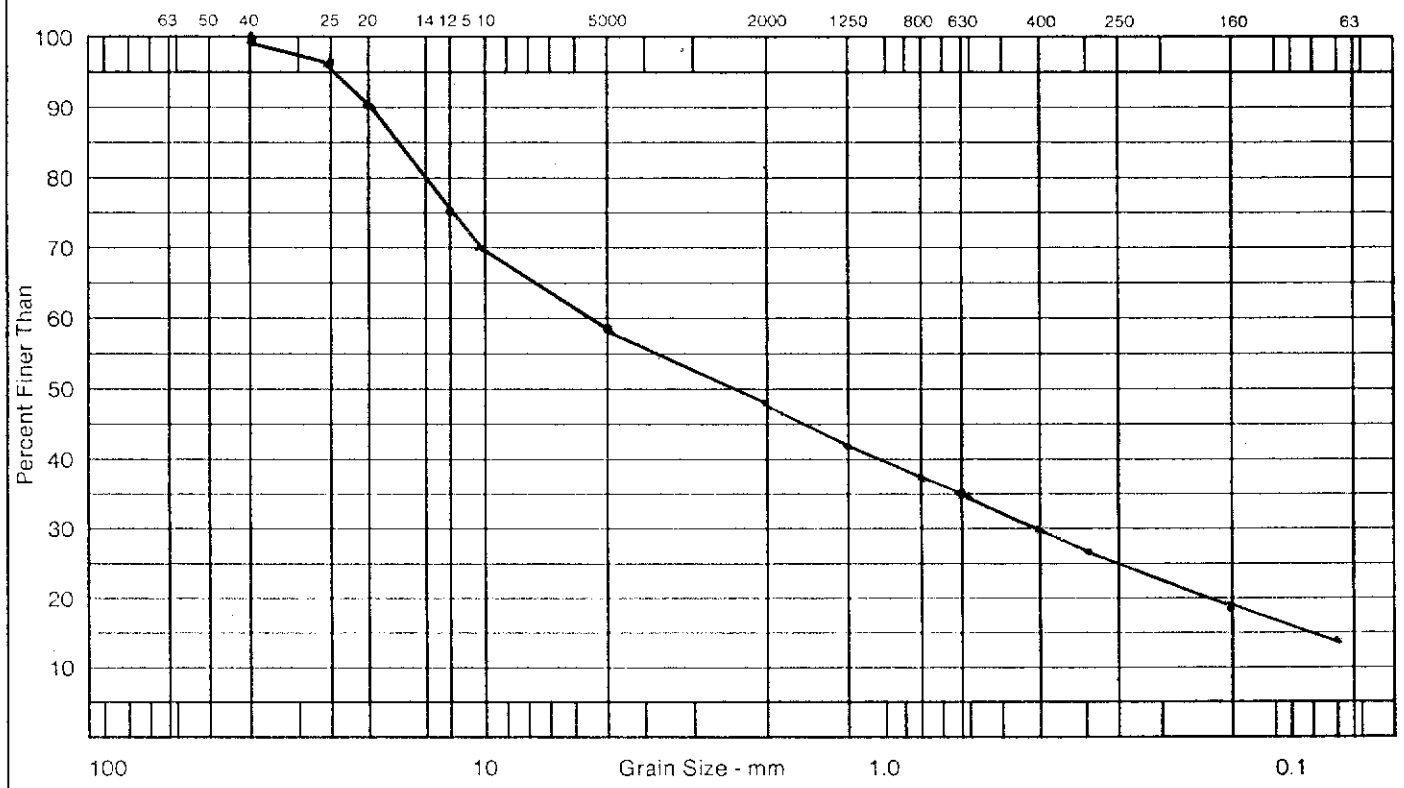
Gravelly Sand, some SILT, SW-SM
Subangular and Subrounded Shapes
Shattered and weathered bedrock

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks

Moisture: 8.4 %
Gravel: 41.8 %
Sand: 44.0 %
Silt: 14.2 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT		CLIENT		DATE RECORDED
Land Claim Reclamation Project		Geo-Analysis & Associates		94/10/04
STA.	SAMPLE TYPE / DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Nucleus Property	15-20 cm		2B	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.057	80	0.005	17
				0.042	70	0.003	15
				0.030	66	0.002	14
				0.022	62	0.001	7
				0.016	58		
				0.012	49		
		0.080	100	0.009	36		
		0.062	99	0.006	24		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

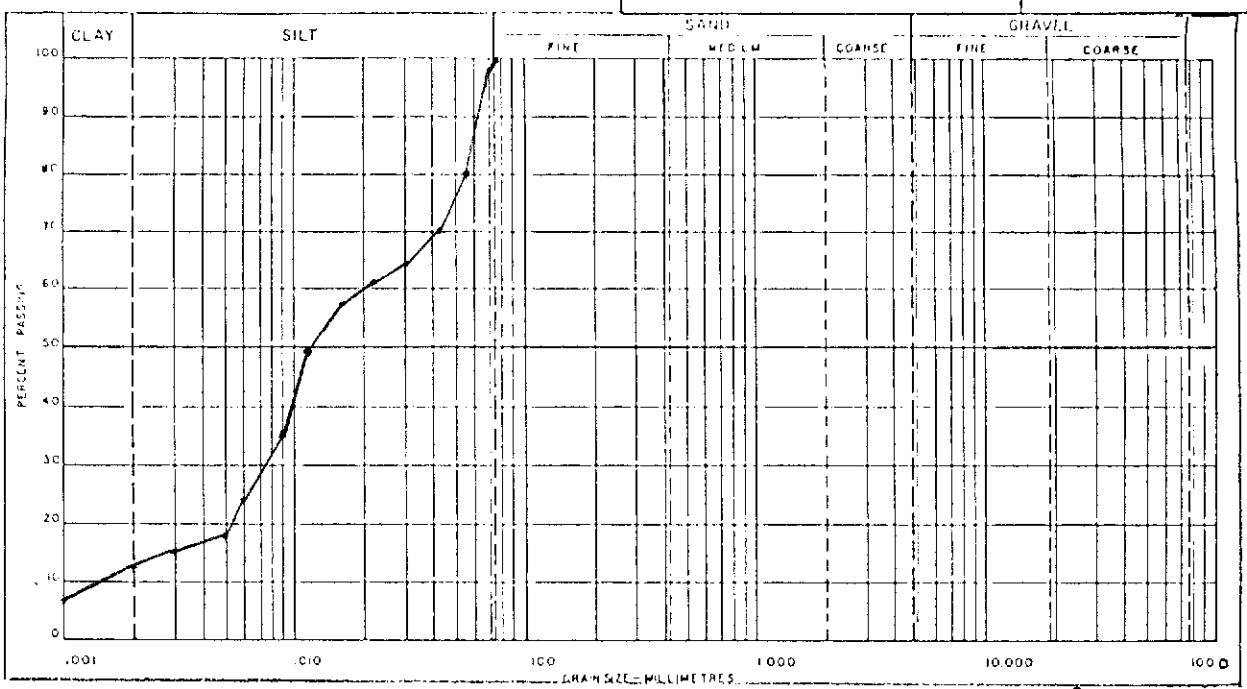
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, some clay - ML-CL	
	Moisture: 21.2%
Fluvial deposition	
Medium stiff or firm	
c = 0.25 - 0.5 tons/ft²	
.125 ÷ 25	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East - Upper belly

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/09/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Reserve Property		15-20cm		RIA1	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.058	82	0.005	20
				0.042	78	0.003	16
				0.030	74	0.002	12
				0.020	64	0.001	12
				0.014	56		
				0.012	41		
		0.063	100	0.009	31		
		0.063	100	0.007	24		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

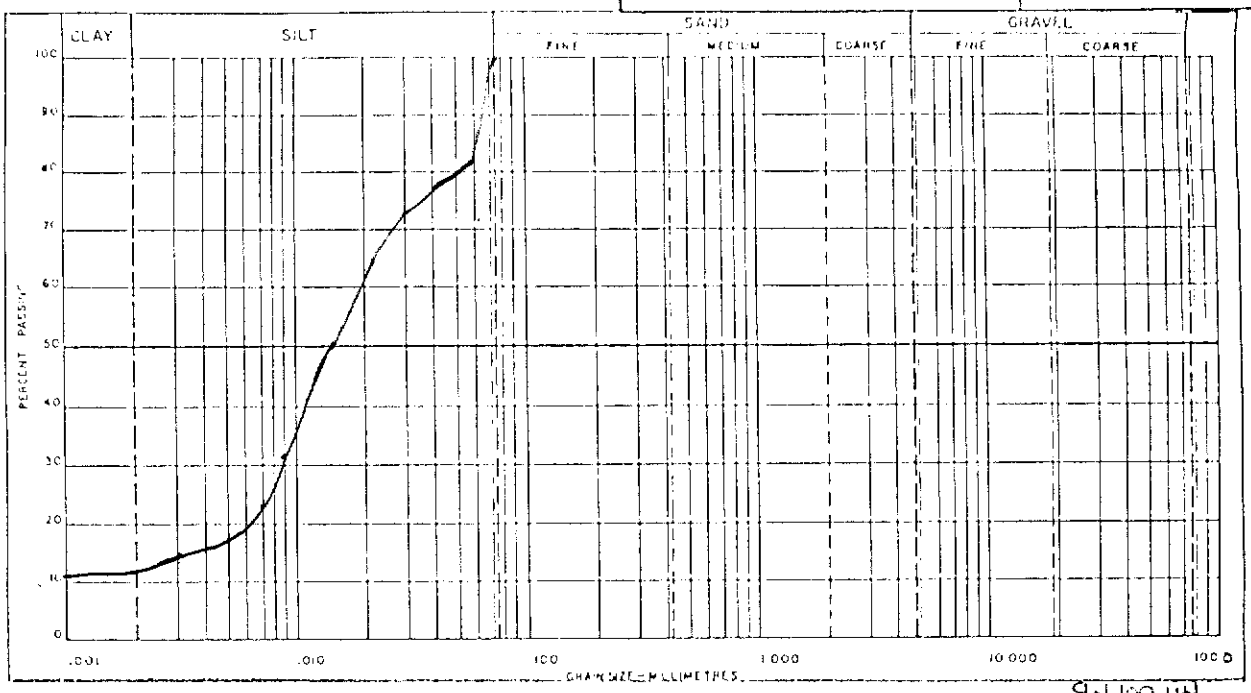
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, some Clay - ML-CL	
	Moisture 19.0%
Tools Location	
Soft c=0.125-0.25 tsf	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East - Trench Bottom
Slope - 3° Width 1.7m

DATE SAMPLED 94/09/14

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RIAZ Depth: 0-30cm
Location: Revenue Property
Aspect - East / North Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/06

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					85.9
25,000	25.0					76.9
20,000	20.0					72.6
12,500	12.5					66.4
10,000	10.0					62.6
5,000	5.0					51.8
2,000	2.0					40.0
1,250	1.25					33.6
800	0.800					29.1
630	0.630					27.1
400	0.400					23.4
315	0.315					21.5
160	0.160					17.6
80	0.080					13.9

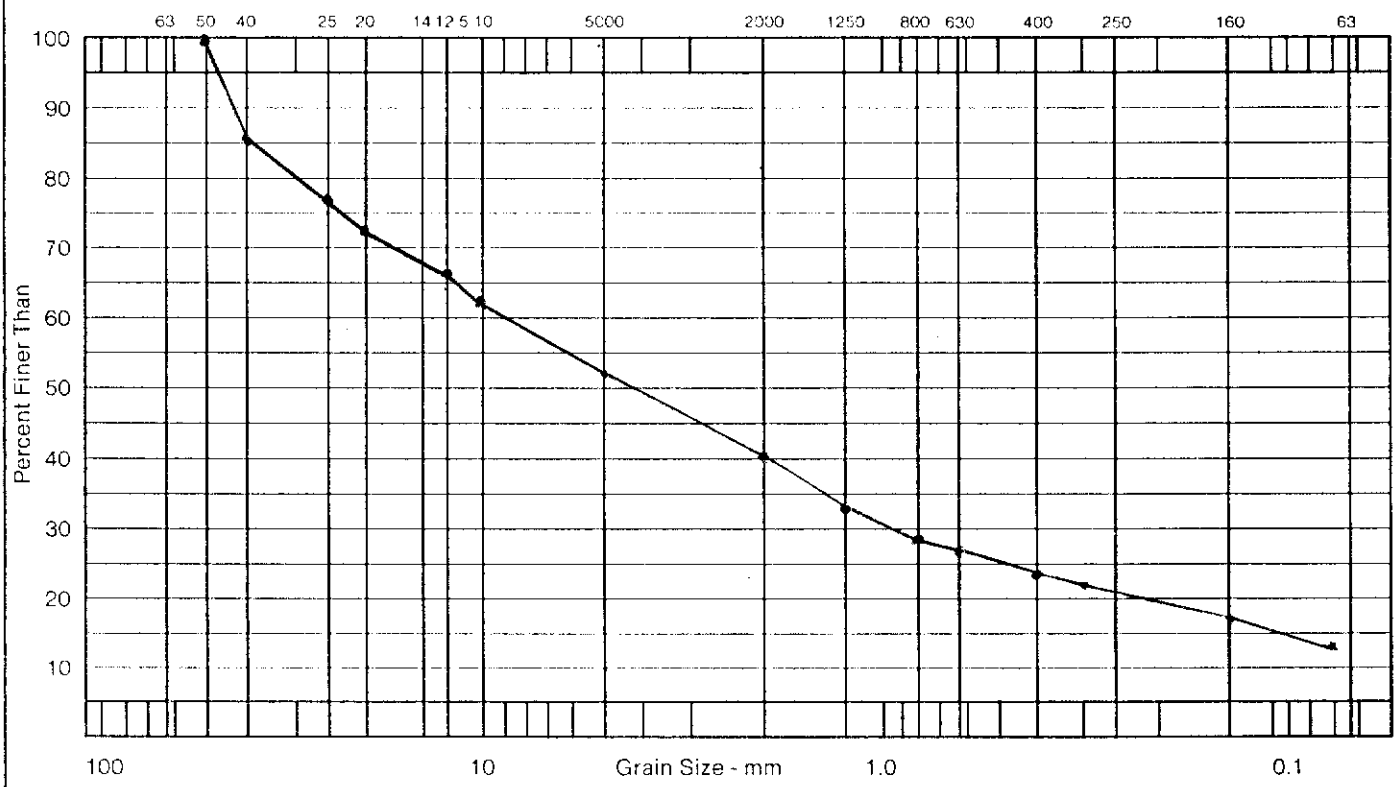
Description of Sample: Sandy Gravel, some silt, trace Angular and Subrounded Stones

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 6.9 %
Gravel: 48.2 %
Sand: 37.9 %
Silt: 13.9 %



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CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RIA3 Depth: 0-30 cm
Location: Revenue Property
Aspect East / South Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/06

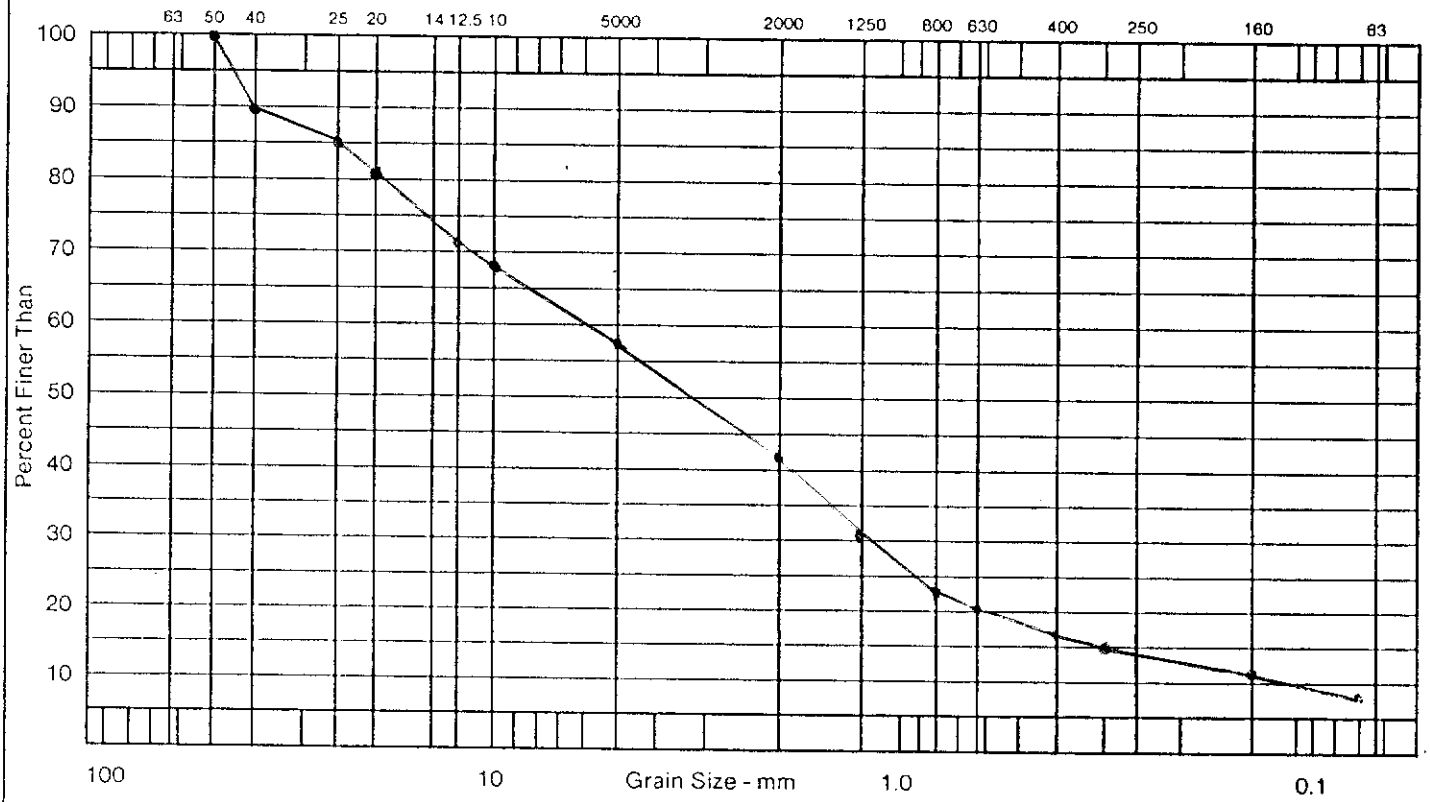
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					89.5
25,000	25.0					86.4
20,000	20.0					80.8
12,500	12.5					71.3
10,000	10.0					68.3
5,000	5.0					57.2
2,000	2.0					41.0
1,250	1.25					30.1
800	0.800					23.1
630	0.630					20.4
400	0.400					16.4
315	0.315					14.6
160	0.160					11.3
80	0.080					8.8

Description of Sample
Gravelly Sand, trace of silt, SW
Subangular and Subrounded Shapes
Shattered, weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 7.0 %
Gravel: 42.5 %
Sand: 48.7 %
Silt: 8.8 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: R2B1 Depth: 0-30cm
Location: Revenue Property
Aspect - West / South Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: Date: 1994/10/07

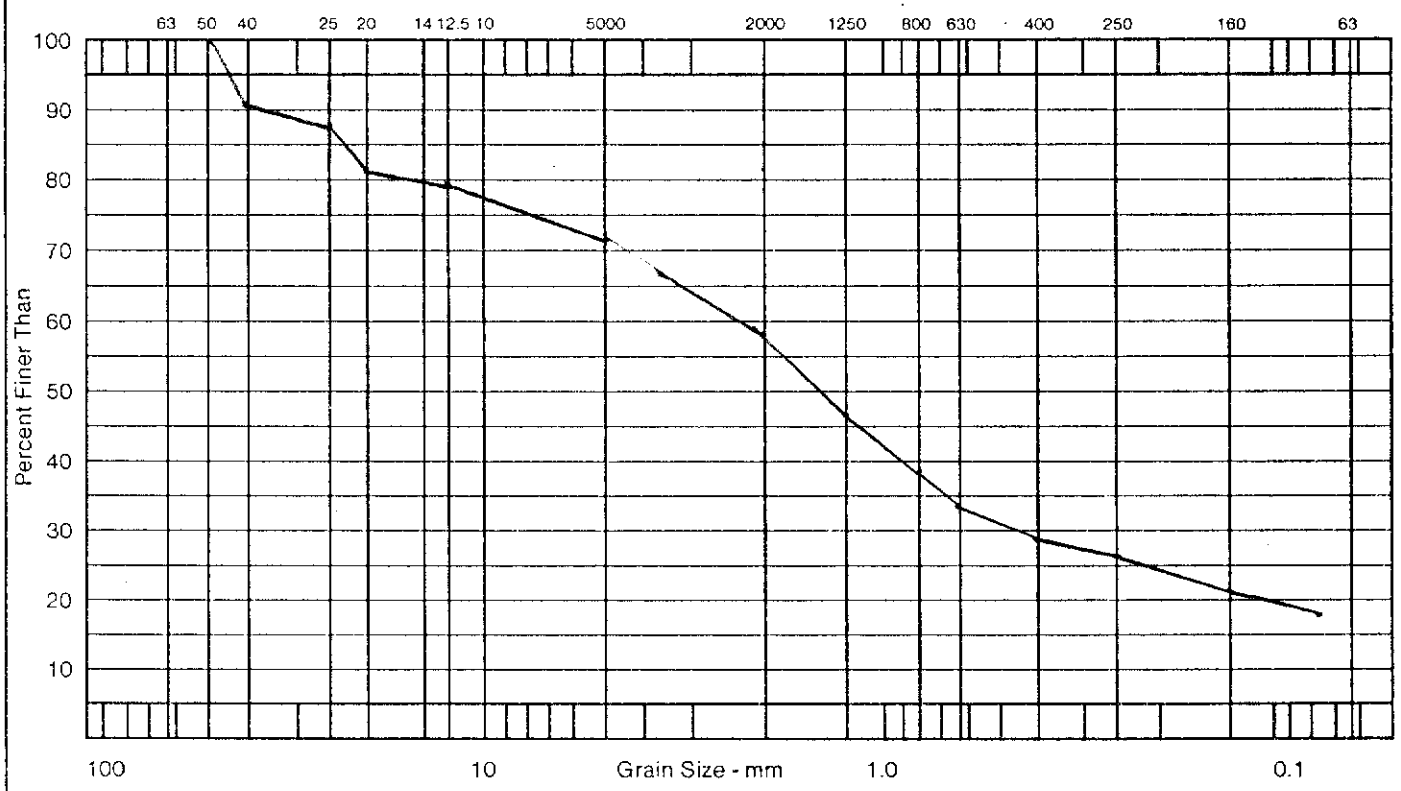
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					90.9
20,000	20.0					87.6
12,500	12.5					82.6
10,000	10.0					79.6
5,000	5.0					71.8
2,000	2.0					58.0
1,250	1.25					46.6
800	0.800					38.0
630	0.630					34.3
400	0.400					28.6
315	0.315					26.0
160	0.160					21.4
80	0.080					17.2

Description of Sample
Silty Gravelly Sand, SM
Shattered and weathered bedrock

Time of Sieving ____ Min. 15

Method of Preparation ____ Dry ____ Washed X

Remarks
Moisture: 6.2 %
Gravel: 28.2 %
Sand: 54.6 %
Silt: 17.2 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RBB2 Depth: 0-30cm
Location: Revenue Property
Aspect-West / South Trench Bottom Wall

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/05

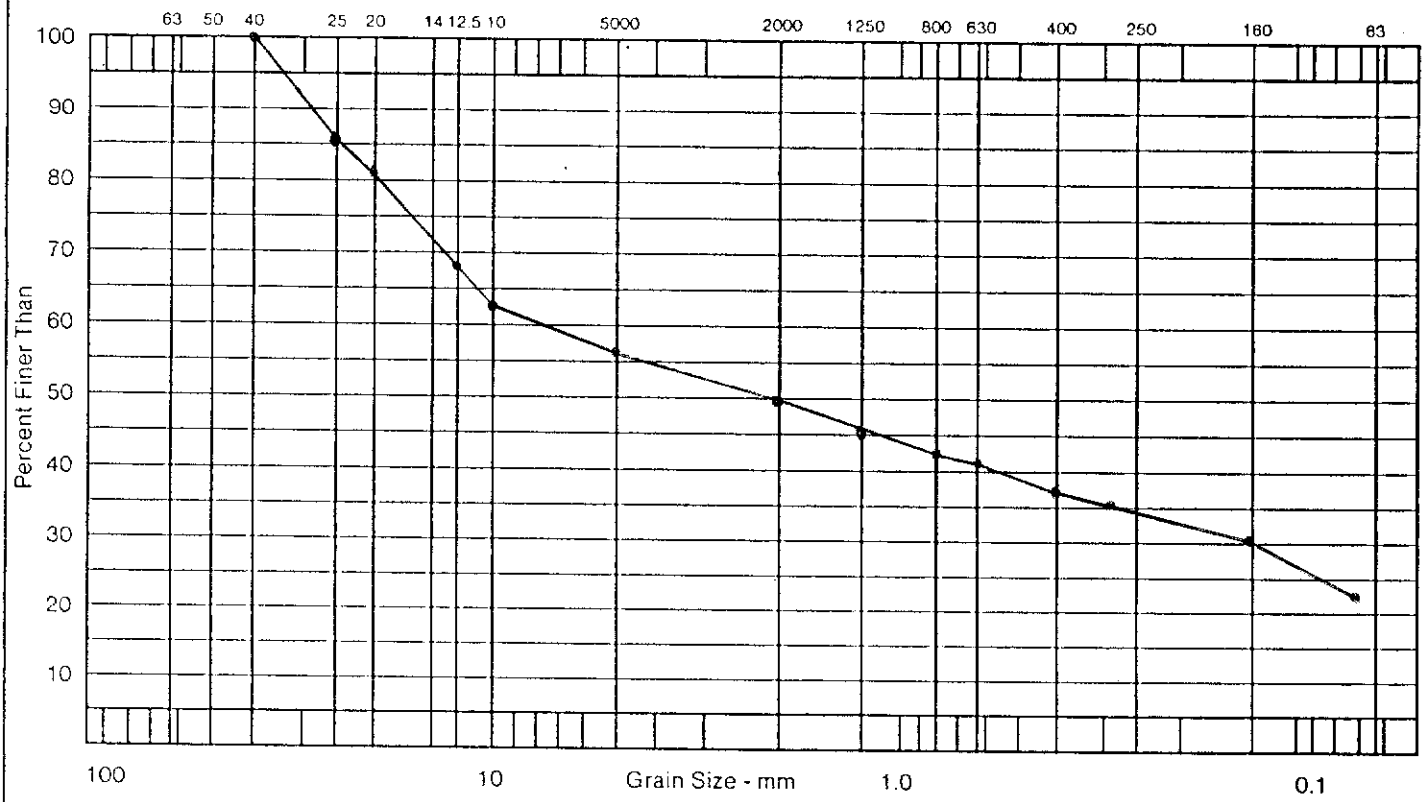
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					86.6
20,000	20.0					81.2
12,500	12.5					68.3
10,000	10.0					63.0
5,000	5.0					56.1
2,000	2.0					49.5
1,250	1.25					45.8
800	0.800					42.8
630	0.630					41.3
400	0.400					38.0
315	0.315					35.6
160	0.160					30.1
80	0.080					22.4

Description of Sample
Silty Sandy Gravel, GM
Subangular and Subrounded Shapes
Shattered, weathered bedrock

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 9.8 %
Gravel: 43.9 %
Sand: 33.7 %
Silt: 22.4 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/19

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Reuse Property		0-20cm		R2A2	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.044	54	0.003	8
				0.0315	50	0.002	5
				0.023	46	0.001	3
				0.016	40		
				0.012	30		
				0.009	22		
		10.000	100	0.006	17		
		0.063	96	0.005	11		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	PL	PI	NATURAL % H2O	SG

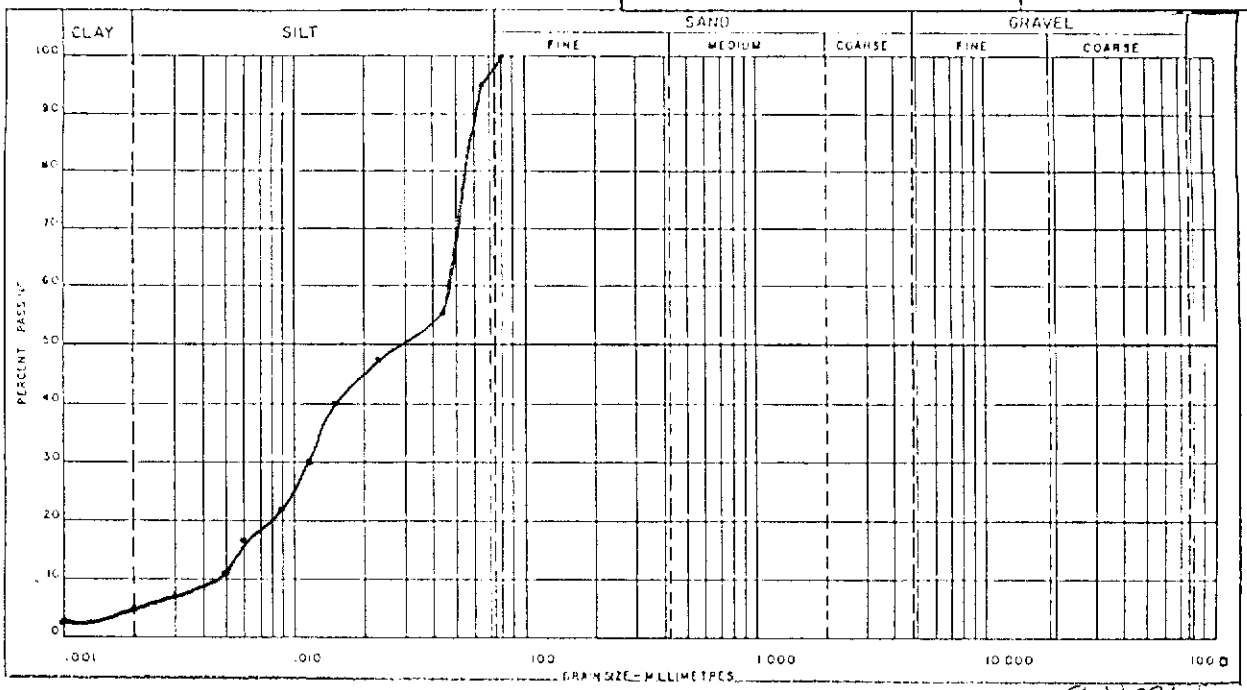
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt ML	
	Number I 48.1%
Loose condition	
Soft c = 0.125 - 0.25 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Impact - West
Slope 27° South Wall
Height 52m

DATE SAMPLED 94/09/18

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/09/18

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Source Property		0-30cm		R2A1	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.058	76	0.004	12
				0.042	70	0.003	9
				0.030	64	0.002	6
				0.022	58	0.001	5
				0.016	46		
				0.012	36		
		0.650	100	0.008	26		
		Total	89	0.006	18		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

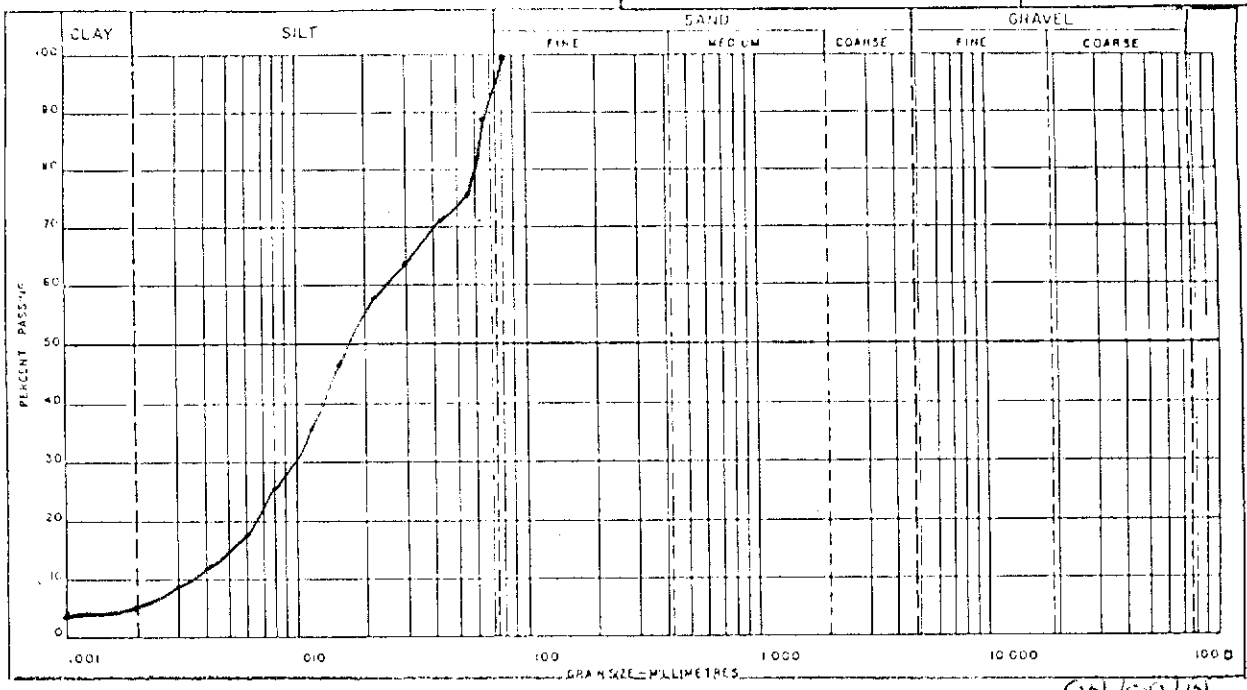
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, Trace of Clay, ML	
	Plastic: 61.7%
Iron to Lead Iron	
Soft c: 0.125-0.25 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Impact - West
Inch Bottom / Width - 50m

DATE SAMPLED 94/09/14

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: R2E1 Depth:
Location: Revenue Property
Aspect - East / South East / Trench Bottom

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: Date: 1994/10/06

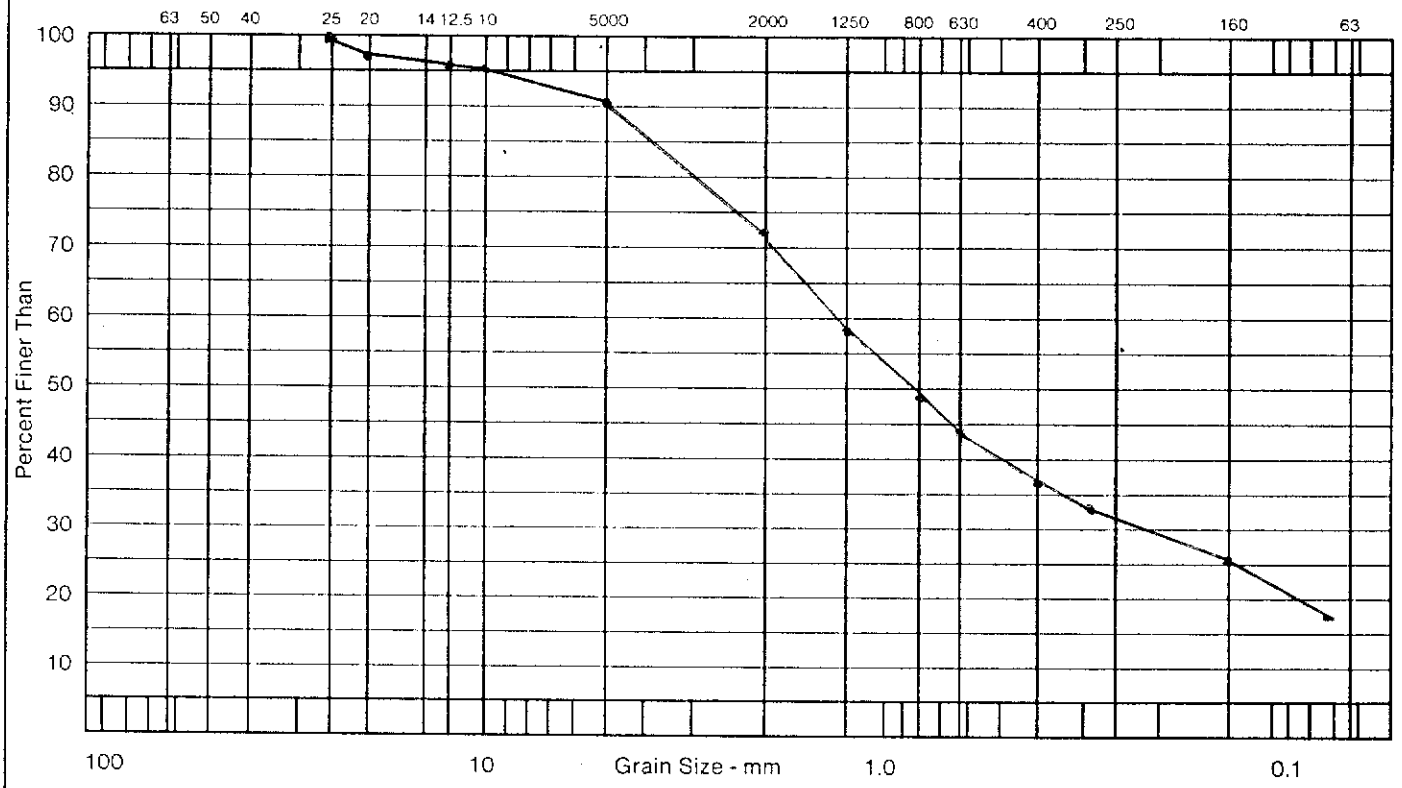
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					97.0
12,500	12.5					96.3
10,000	10.0					95.3
5,000	5.0					90.9
2,000	2.0					72.1
1,250	1.25					58.0
800	0.800					48.3
630	0.630					44.2
400	0.400					36.5
315	0.315					32.7
160	0.160					25.2
80	0.080					17.0

Description of Sample
Silty Sand, trace of gravel, SM
Subangular and Rounded Shapes

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks
Moisture: 15.8 %
Gravel: 9.1 %
Sand: 73.9 %
Silt: 17.0 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Reserve Property		0-20cm		R2E2	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.055	88	0005	12
				0040	80	0008	8
				0029	70	0012	6
				0022	60	0014	4
				0017	34		
				0013	26		
				0009	18		
		0.061	100	0007	14		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	PL	PI	NATURAL % dry	SG

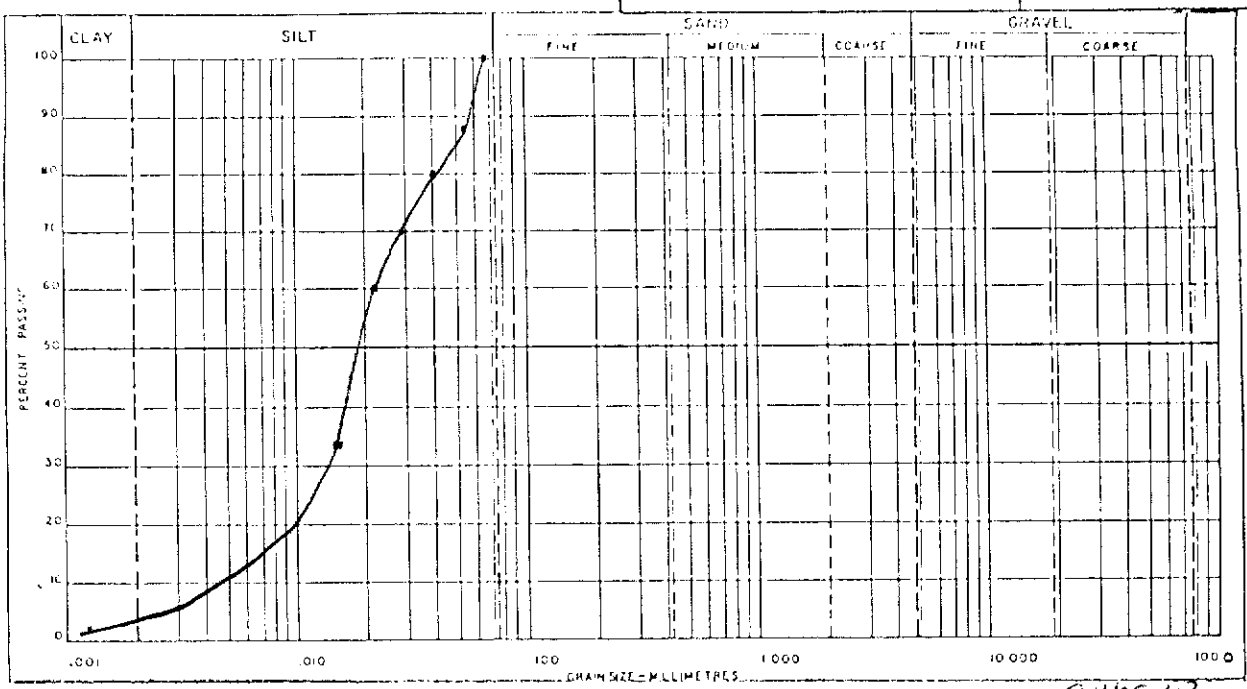
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, ML	Moisture = 4.6%
Frozen Condition	
Very Soft ≤ less than	
0.125 tons	
ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - East / South East

North Wall 18° easterly pitch

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/18

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	9-1/10/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Reserve Property		0-20cm		R3A	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.078	100	0.004	42
				0.039	94	0.003	37
				0.029	86	0.002	32
				0.021	78	0.001	28
				0.015	69		
				0.012	60		
		0.080	100	0.008	55		
		0.038	100	0.006	52		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

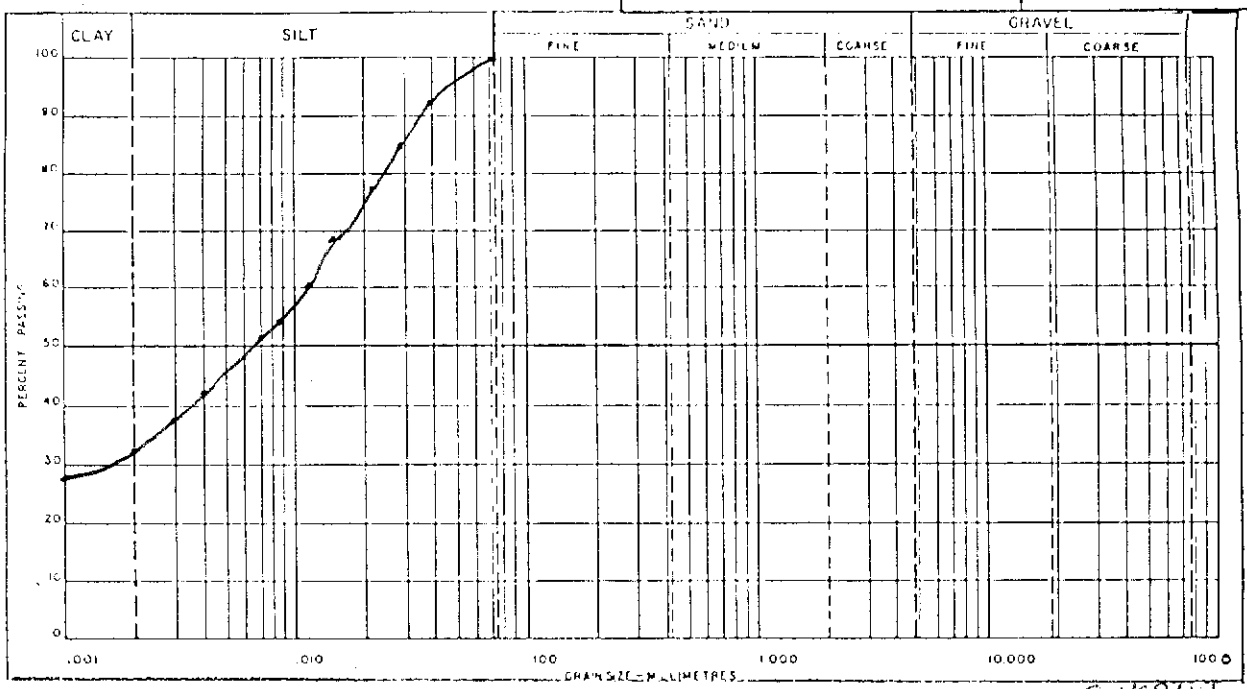
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Clayey Silt CL-ML	
	Moisture: 16.3%
In-situ condition	
Very Soft c: less than 0.125 tsf	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - North/North East

- Trench Bottom/Width: 50cm

DATE SAMPLED 9-1/09/14

DATE RECEIVED 9-1/09/15

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/09/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO	FIELD NO.	LAB NO
Reserve Property		0-20cm		R3B	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.045	72	0.002	14
				0.022	62	0.001	13
				0.016	54		
				0.012	44		
				0.006	36		
				0.004	24		
		0.850	100	0.004	19		
		0.063	93	0.003	14		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

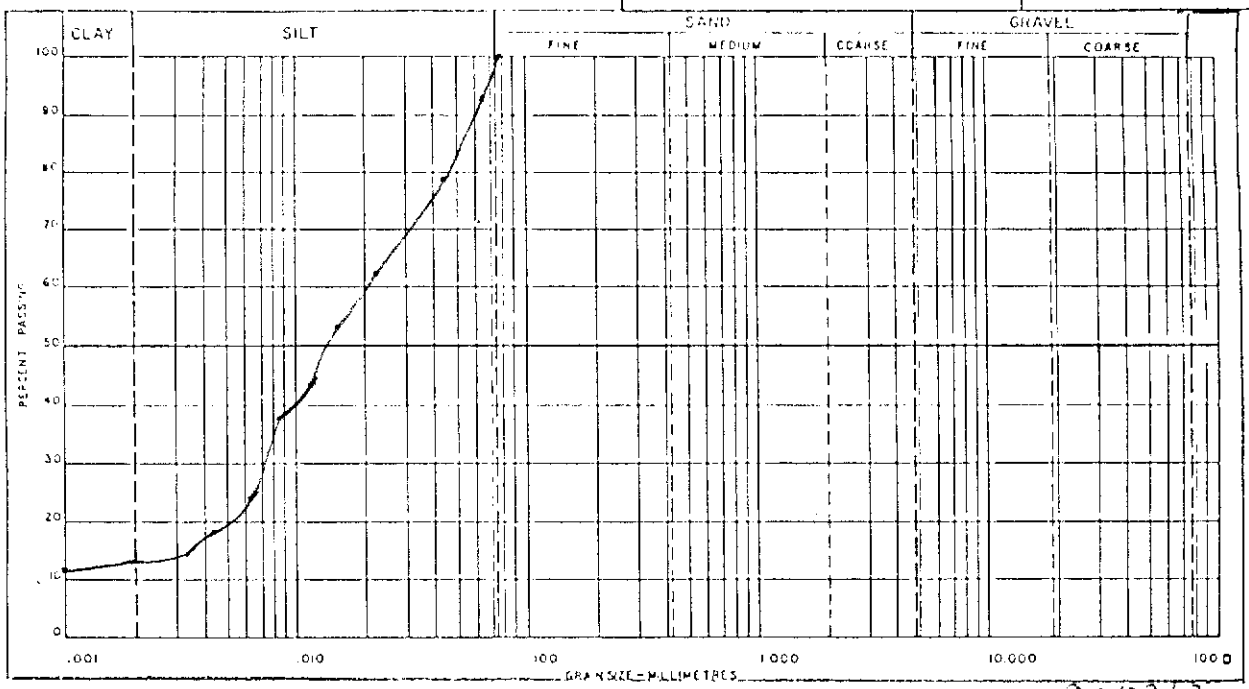
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
SILT, some CLAY, Mi-Cl-	
	Moisture 31.3%
Ingle Consistency	
Very Soft	
Cu less than 0.125 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Project - North / North East
Floor Width - 5.0m
South / Southwest Wall / Slope 14°

DATE SAMPLED 94/09/13

DATE RECEIVED 94/09/16

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT		CLIENT		DATE RECORDED
Land Claim Reclamation Project		Geo-Analysis & Associates		94/10/09
STA.	SAMPLE TYPE / DEPTH	HOLE NO	FIELD NO.	LAB NO
Revenue Property	14-16cm		RC1A	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.083	78	0.007	17
				0.060	76	0.005	6
				0.042	71	0.003	1
				0.031	63	0.002	/
				0.023	53	0.001	/
				0.017	40		
				0.013	33		
				0.009	26		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

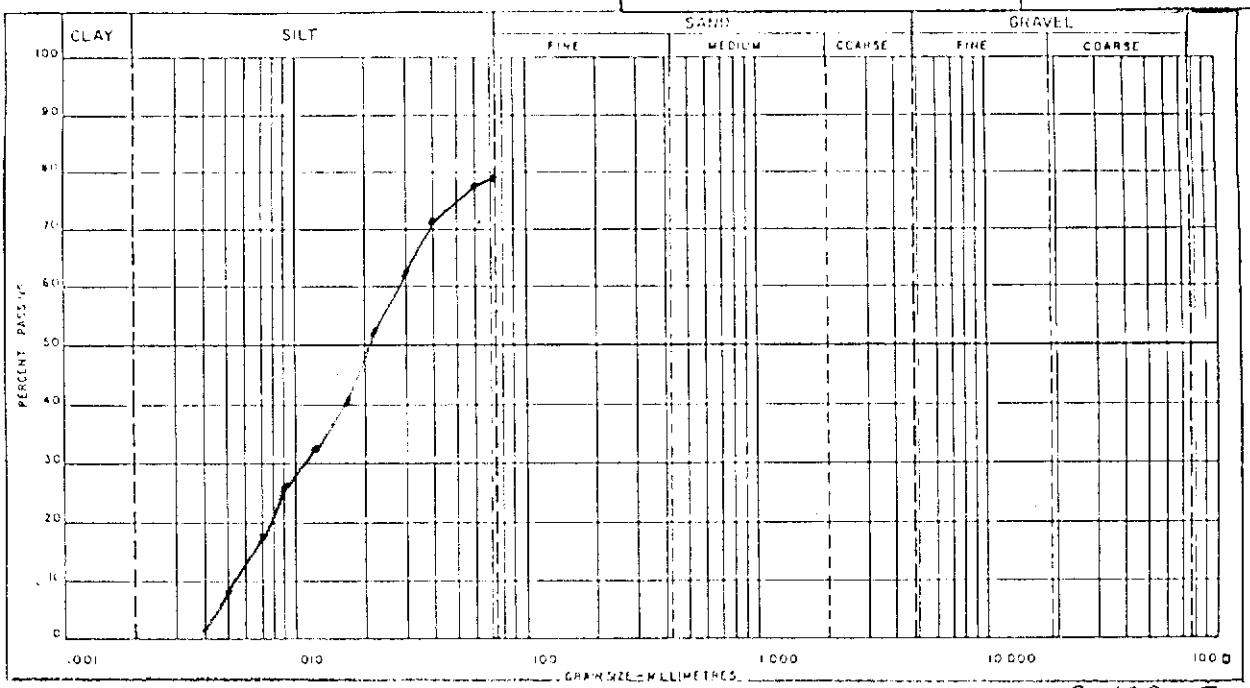
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt - ML	
	Moisture 52.3%
In-situ Condition	
Hard / Estimated 100+ Kpa	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Settling Pond - Side Berm

Sample taken below sand stratum

DATE SAMPLED 94/09/15

DATE RECEIVED 94/09/16

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RR2A Depth: 0-10cm
Location: Red Ridge Property
Aspect - Southeast / Slope 60°

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					96.3
20,000	20.0					87.1
12,500	12.5					78.7
10,000	10.0					73.9
5,000	5.0					62.3
2,000	2.0					46.9
1,250	1.25					34.8
800	0.800					25.8
630	0.630					22.0
400	0.400					16.1
315	0.315					13.6
160	0.160					9.8
80	0.080					7.1

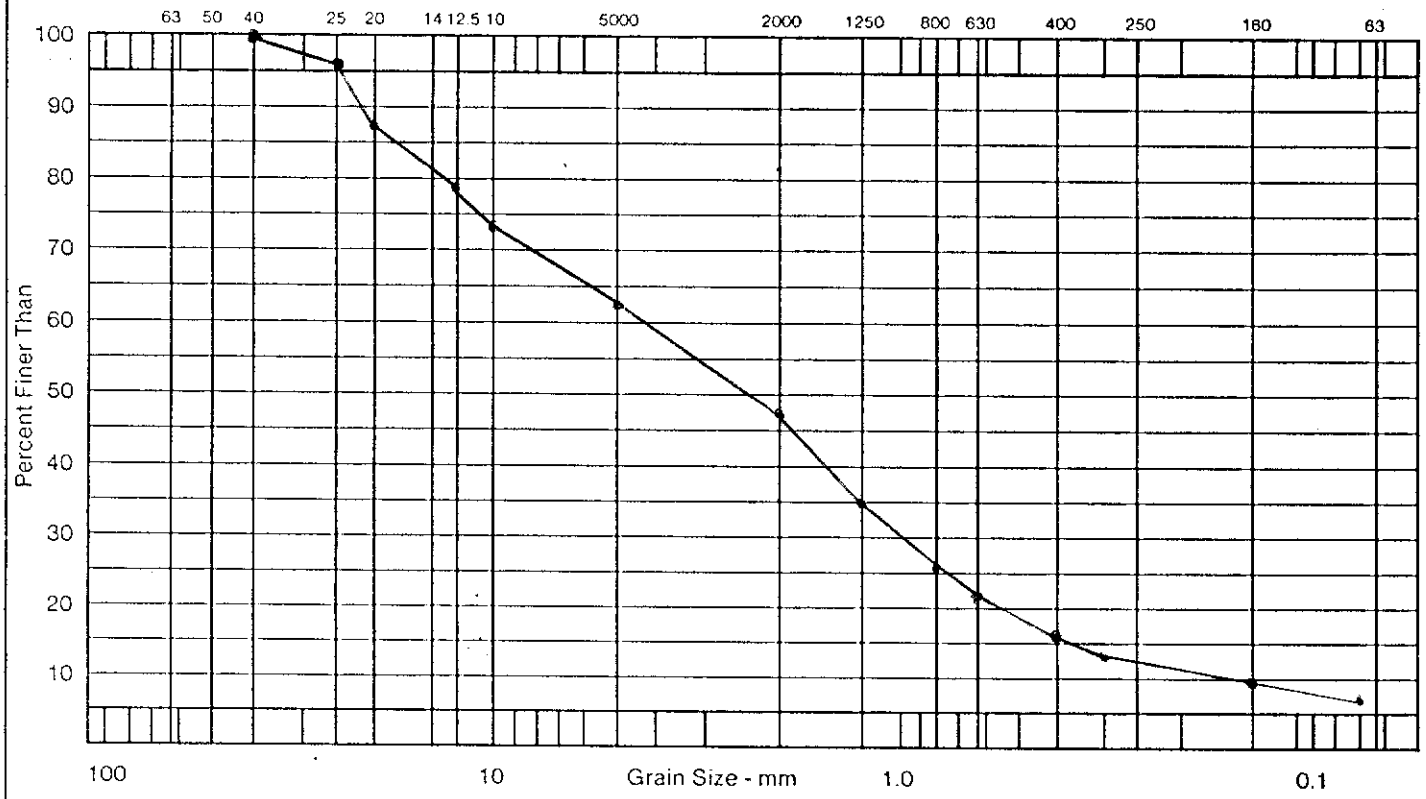
Description of Sample: Gravelly Sand, trace of silt, SW
Subangular and Subrounded Shapes
Shattered bedrock fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 5.4 %
Gravel: 37.7 %
Sand: 55.2 %
Silt: 7.1 %



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CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RRZB Depth: 0-30cm

Location: Red Ridge Property

Aspect - Southeast / Slope - 60°

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					92.8
12,500	12.5					83.4
10,000	10.0					79.3
5,000	5.0					74.3
2,000	2.0					69.5
1,250	1.25					61.3
800	0.800					54.1
630	0.630					50.1
400	0.400					43.1
315	0.315					39.3
160	0.160					32.2
80	0.080					24.6

Description of Sample

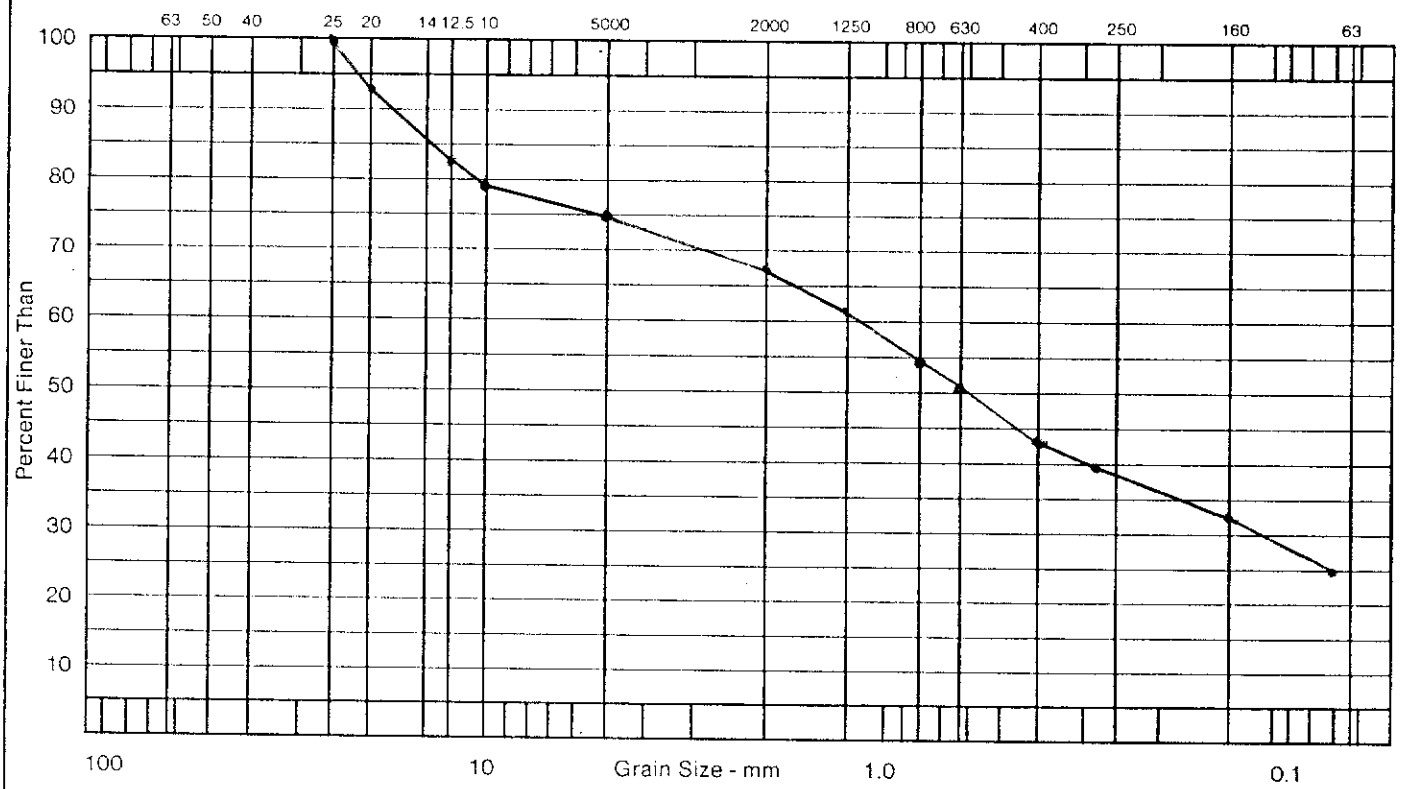
Silty Gravelly Sand, SM
Subangular and Subrounded Shapes
Shattered Bedrock fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 18.2 %
Gravel: 25.7 %
Sand: 49.7 %
Silt: 24.6 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: RRM10 Depth: 0-30cm

Location: Red Ridge Property

Aspect - South / Slope 39° / Height 10.5m

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					98.3
20,000	20.0					93.8
12,500	12.5					83.8
10,000	10.0					75.9
5,000	5.0					41.1
2,000	2.0					28.1
1,250	1.25					24.0
800	0.800					20.8
630	0.630					19.1
400	0.400					15.7
315	0.315					13.6
160	0.160					9.5
80	0.080					5.8

Description of Sample "Shale"

Sandy Gravel, trace of silt, GW

Angular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

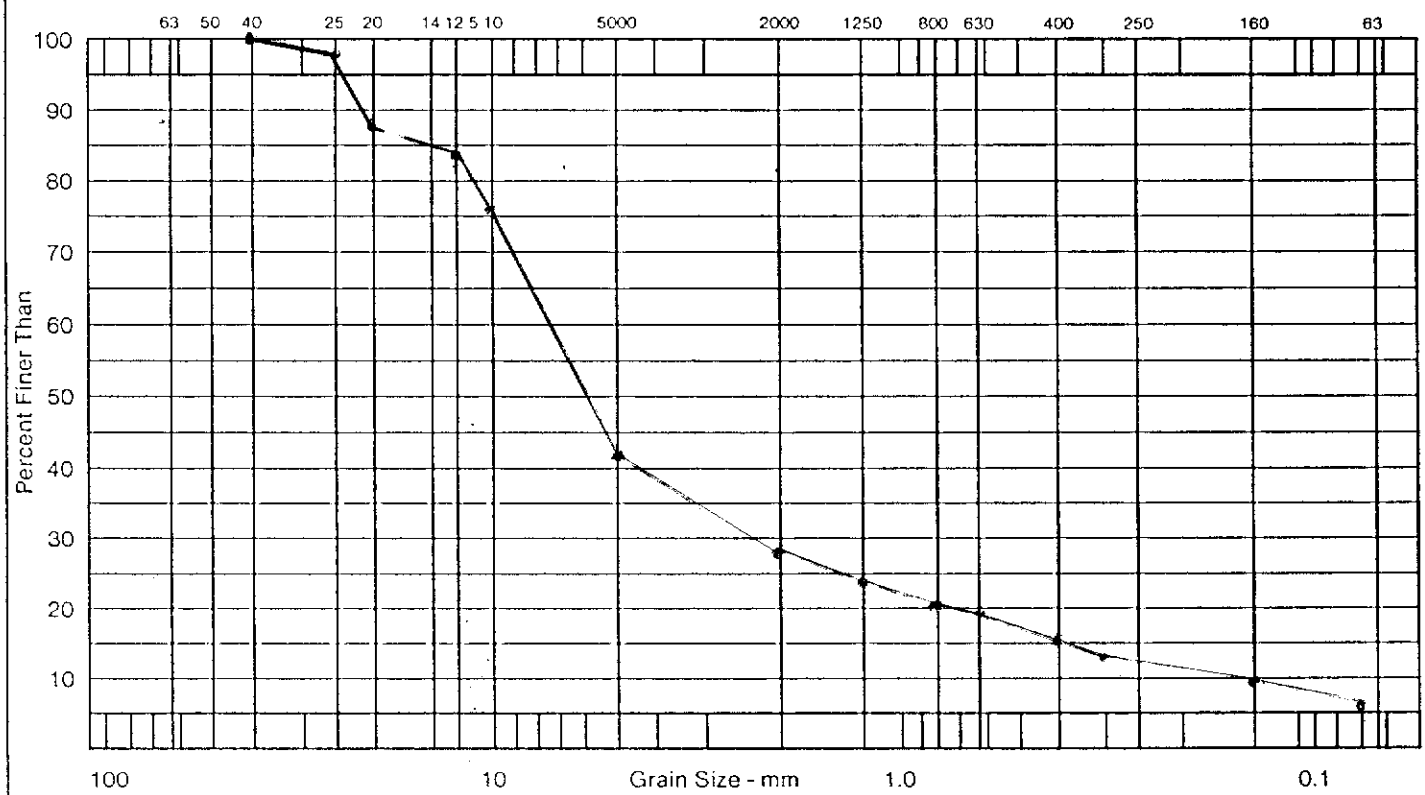
Remarks

Moisture: 12.5 %

Gravel: 58.9 %

Sand: 35.3 %

Silt: 5.8 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: C1B/H1A Depth: 0-30cm
Location: Campbell Property
Aspect-East / Toe of slope

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/15

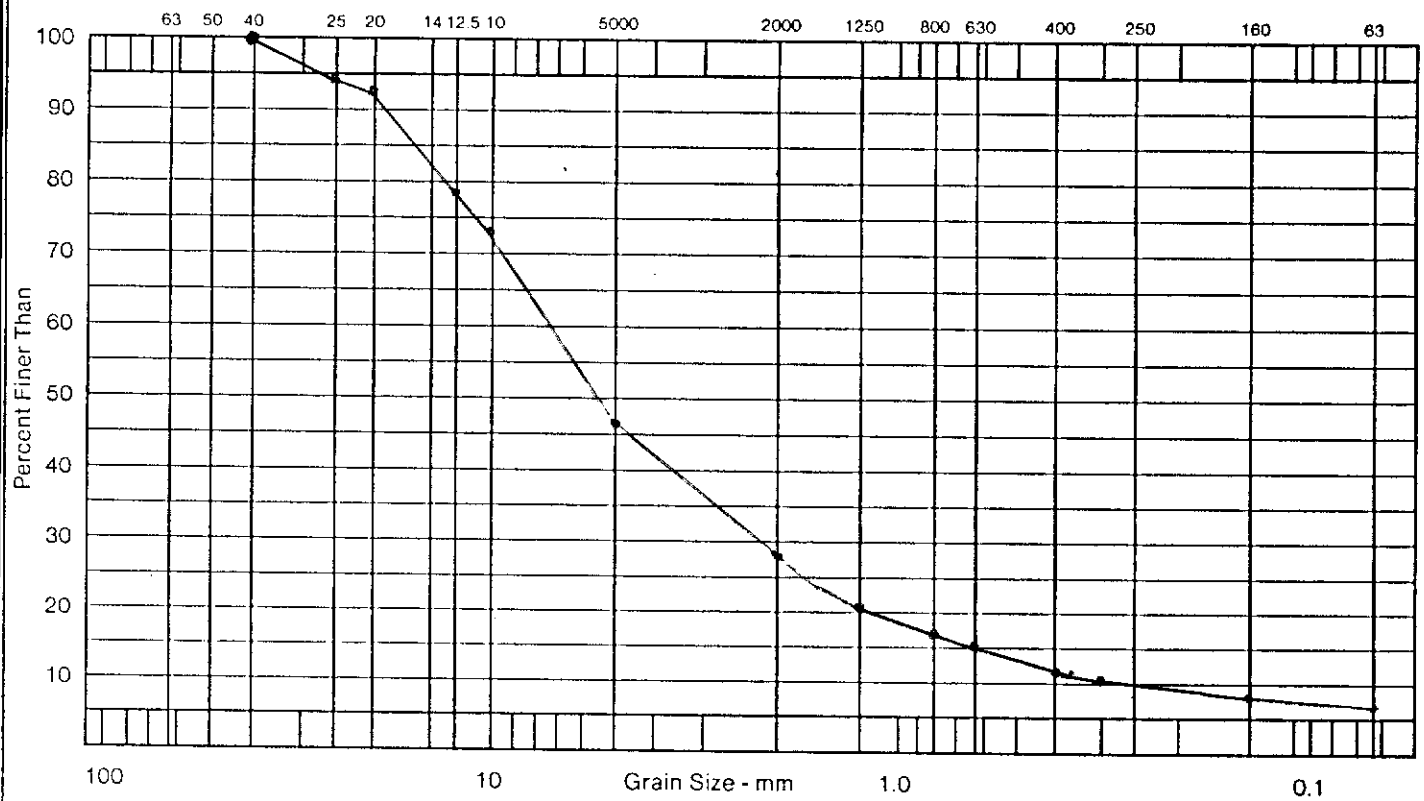
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					94.4
20,000	20.0					93.1
12,500	12.5					78.3
10,000	10.0					72.9
5,000	5.0					46.0
2,000	2.0					28.0
1,250	1.25					20.9
800	0.800					16.8
630	0.630					14.9
400	0.400					12.0
315	0.315					10.6
160	0.160					8.1
80	0.080					5.9

Description of Sample: Sandy Gravel, trace of silt, GW
Angular and Rounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 11.4 %
Gravel: 54.0 %
Sand: 40.1 %
Silt: 5.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 1H1A Depth: 0-30cm

Location: Campbell Property Project-East / Toe of slope

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/15

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					
20,000	20.0					100.0
12,500	12.5					93.8
10,000	10.0					92.3
5,000	5.0					78.4
2,000	2.0					53.6
1,250	1.25					37.9
800	0.800					26.7
630	0.630					22.0
400	0.400					15.1
315	0.315					12.3
160	0.160					8.3
80	0.080					5.5

Description of Sample: Gravelly Sand, trace of SILT, SW Angular and Rounded shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

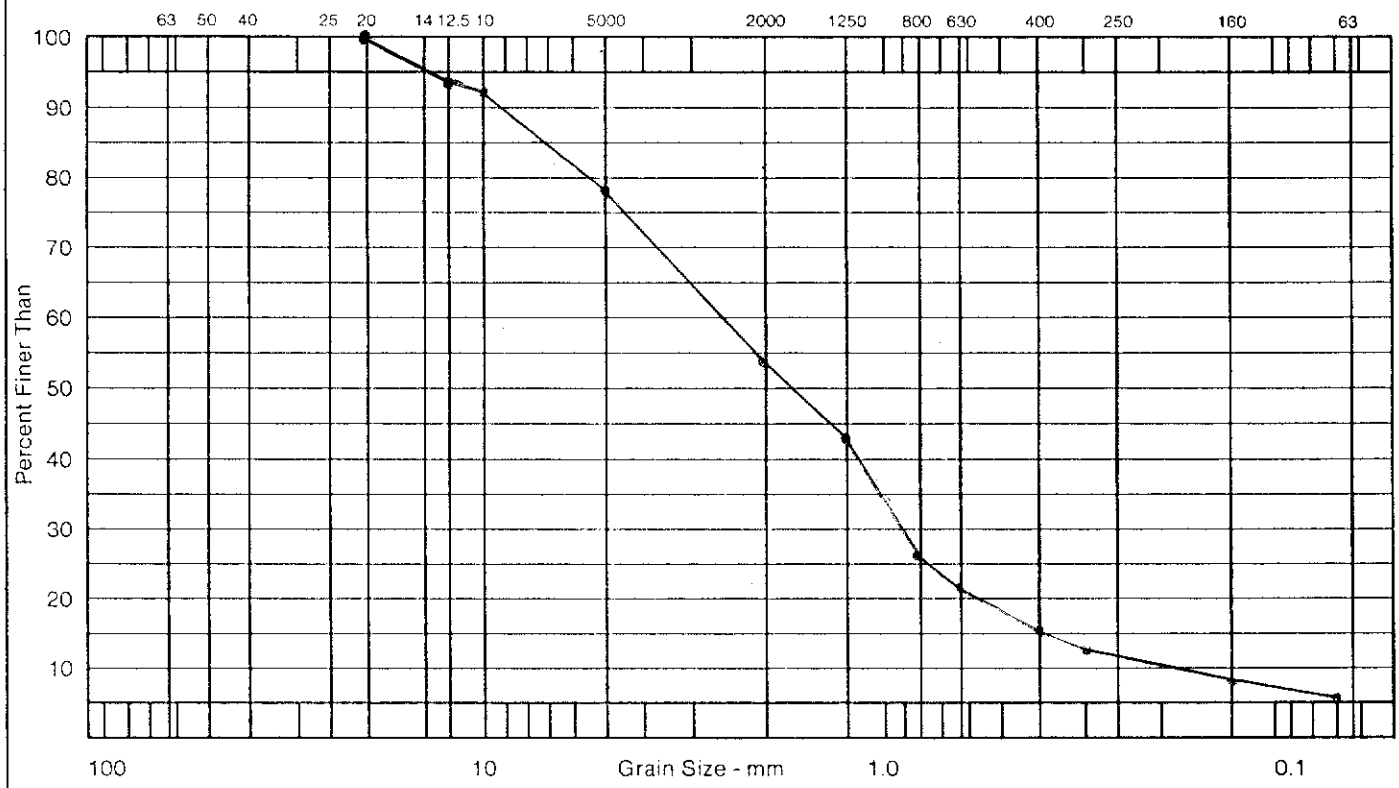
Remarks

Moisture: 11.6 %

Gravel: 21.6 %

Sand: 72.9 %

Silt: 5.5 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: H1A Depth: 10 - 40cm

Location: Campbell Property

Slope - 35° / Aspect - East / Height - 6.2m

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/15

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					95.9
20,000	20.0					93.5
12,500	12.5					84.3
10,000	10.0					79.4
5,000	5.0					65.5
2,000	2.0					50.0
1,250	1.25					40.9
800	0.800					34.0
630	0.630					30.7
400	0.400					25.4
315	0.315					22.6
160	0.160					17.8
80	0.080					13.5

Description of Sample

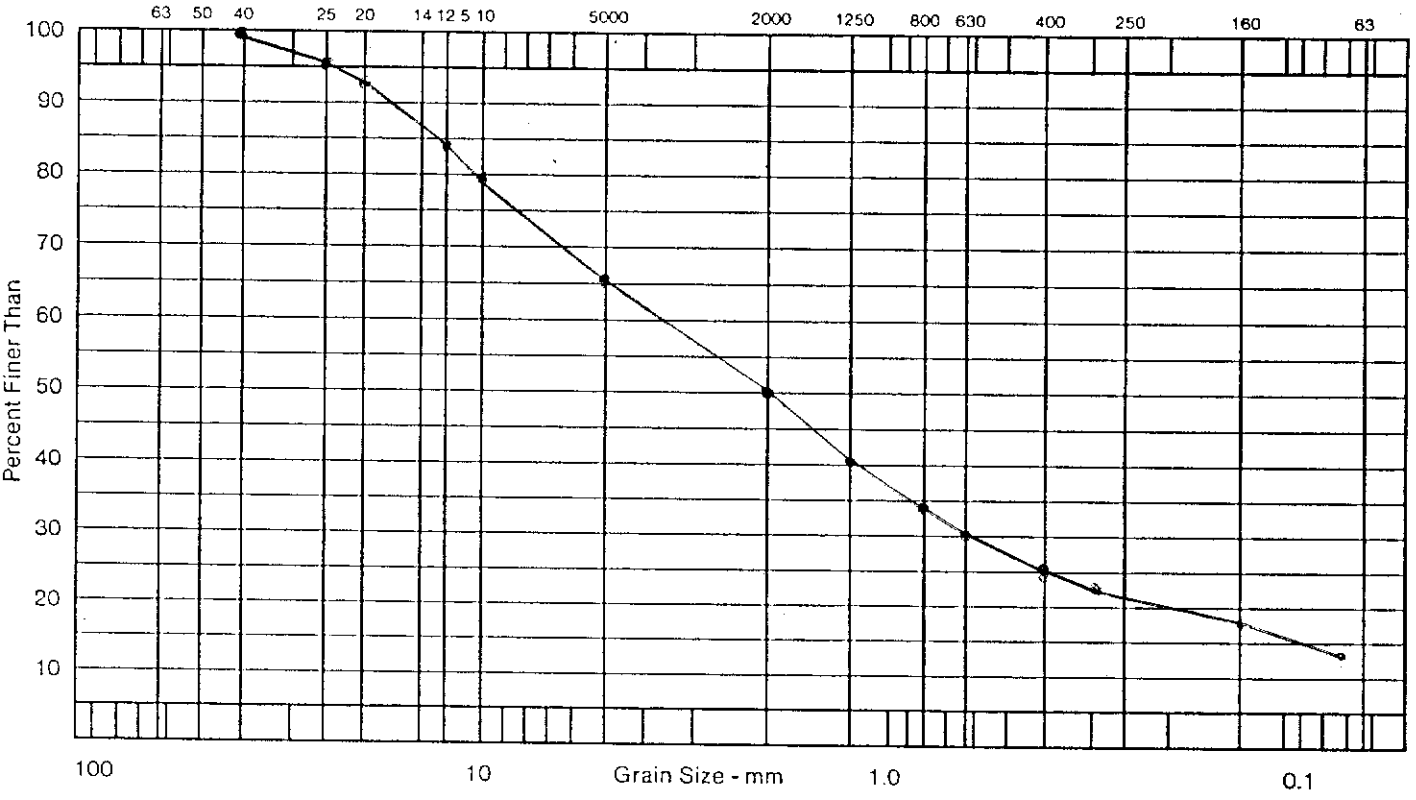
Gravelly Sand, some silt, SW-SM
Subangular and Subrounded Shapes
Shattered bedrock fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 13.7 %
Gravel: 34.5 %
Sand: 52.0 %
Silt: 13.5 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: IIA Depth: 0-30cm
Location: Seven Pup 7P1 Northeast Facing Sloping

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: JP Date: 1994/10/06
1912 TAILINGS

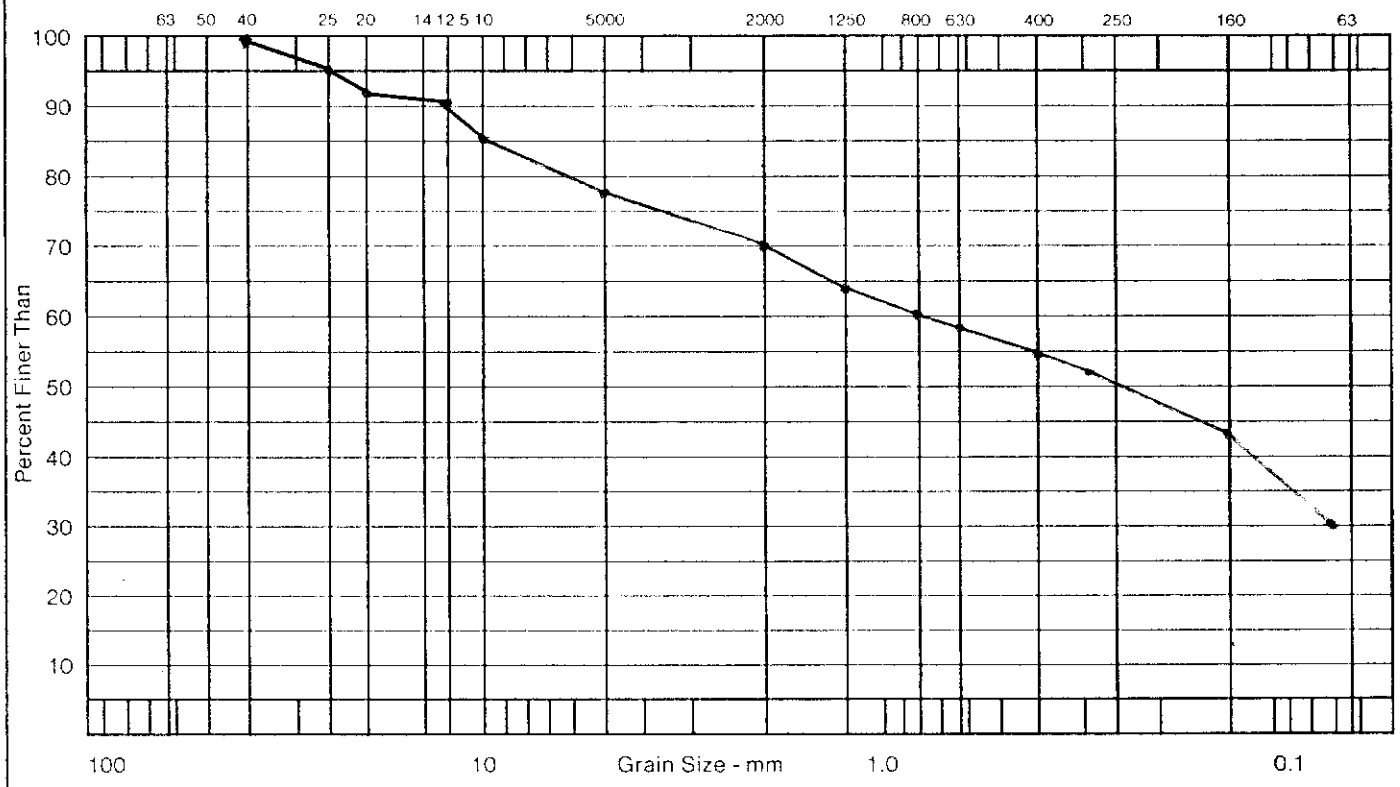
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					95.3
20,000	20.0					92.0
12,500	12.5					89.9
10,000	10.0					85.2
5.000	5.0					77.2
2.000	2.0					69.2
1.250	1.25					63.9
800	0.800					60.1
630	0.630					58.1
400	0.400					54.6
315	0.315					52.2
160	0.160					43.7
80	0.080					29.7

Description of Sample
Gravelly Silty Sand SM
Grain Shape (All Shapes Noted)

Time of Sieving ____ Min. 15

Method of Preparation ____ Dry ____ Washed X

Remarks
Moisture: 22.9 %
Gravel: 22.8 %
Sand: 47.5 %
Silt: 29.7 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA	SAMPLE TYPE	DEPTH	HOLE NO	FIELD NO.	LAB NO
Seven Pup	TP2			11B	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.064	71	0.003	9
				0.031	58	0.002	6
				0.023	51	0.001	5
				0.016	45		
				0.012	35		
				0.009	24		
				0.007	19		
		0.063	100.0	0.005	14		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

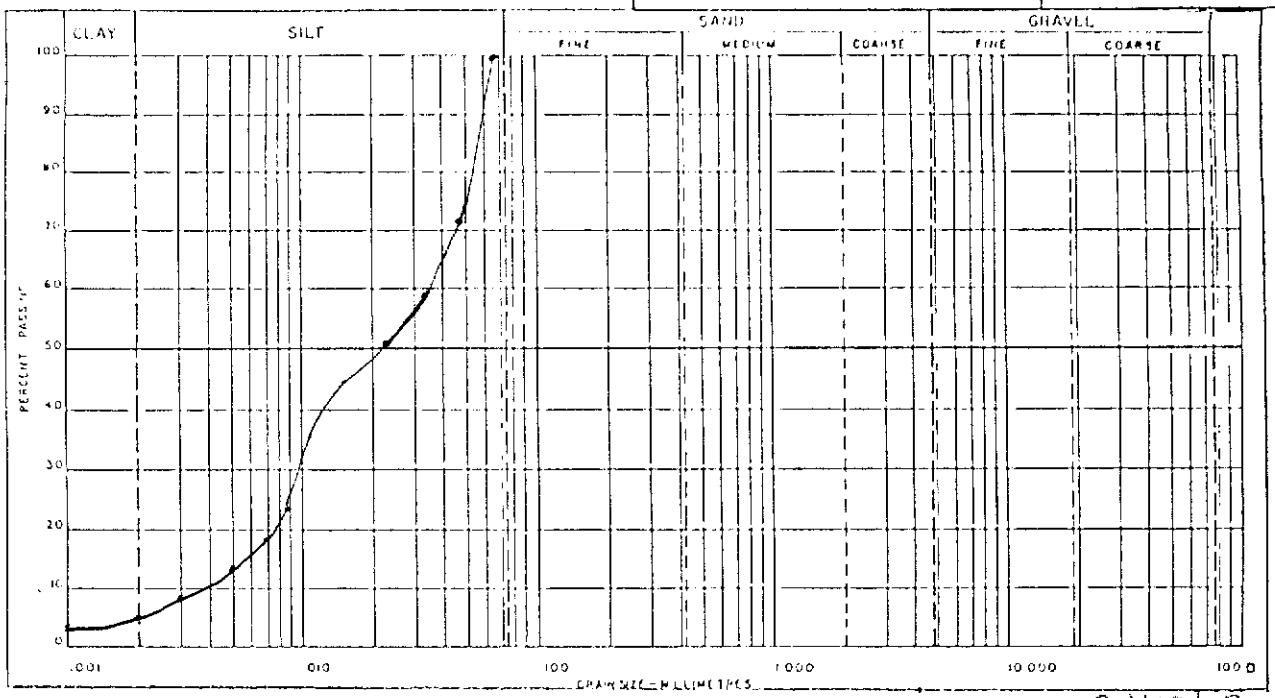
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, Trace of Clay, ML	
	Moisture 32.2%
Ice to Lenticular	
Stiff	
c = 0.5 - 1 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Apart - North East
Undisturbed Site

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Settling Pond	TP 2	0-30cm		11C	

Settling pond (lowest)

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.056	89	0.005	17
				0.040	84	0.003	12
				0.029	76	0.002	9
				0.021	71	0.001	8
				0.015	62		
		0.350/100		0.012	46		
		0.063/100		0.009	35		
				0.006	24		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	PL	PI	NATURAL % <#40	SG

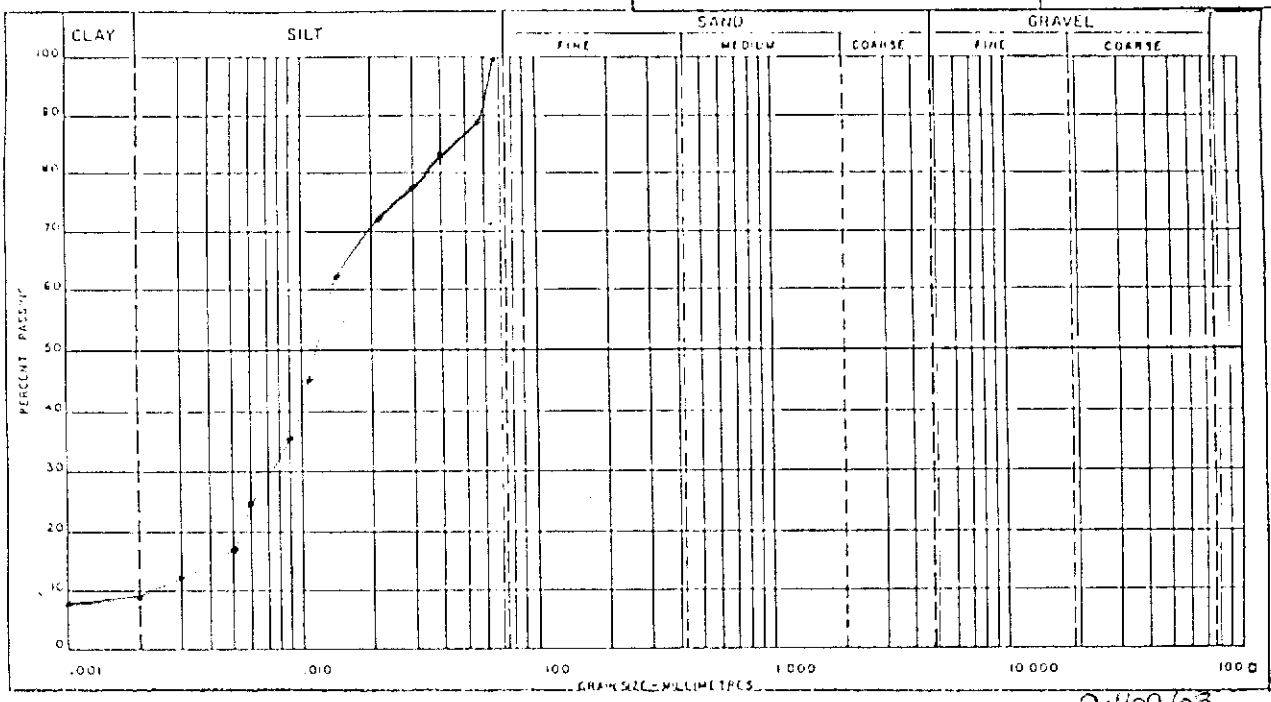
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of clay	Moisture: 51.9%
ML	
Toxite Consistency	
Stiff	
C = 0.5 - 1 ton/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Settling Pond.
Lowest Pond

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT		CLIENT		DATE RECORDED
Land Claim Reclamation Project		Geo-Analysis & Associates		94/10/05
STA.	SAMPLE TYPE / DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Seven Pup	TP3B 0-30cm		110	

SETTLING POND

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.043		0.003	11
				0.031	66	0.002	8
				0.022	61	0.001	7
				0.016	47		
				0.012	34		
				0.009	27		
		0.180	100.0	0.007	18		
		0.063	100.0	0.005	13		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

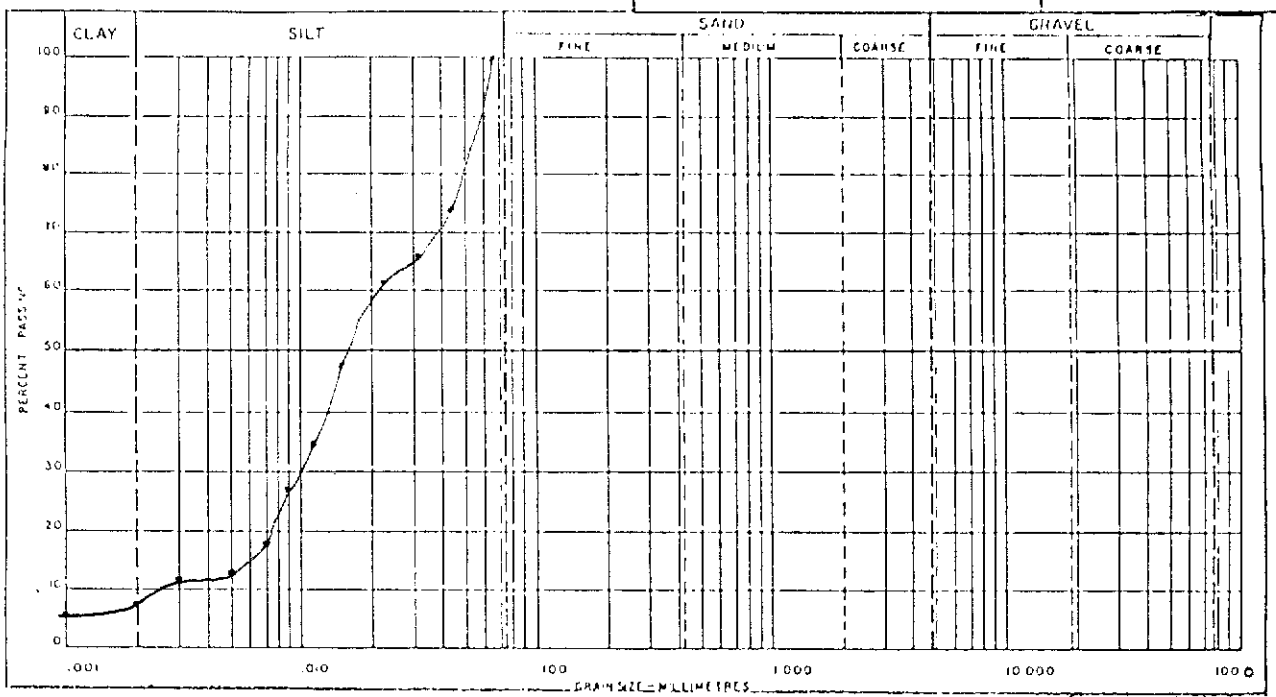
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of clay ML	Moisture 58.1%
Insitu Condition	
Stiff to	
c = 0.5 - 1 tsf	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Settling Pond

Highest Pond

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Otc Grande		0-20cm		12A	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.061	82	0.005	9
				0.044	66	0.003	5
				0.031	61	0.002	3
				0.022	56	0.001	2
				0.016	46		
				0.013	30		
				0.009	22		
		0.063	100.0	0.007	14		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H_2O	S.G.

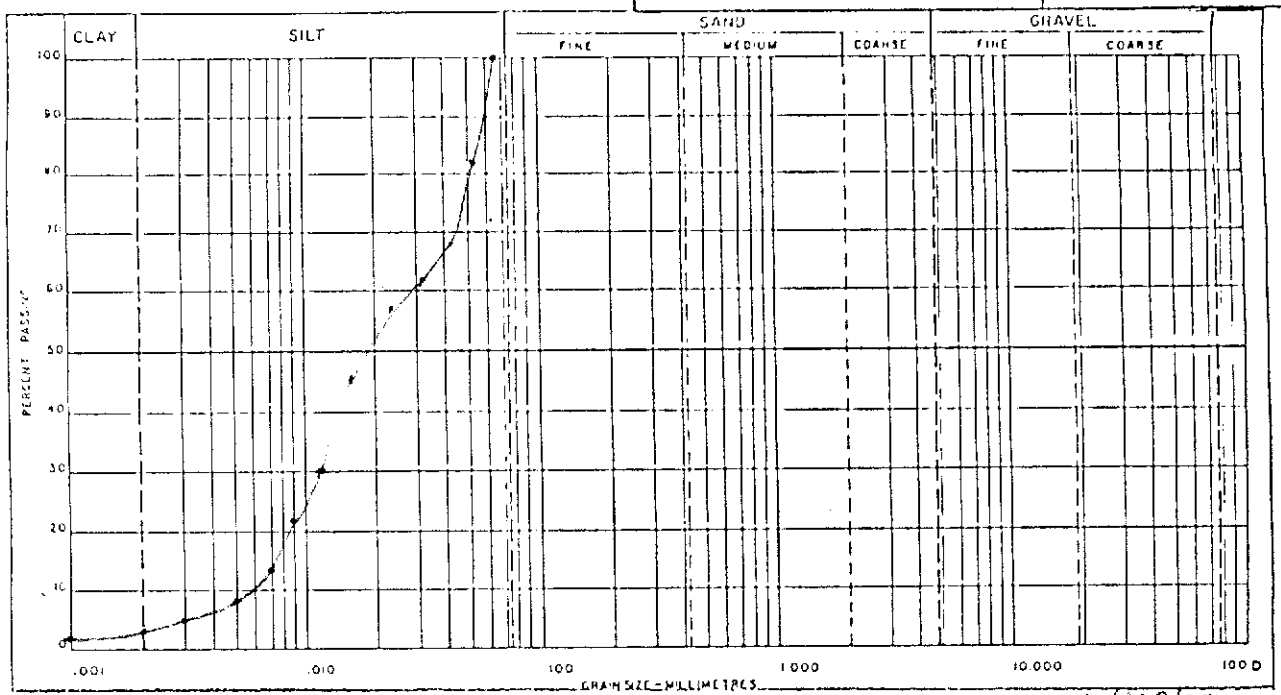
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, ML	Moisture 47.3%
Insitu condition	
Medium St. ff or Firm	
c = 0.25-0.5 ton/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - North / Slope N3°

Height - 15m

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Ore Grande		0-20cm		12B	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.044	68	0.003	9
				0.032	58	0.002	6
				0.024	42	0.001	5
				0.017	28		
				0.013	24		
				0.009	22		
		0.080	100.0	0.007	20		
		0.063	100.0	0.005	11		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % MC	S.G.

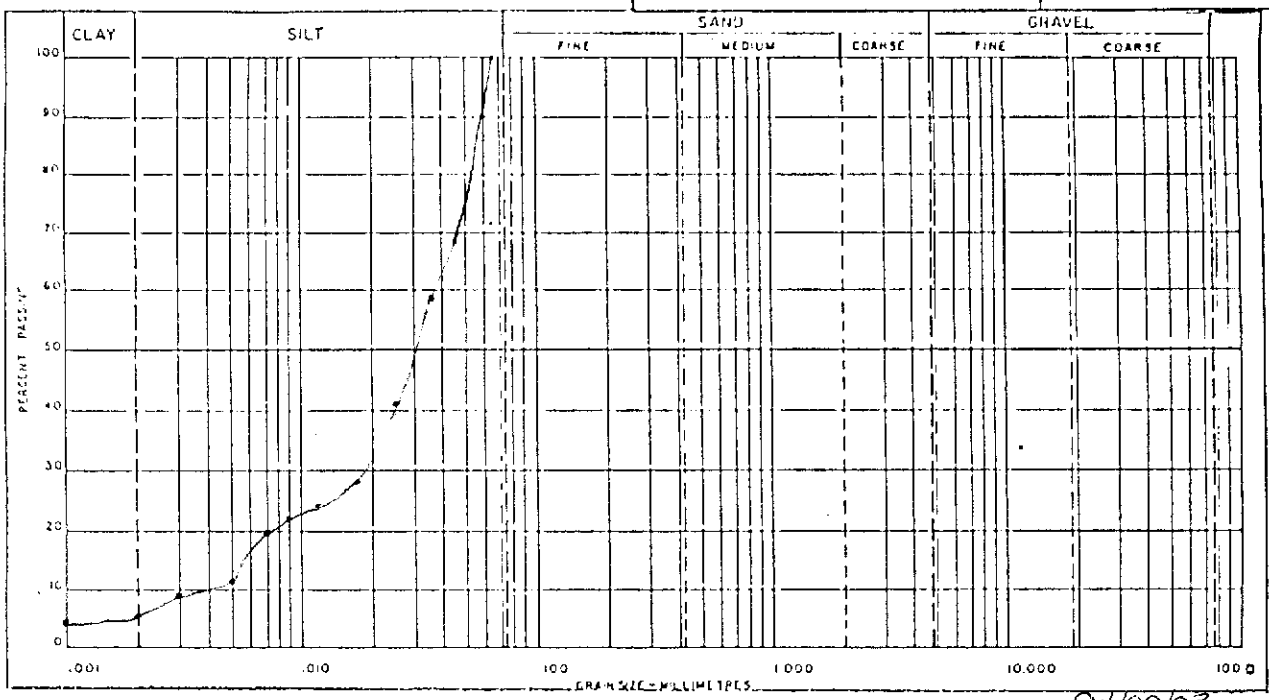
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of Clay	
ML	Moisture: 43.3%
In-situ Condition	
Medium Stiff or Firm	
c: 0.25-0.5 tons ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - North
Slope - 43°
Height - 23m

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 12C Depth: 0-30cm

Location: Ore Grande North Facing Slope

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/03

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					100.0
50,000	50.0					81.4
40,000	40.0					73.4
25,000	25.0					60.5
20,000	20.0					49.2
12,500	12.5					43.4
10,000	10.0					32.1
5,000	5.0					25.4
2,000	2.0					24.5
1,250	1.25					21.1
800	0.800					19.0
630	0.630					18.0
400	0.400					16.4
315	0.315					15.5
160	0.160					13.5
80	0.080					8.1

Description of Sample

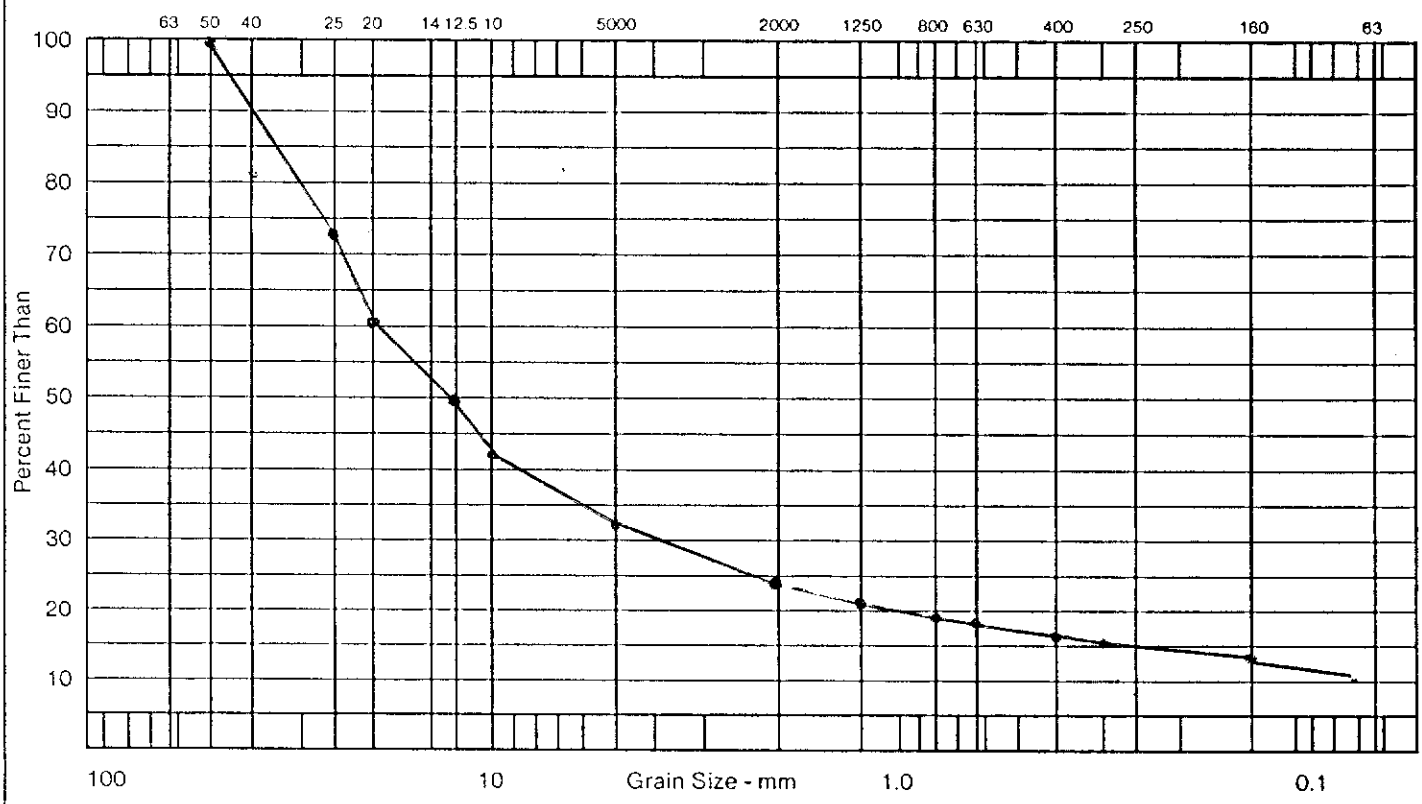
Sandy Gravel, trace of silt, GW
Subangular and Strongly Shaped
Fractured Bedrock Fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 5.5 %
Gravel: 67.9 %
Sand: 22.1 %
Silt: 8.1 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 12D Depth: 0-30cm
Location: Ore Grande South facing Slope

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/04

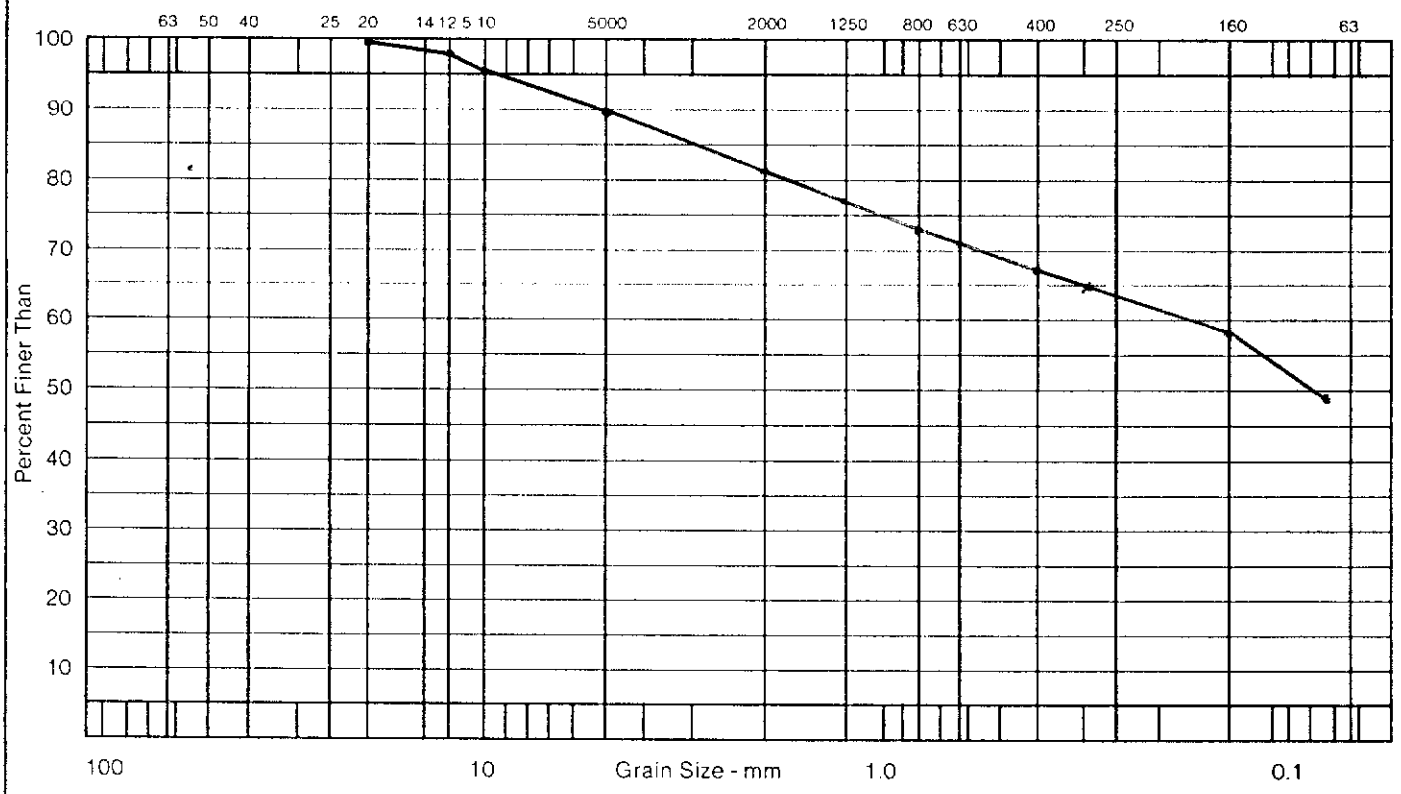
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					
20,000	20.0					100.0
12,500	12.5					98.2
10,000	10.0					95.4
5,000	5.0					89.3
2,000	2.0					81.8
1,250	1.25					76.9
800	0.800					73.3
630	0.630					71.2
400	0.400					67.3
315	0.315					64.8
160	0.160					57.8
80	0.080					48.3

Description of Sample
Sandy Silt, some gravel, ML
Subangular and Sub rounded shapes
fractured Bedrock fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 16.7 %
Gravel: 10.7 %
Sand: 41.0 %
Silt: 48.3 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 12E Depth: 0-30cm
Location: Ore Grande South/Southwest Facing

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/04

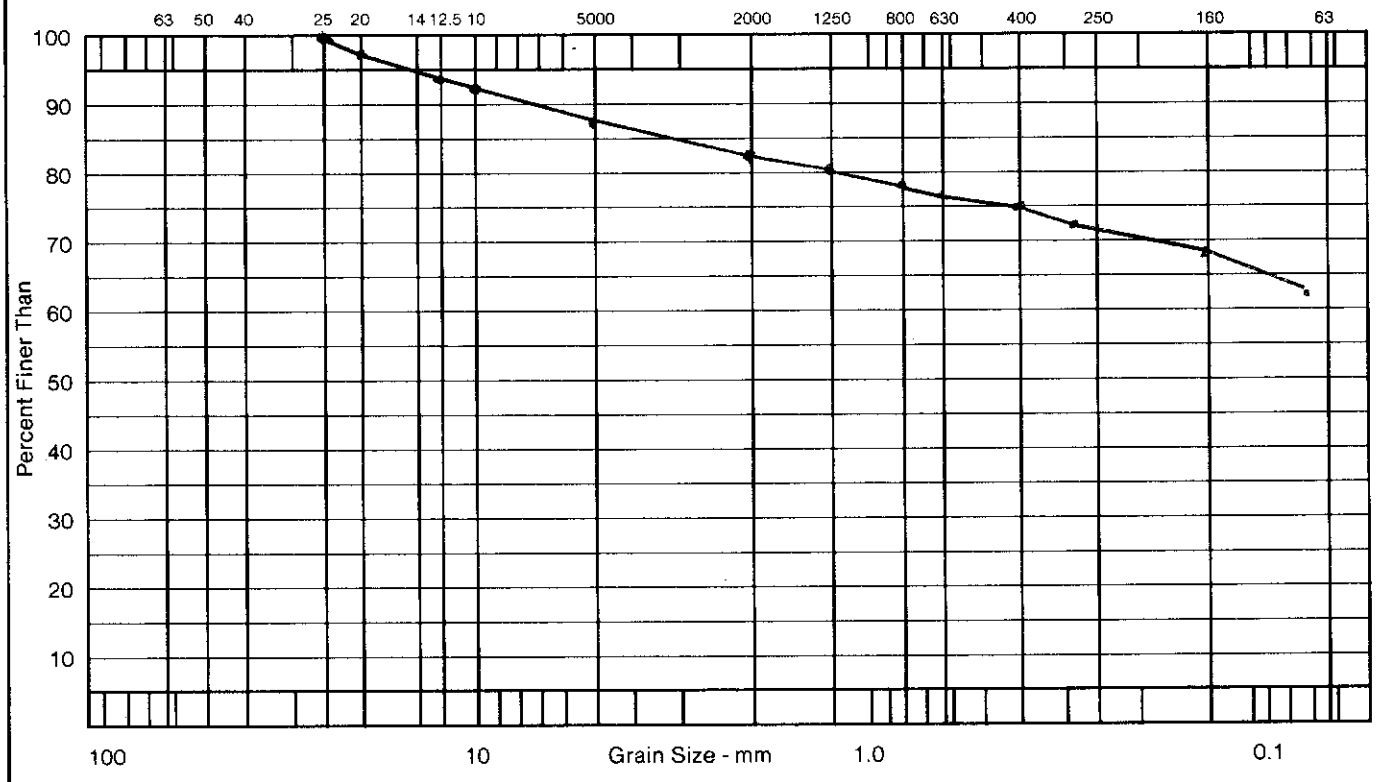
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					97.9
12,500	12.5					93.9
10,000	10.0					92.3
5,000	5.0					87.8
2,000	2.0					83.1
1,250	1.25					80.3
800	0.800					78.3
630	0.630					77.0
400	0.400					74.7
315	0.315					73.0
160	0.160					68.4
80	0.080					61.8

Description of Sample
Sandy Silt, some Gravel, ML
Subangular and Subrounded Shapes
Fractured Bedrock fragments

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 23.1
Gravel: 12.2
Sand: 26.0
Silt: 61.8



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Orc. Grande		0-20cm		12F	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.042	68	0.003	12
				0.030	62	0.002	11
				0.022	52	0.001	10
				0.017	38		
				0.012	30		
				0.009	22		
		0.080	100.0	0.006	17		
		0.063	96	0.004	13		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	PL	PI	NATURAL % H2O	SG

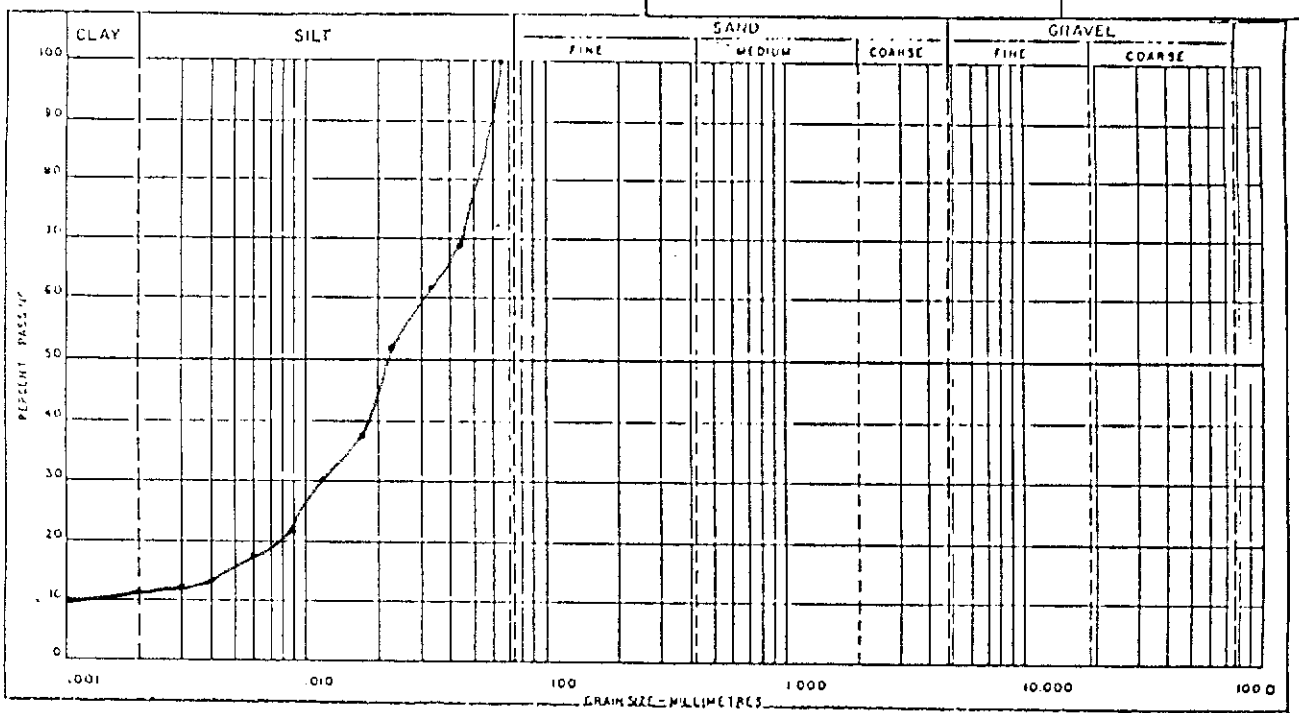
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt some Clay	
ML-CL	Moisture: 21.4%
Insitu Condition	
Soft	
C = 0.125 - 0.25 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Impact - South
Slope - 50° / Height - 21.5m

DATE SAMPLED 94/09/03

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 8A Depth: 0-30cm
Location: Bay Gulch South Facing Slope

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/04

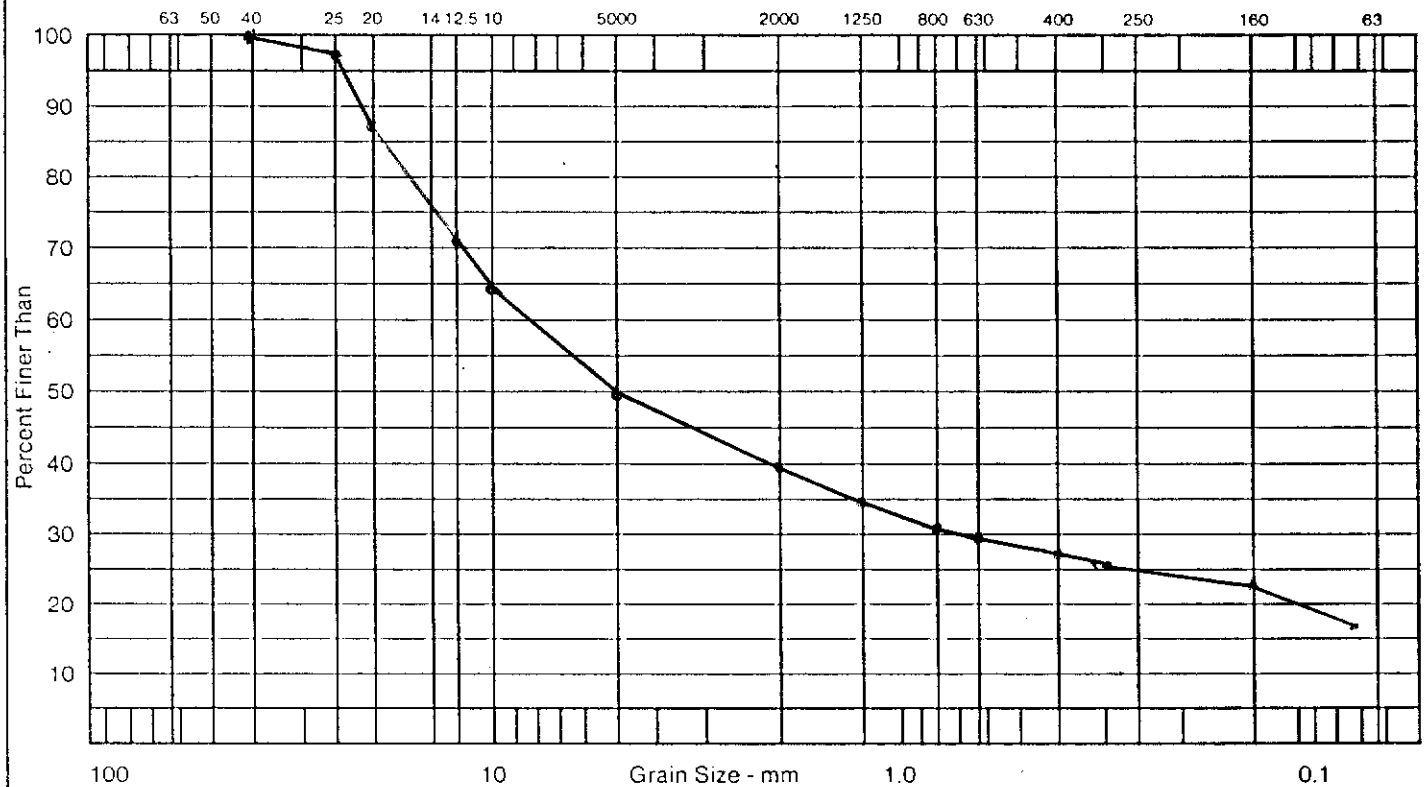
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					97.4
20,000	20.0					87.1
12,500	12.5					70.4
10,000	10.0					64.0
5,000	5.0					49.7
2,000	2.0					39.6
1,250	1.25					34.3
800	0.800					31.0
630	0.630					29.3
400	0.400					26.9
315	0.315					25.7
160	0.160					23.0
80	0.080					16.5

Description of Sample: Silty Sandy Gravel, GW-GM
Large Bedrock fragments to 200mm in size, Subangular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 3.8 %
Gravel: 50.3 %
Sand: 33.2 %
Silt: 16.5 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 8B Depth: 0-30cm

Location: Bay Gulch North Facing Slope

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					94.6
12,500	12.5					84.9
10,000	10.0					79.6
5,000	5.0					69.0
2,000	2.0					54.2
1,250	1.25					47.5
800	0.800					43.0
630	0.630					40.7
400	0.400					37.5
315	0.315					35.9
160	0.160					32.4
80	0.080					27.4

Description of Sample

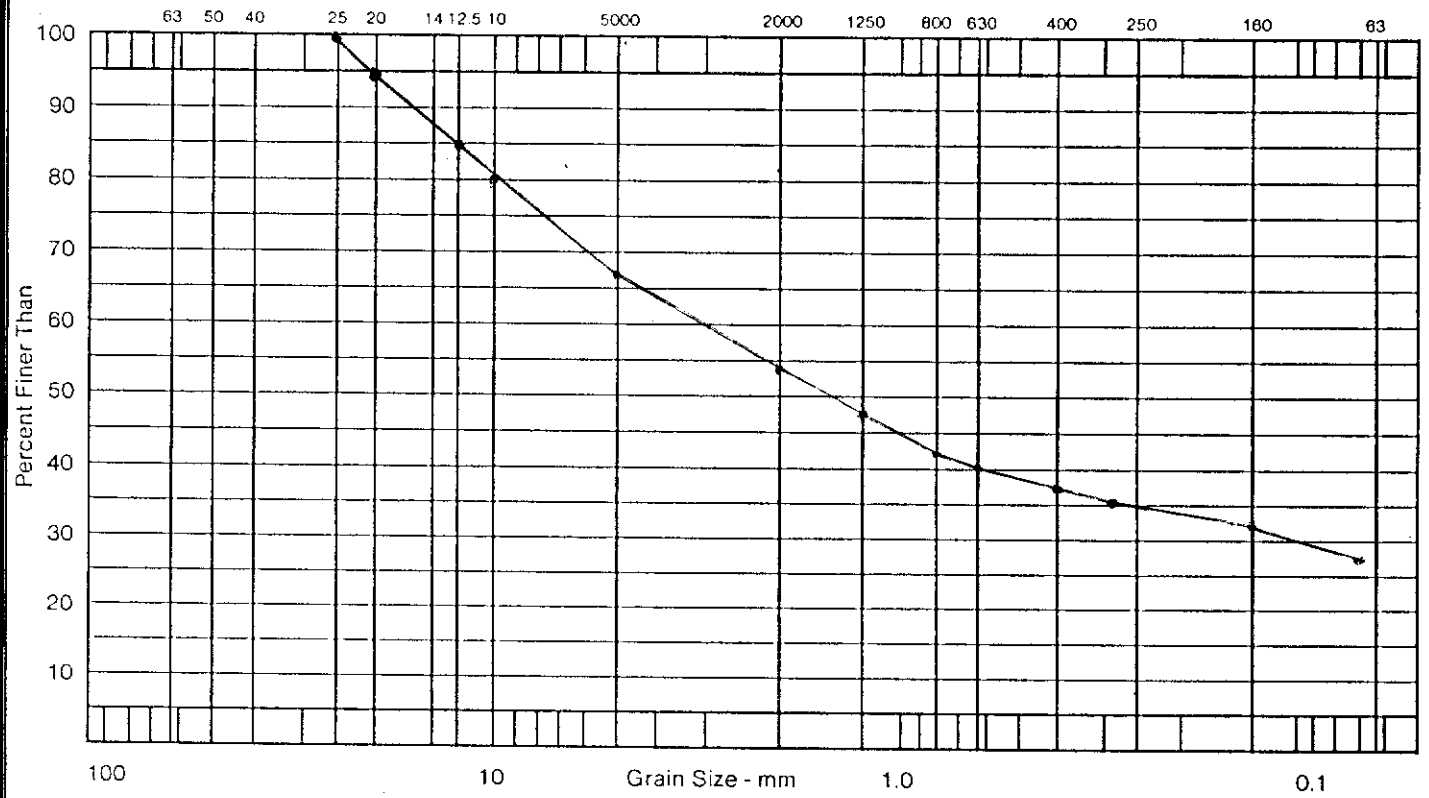
Silty Gravelly Sand, SW-SM
Large Bedrock Fragments to 200mm in size, Subangular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 6.8 %
Gravel: 33.0 %
Sand: 60.4 %
Silt: 27.4 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 9A Depth: 0-30cm
Location: Bay Gulch
South Facing Slope

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: _____ Date: 1994/10/17

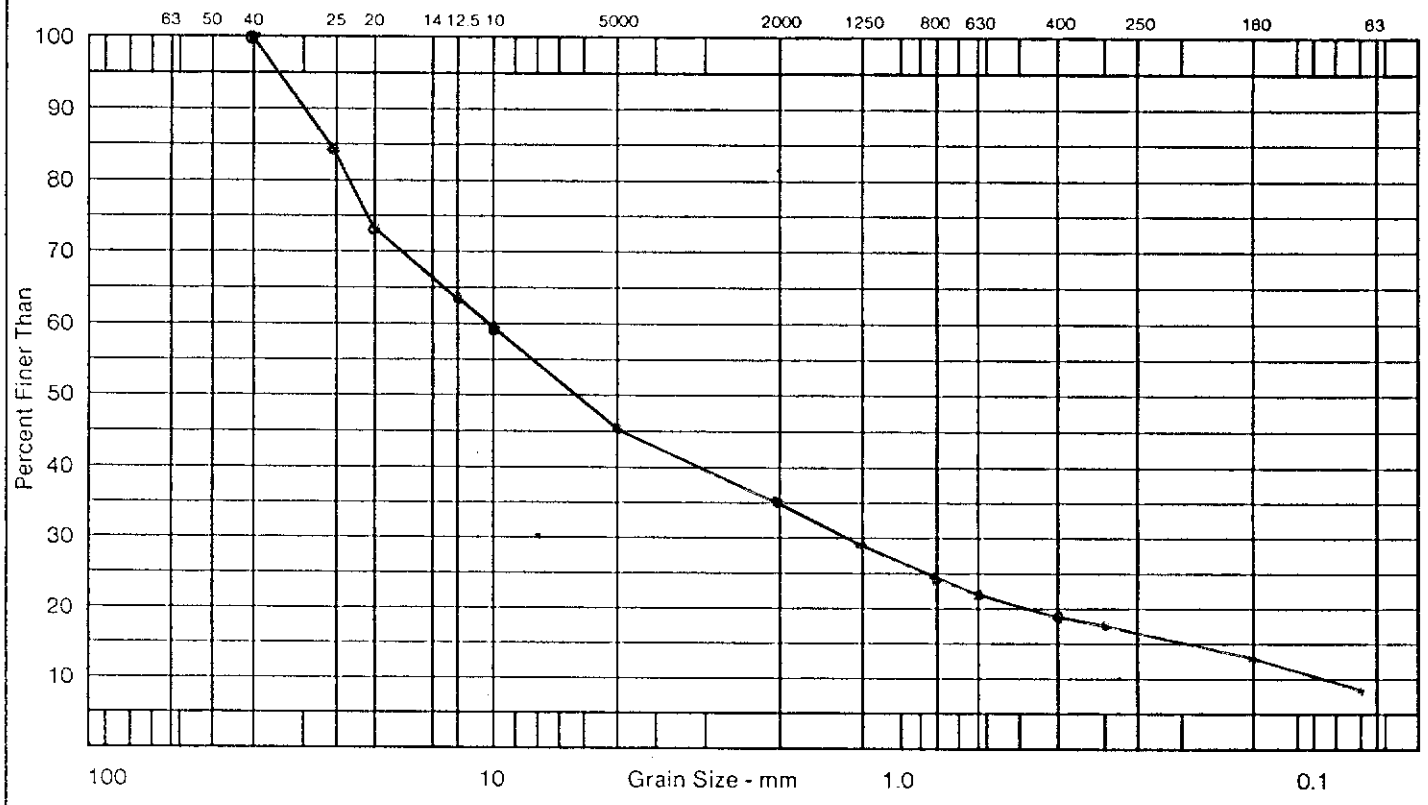
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					84.8
20,000	20.0					72.9
12,500	12.5					63.9
10,000	10.0					59.6
5,000	5.0					46.0
2,000	2.0					34.7
1,250	1.25					28.2
800	0.800					24.1
630	0.630					22.1
400	0.400					18.9
315	0.315					17.2
160	0.160					13.4
80	0.080					9.0

Description of Sample
Sandy Gravel, trace of silt, GW
Subangular and Subrounded Shapes
Fractured Bedrock Fragments to 300mm

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks
Moisture: 3.8 %
Gravel: 54.0 %
Sand: 37.0 %
Silt: 9.0 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/10/08

STA.	SAMPLE TYPE	DEPTH	HOLE NO	FIELD NO.	LAB NO
Nugget Gulch		0-10cm		10A	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.045	55	0.003	10
				0.033	44	0.002	7
				0.024	34	0.001	5
				0.018	23		
				0.013	20		
				0.009	19		
		0.080	100.0	0.007	18		
		0.063	82	0.006	17		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

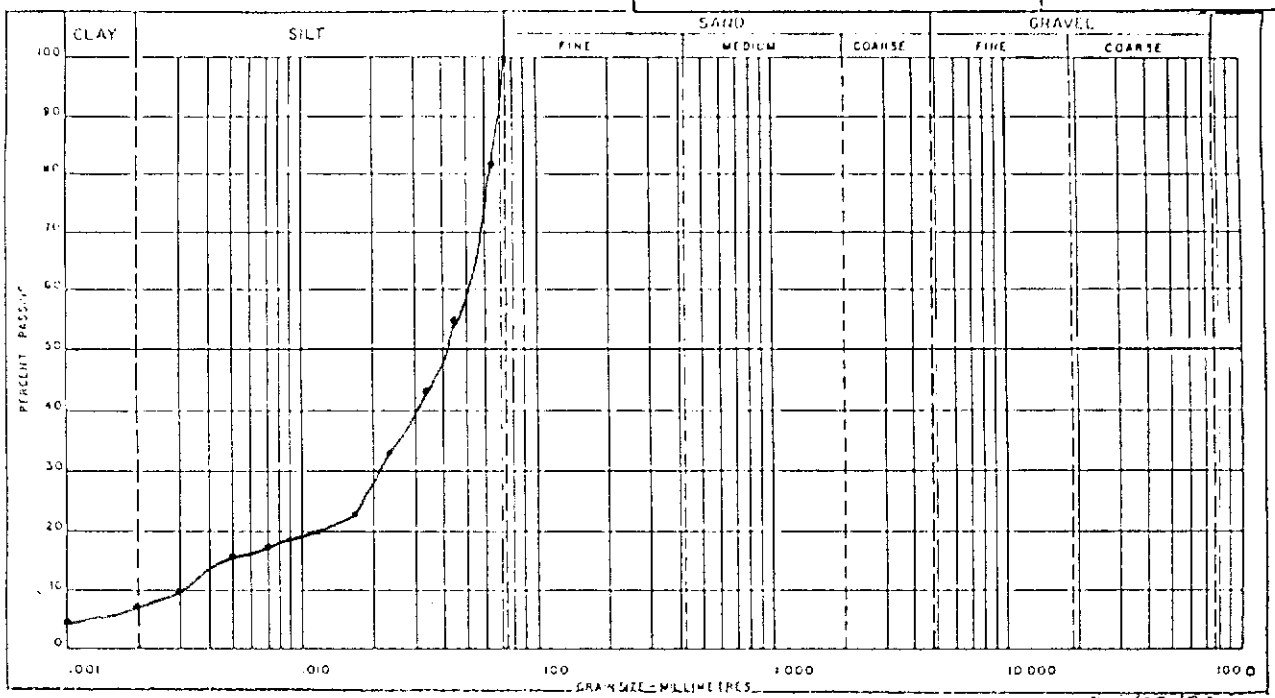
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of Clay	
	Moisture 23.3%
Industry Condition	
Frozen	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Slope 26°

Ice Rich Permafrost Note 2-5mm ice crystals

DATE SAMPLED 94/09/02

DATE RECEIVED 94/09/05

TECHNICIAN(S) MK

CHECKED BY

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 10B Depth: 0-30cm
Location: Nugget Gulch South Facing Slope

Client: GEO-ANALYSIS & ASSOCIATES
Project: Land Claim Reclamation Project
Made by: MK Job No.: 8108
Ck'd by: Date: 1994/10/06

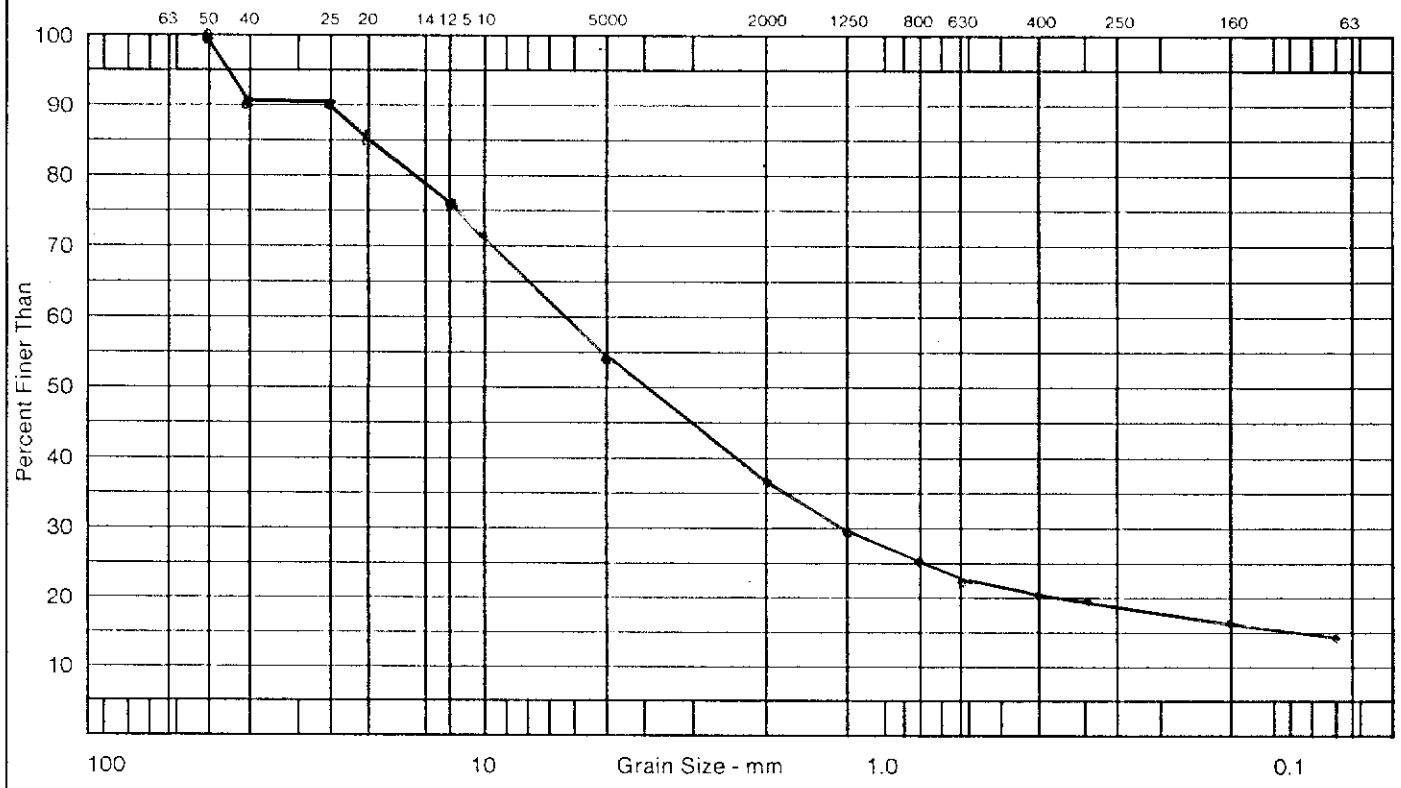
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					90.3
25,000	25.0					90.3
20,000	20.0					86.3
12,500	12.5					75.6
10,000	10.0					72.0
5,000	5.0					53.5
2,000	2.0					36.2
1,250	1.25					29.3
800	0.800					25.1
630	0.630					23.3
400	0.400					20.6
315	0.315					19.3
160	0.160					16.9
80	0.080					14.0

Description of Sample
Sandy Gravel, some silt, GM
Subangular and Subrounded Shapes

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks
Moisture: 6.8 %
Gravel: 46.5 %
Sand: 39.5 %
Silt: 14.0 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 10C Depth: 0-30cm

Location: Nugget Gulch Tailings Pile

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/17

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					
25,000	25.0					100.0
20,000	20.0					78.0
12,500	12.5					66.3
10,000	10.0					55.4
5,000	5.0					34.8
2,000	2.0					22.5
1,250	1.25					18.5
800	0.800					16.5
630	0.630					15.3
400	0.400					13.8
315	0.315					13.0
160	0.160					11.1
80	0.080					8.5

Description of Sample

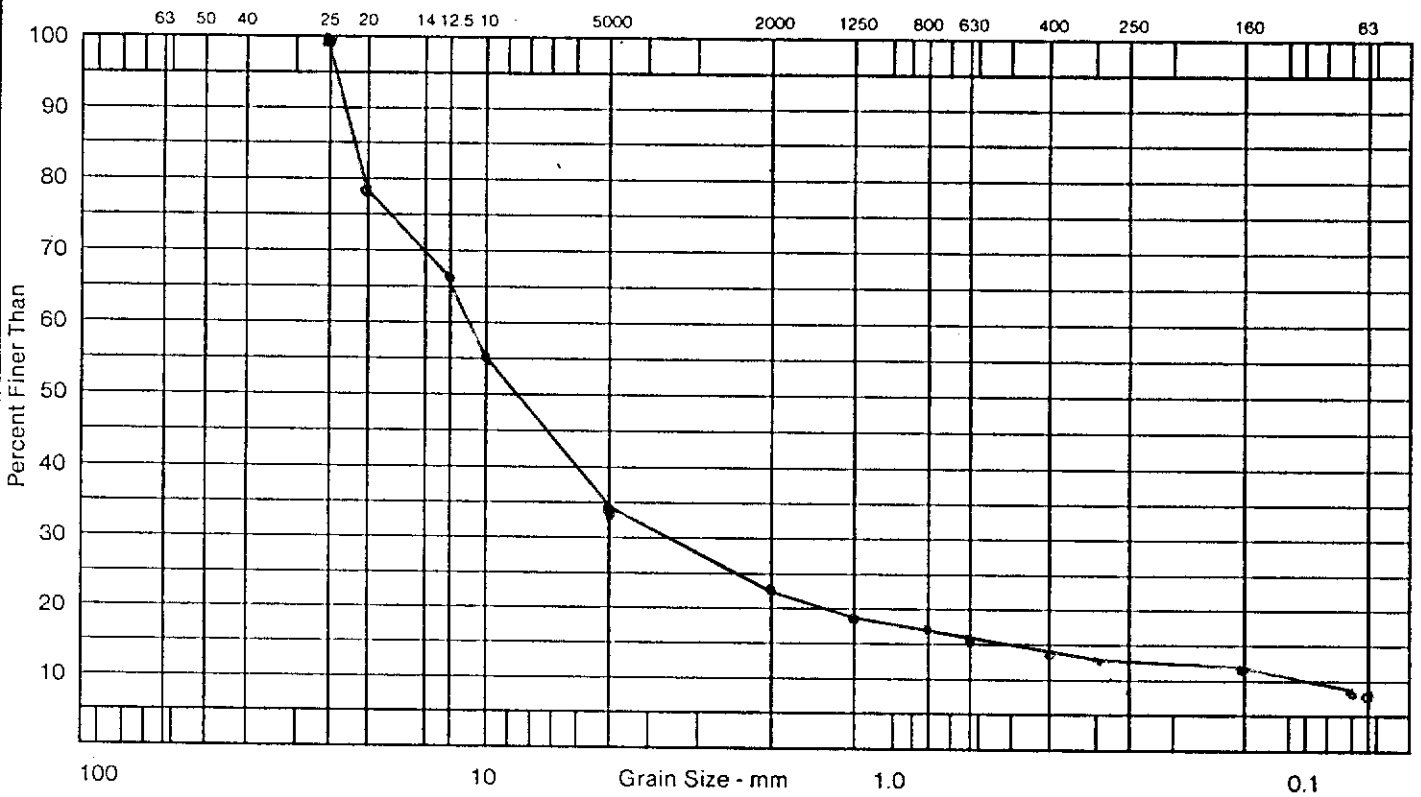
Sandy Gravel, trace of silt, GW
Subangular and Subrounded Shapes
Medium Dense to Dense / Machine Compacted

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 4.1%
Gravel: 65.2%
Sand: 26.3%
Silt: 8.5%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 10D Depth: 0-30cm

Location: Nugget Gulch

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/05

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					87.3
25,000	25.0					84.8
20,000	20.0					84.8
12,500	12.5					84.8
10,000	10.0					84.8
5,000	5.0					84.7
2,000	2.0					67.9
1,250	1.25					53.3
800	0.800					43.0
630	0.630					38.5
400	0.400					30.4
315	0.315					26.2
160	0.160					17.6
80	0.080					9.9

Description of Sample

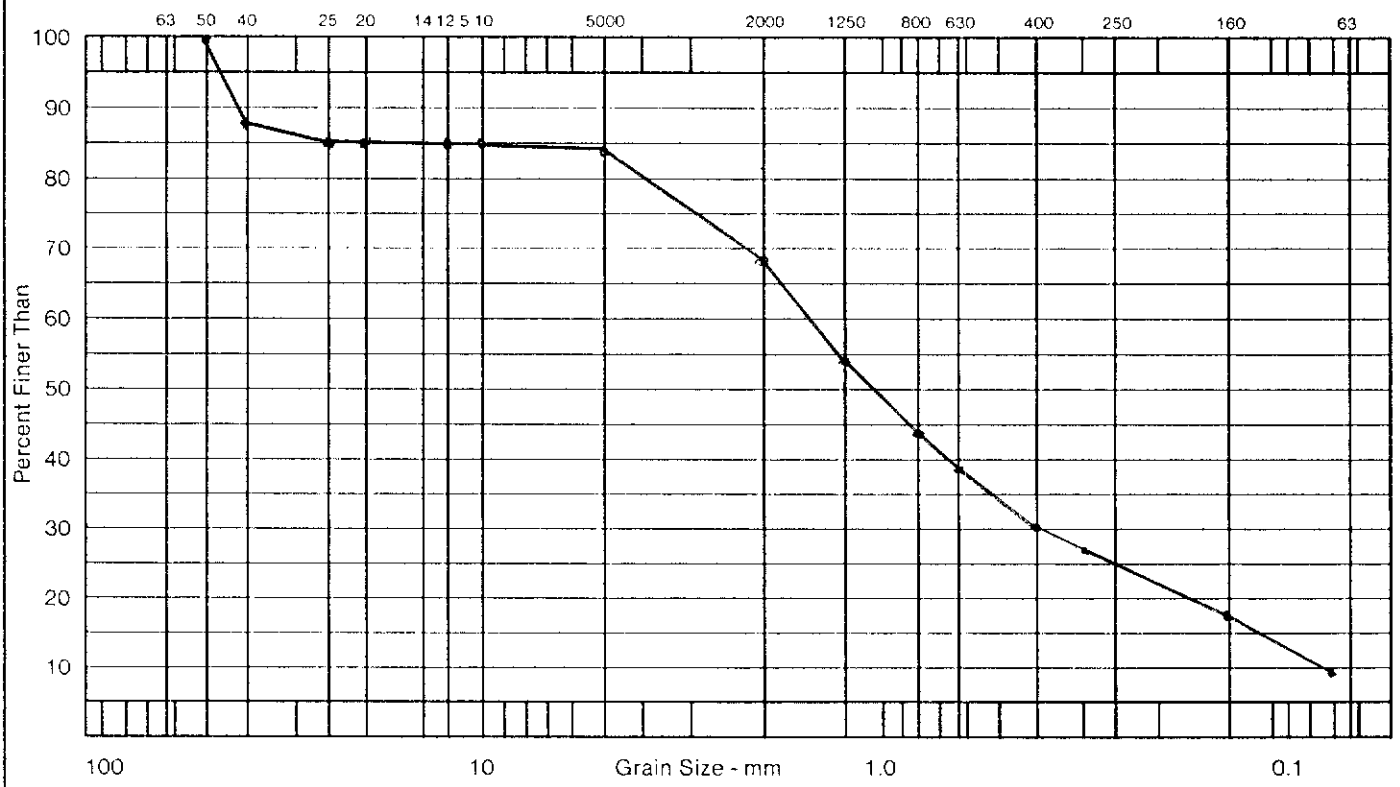
Gravelly Sand, trace of SILT SW
Subrounded and Subangular Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 4.3 %
Gravel: 15.3 %
Sand: 74.8 %
Silt: 9.9 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 10E Depth: 0-30cm

Location: Nugget Gulch

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/04

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					100.0
40,000	40.0					90.4
25,000	25.0					72.8
20,000	20.0					58.0
12,500	12.5					49.3
10,000	10.0					44.7
5,000	5.0					31.7
2,000	2.0					21.3
1,250	1.25					16.7
800	0.800					14.0
630	0.630					12.9
400	0.400					11.3
315	0.315					10.4
160	0.160					9.1
80	0.080					7.4

Description of Sample

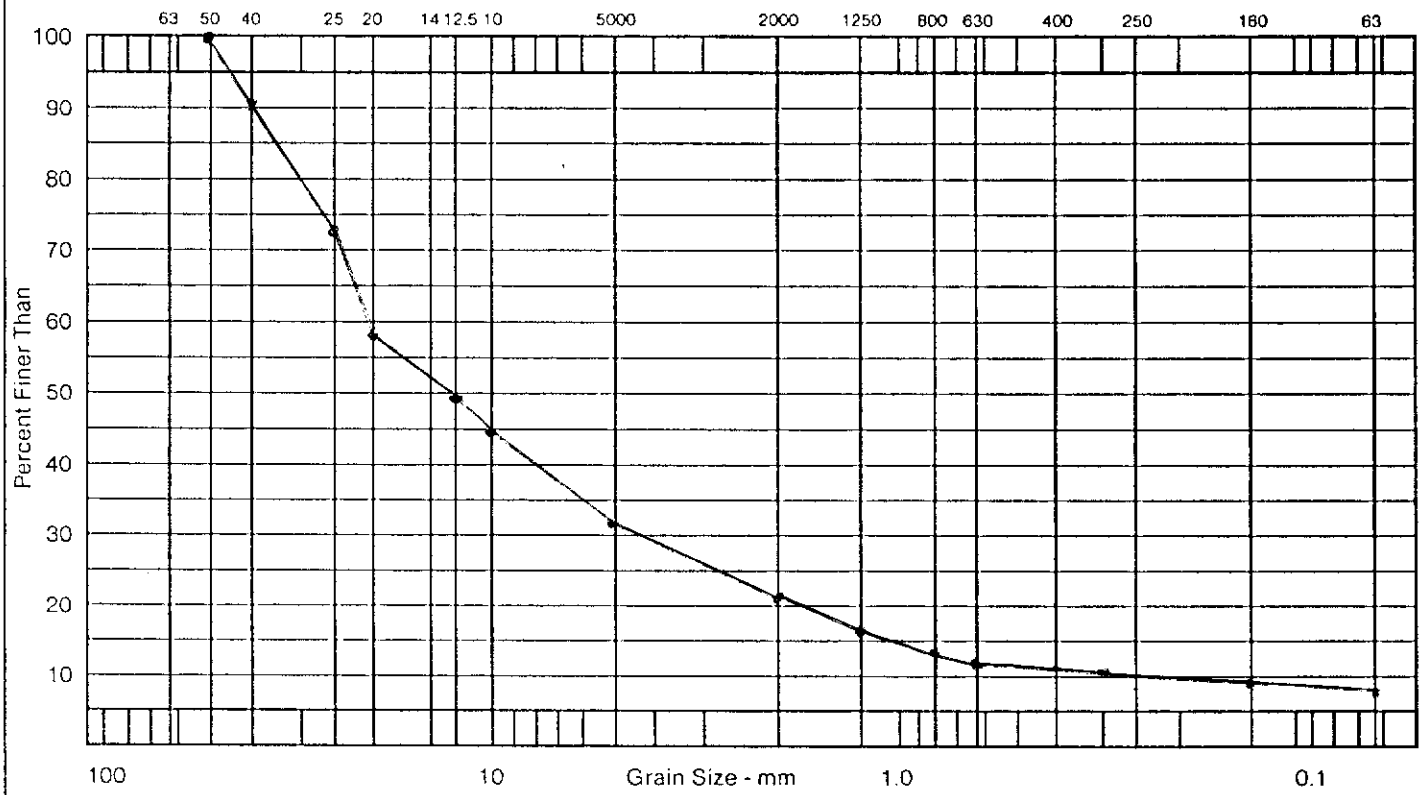
Sandy Gravel, trace of silt, GW
Subangular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 9.3 %
Gravel: 68.3 %
Sand: 24.3 %
Silt: 7.4 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: 10F Depth: 0-30cm

Location: Nugget Gulch North/North West Facing

Client: GEO-ANALYSIS & ASSOCIATES

Project: Land Claim Reclamation Project

Made by: MK Job No.: 8108

Ck'd by: _____ Date: 1994/10/06

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
63,000	63.0					
50,000	50.0					
40,000	40.0					100.0
25,000	25.0					97.7
20,000	20.0					92.3
12,500	12.5					88.2
10,000	10.0					84.4
5,000	5.0					74.8
2,000	2.0					65.0
1,250	1.25					60.2
800	0.800					56.7
630	0.630					55.1
400	0.400					52.4
315	0.315					51.0
160	0.160					48.2
80	0.080					44.1

Description of Sample

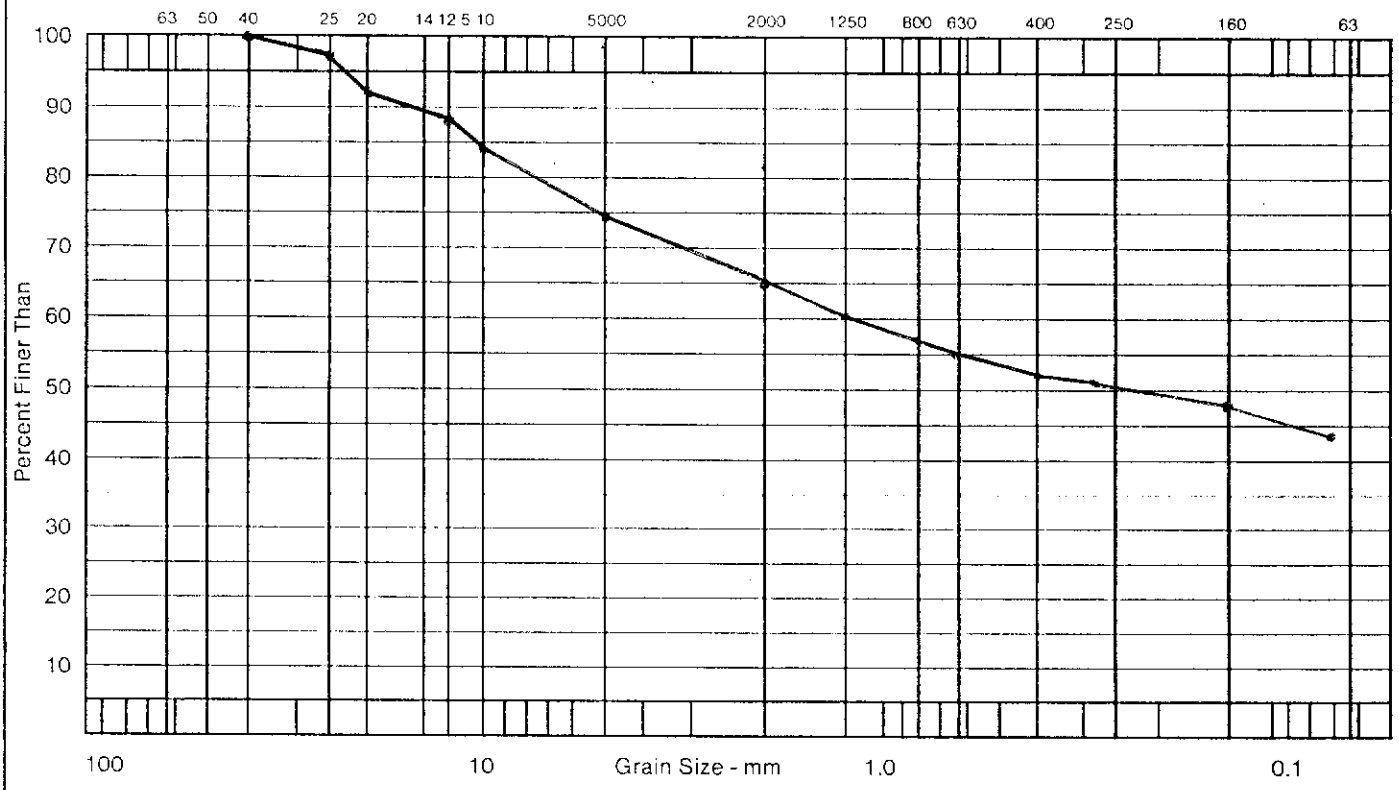
Gravelly Sandy Silt, ML
Subangular and Subrounded Shapes

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X

Remarks

Moisture: 19.8 %
Gravel: 25.2 %
Sand: 30.7 %
Silt: 44.1 %



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT		CLIENT		DATE RECORDED
Land Claim Reclamation Project		Geo-Analysis & Associates		
STA. MT Fregeau Placer Property	SAMPLE TYPE	DEPTH 14-18 cm	HOLE NO.	FIELD NO. RC1	LAB NO.

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.057	78	0.004	8
				0.043	64	0.003	6
				0.032	48	0.002	6
				0.024	36	0.001	6
				0.017	24		
				0.013	16		
		0.080	100	0.009	12		
		0.063	86	0.009	10		

SAMPLE NO.	UNIFIED CLASSIFICATION	LL	P.L.	P.I.	NATURAL % H2O	S.G.

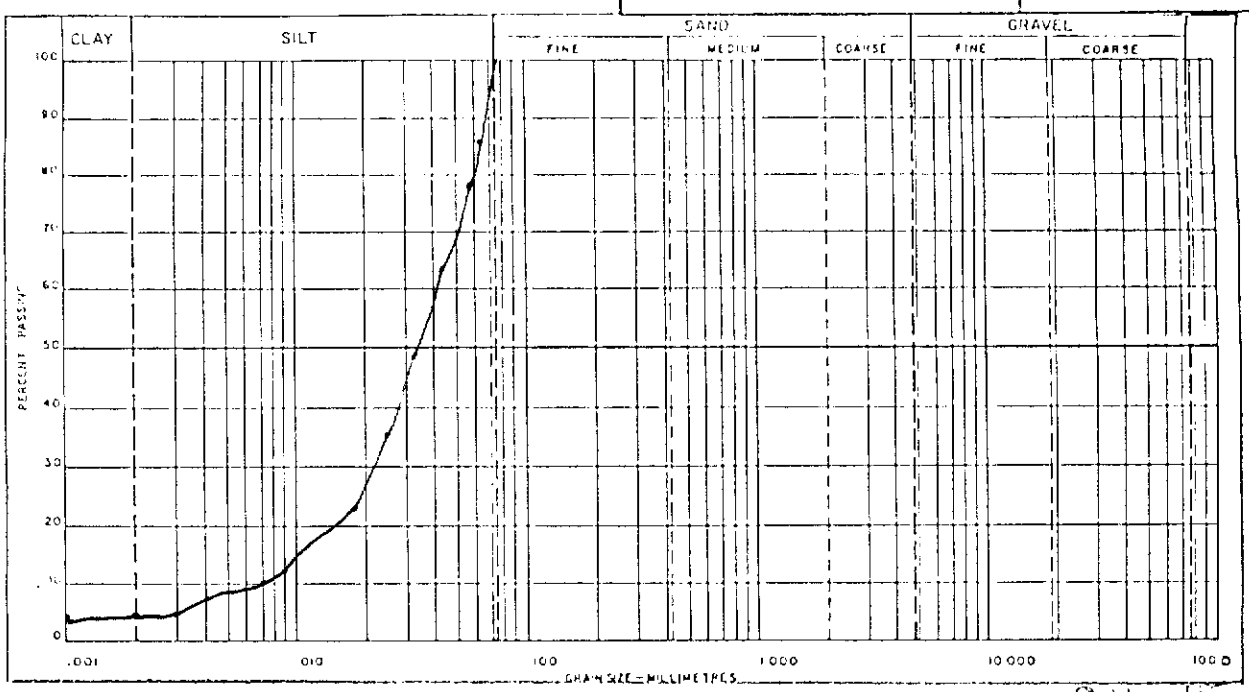
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Silt, trace of Clay, ML	
	Moisture: 34.5%
Frosty condition	
St. If C_c: 0.5 - 1	
Actual 0.9 ; 90 Kpa	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS: Settling Pond - Pond Bottom

DATE SAMPLED: 9-11-15

DATE RECEIVED: 94/09/18

TECHNICIAN(S): MK

CHECKED BY: _____

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

EDMONTON – GRANDE PRAIRIE – WHITEHORSE – PEACE RIVER

PROJECT	CLIENT	DATE RECORDED
Land Claim Reclamation Project	Geo-Analysis & Associates	94/09/09

STA.	SAMPLE TYPE	DEPTH	HOLE NO.	FIELD NO.	LAB NO.
Mt Eaggold Placer Property		0-20cm		RC3	

GRAIN SIZE ANALYSIS

SIEVE SIZE	% FINER BY WEIGHT	SIEVE SIZE	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT	DIA. mm	% FINER BY WEIGHT
				0.087	67	0.006	18
				0.063	56	0.005	15
				0.044	54	0.003	12
				0.032	48	0.002	8
				0.023	46	0.001	6
				0.017	38		
				0.012	30		
				0.009	24		

SAMPLE NO.	UNIFIED CLASSIFICATION	L.L.	P.L.	P.I.	NATURAL % H2O	S.G.

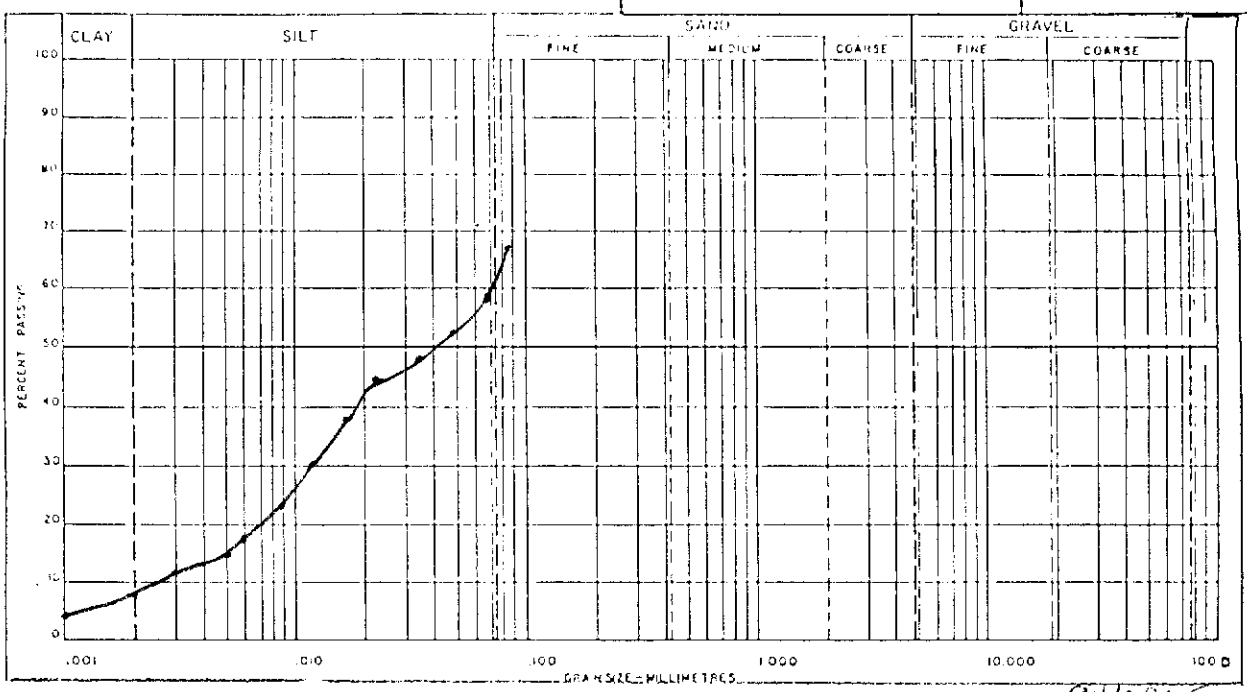
PETROGRAPHIC ANALYSIS

MATERIAL TYPE	% OF TOTAL SAMPLE
Sandy Silt, trace of Clay ML-SM	Moisture 13.5%
Inplace Condition Soft c=0.125-0.25 tons/ft²	

PARTICLE SHAPE ANALYSIS

ROUND	
SUB-ROUND	
ANGULAR	
SUB-ANGULAR	
FLATS	
NEEDLES	

CRUSH COUNT _____ %



LABORATORY'S REMARKS

Aspect - West
Slope 40° / Height 97m

DATE SAMPLED 94/09/15

DATE RECEIVED 94/09/16

TECHNICIAN(S) MK

CHECKED BY