KLUANE FIRST NATION

AQUIFER AND WELLHEAD PROTECTION PLAN
KLUANE FIRST NATION COMMUNITY WELLS

BURWASH LANDING, YT

W23101003

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EXECUTIVE SUMMARY

At the request of Mr. Ted Danyluk, Capital Project Director of Kluane First Nation (KFN), EBA Engineering Consultants Limited (EBA) has completed an Aquifer and Wellhead Protection Plan (AWHPP) for three Community Wells currently in use in Burwash Landing, Yukon. The AWHPP also includes two potential locations being considered for one proposed Back-up Well (See Figures 1 through 3).

The objective of an AWHPP is to provide realistic protective measures to pragmatically manage activities in the capture zone or recharge area of a well or well field to reduce risks to a water supply source. This is important to protect the valuable resource, the health and safety of the community, and to protect the investment in water supply infrastructure.

Based on Community Well logs the wells are completed in sand and gravel aquifer below the silt and clay unit at a depth of 47 to 61 m depth below surface. There is a significantly thick fine-grained soil unit protecting the confined aquifer (Kluane Aquifer). This soil layer acts to minimize the risk to the aquifer from contamination from the surface by slowing travel times, which allows for some breakdown and renovation of potential contaminants.

Based on the findings of this study, EBA emphasizes the following conclusions:

- To date there has been no identified contamination in groundwater sampled from the Community Wells; however, any release of contaminants within the identified capture zones would represent a potential risk to the aquifer and water quality of the Community Wells;
- Water quality results from the Community Wells do not suggest that the leach pits serving the Teachery and Daycare are impacting the water quality of the wells at this time. However, it is considered prudent to replace these improperly constructed septic systems with properly constructed and approved septic tanks for sewage reduction;
- The highest risks to the Community Well KFN-F and potential Back-up Well location MV-A were potential releases and spills from, or while filling or servicing the AST and the wood fired boiler systems near the Water Truck Garage;
- The highest risk to the potential Back-up Well location MV-B was the livestock pen;
- There were no identified risks found within the capture zones for KFN-G based on the conceptual hydrogeological model. However, future revisions, updates of APECs and potential planning and development management strategies still apply to these wells;
- No solid waste dumps are known to exist within the capture zones of the Community Wells and Back-up Well locations. However, it was reported that in the past, it was common practice to dig a pit in the vicinity of a dwelling and deposit the refuse from that dwelling into the pit. The locations of all of such pits are unknown and do present a potential source of contamination; and,
- Table 4 and Figures 2, 3 and 5 summarize the risk evaluation based on exposure likelihood and hazard consequence of the potential hazards identified through this process.

Recommendations for risk reduction and management strategies are presented in Table 6, attached, and summarized within section 7.2 of this report.

PAGE

PAGE

TABLES (ATTACHED)

TABLES (IN TEXT)

FIGURES (ATTACHED)

FIGURES (IN TEXT)

PHOTOGRAPHS

APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

At the request of Mr. Ted Danyluk, Capital Project Director of Kluane First Nation (KFN), EBA Engineering Consultants Limited (EBA) has completed an Aquifer and Wellhead Protection Plan (AWHPP) for three Community Wells currently in use in Burwash Landing, Yukon. The AWHPP also includes two potential locations being considered for one proposed Back-up Well (See Figures 1 through 3).

This report presents the findings, discussion, conclusions and recommendations resulting from this study.

1.2 PURPOSE AND SCOPE

The purpose of this project was to provide a Risk-based AWHPP for the KFN Community Wells and two potential locations being considered for a proposed Back-up Well. AWHPPs are established to identify, forestall, manage, mitigate, monitor and communicate issues of water quality and quantity in groundwater supplies used by humans, animals (e.g., livestock), plants (e.g., irrigation) or for process water. Groundwater ultimately entering a well comes from an area that is defined as a capture zone or recharge area for that well. The basic objective of an AWHPP is to provide realistic protective measures to pragmatically manage activities in the capture zone or recharge area of a well or well field to reduce risks to a water supply source. This is important to protect the valuable resource, the health and safety of the community, and to protect the investment in water supply infrastructure.

This AWHPP is presented in five parts: Stage 1 – Background, Stage 2 – Risk Framework, Stage 3 – Risk Assessment, Stage 4 – Areas of Potential Environmental Concern within the Wellhead Protection Areas and Stage 5 – Risk Management, followed by conclusions and recommendations. This model is adapted from British Columbia's Ministry of Environment (BC MoE) Tool Kit.

2.0 STAGE ONE – BACKGROUND

2.1 KFN COMMUNITY WELLS

Indian and Northern Affairs Canada's (INACs) *First Nation Water Management Strategy* provided funding for development of AWHPPs for KFN Community Wells and potential new wells. A community well is defined by INAC to be a well that has more than four service connections or serves a public building. A description of each of the wells included in the study is provided below:

- Community Well **KFN- F** provides water for the Bulk Water Delivery System, and an adjacent home in which Sharon Kabanak resides;

- Community Well **KFN-C** serves the KFN Administration Building, the Laundry Facility and the Health and Social Services Building;
- Community Well **KFN–G** provides water to a Day Care and Teachery (teacher's residence); and,
- **MV-A** and **MV-B,** short for "Main Village–A" and "Main Village–B" are potential back-up well locations being considered for KFN-F. Drilling of a back-up well for KFN-F was recommended by EBA in a June 2005 report entitled, *Assessment of Existing Water Supply and Options for Improvement for the Kluane First Nation at Burwash Landing Report for Phase 2 and 3*. Two potential locations for a Back-up Well were proposed in subsequent work detailed in a report titled *"Feasibility study for Water Supply Well Locations"* (EBA, 2006). At the request of KFN, these two locations being considered within the Main Village: MV-A and MV-B: were assessed within this AWHPP. It is likely that only one of these well locations will be selected for test drilling, and by including these in the AWHPP, it provides some useful information regarding which location would be more suitable from a wellhead protection perspective. MV-A is located approximately 240 m downgradient (south-southwest) to KFN-F and60 m upgradient from Kluane Lake. MV-B is located approximately 66 m upgradient from KFN-F.

Figure 2 and 3, attached, show Community Well locations and Potential New Well Locations.

2.2 PHYSICAL SETTING

Burwash Landing is located on the shore of Kluane Lake approximately 290 km northwest of Whitehorse, Yukon on the floor of an area known as the Shakwak Trench (Figure 1). The Shakwak trench lies between Kluane Lake and the steep slopes of the Kluane Range mountains. The relief of the immediate study area shows a gentle but irregular slope to the northeast towards Kluane Lake. The KFN Community Well sites in Burwash lie within the discontinuous permafrost zone of the Yukon.

The Shakwak trench is the surficial expression of numerous active and inactive bedrock faults called the Denali fault system. Overlying the Denali fault system are various surficial geology units formed by glacial, fluvial and modern processes (Rampton 1977).

Burwash Landing is underlain by glaciofluvial soils described as sand and gravel with a thin overlying veneer of silt (Rampton 1977).

2.3 HYDROGEOLOGY

Well logs for KFN- F and KFN- G (Appendix A) indicate that course-grained sediments at the surface (likely glaciofluvial) extend to a depth of 3 to 8 m below surface. Below the coarse-grained sediments are a clay and silt unit (possibly till) to a depth of approximately 50 m below ground. Interstitial water in the clay and silt unit is predominantly frozen; suggesting permafrost is found in the vicinity of KFN-F and KFN-G. The wells are

completed in sand and gravel aquifer below the frozen silt and clay unit at a depth of 47 to 61 m depth below surface. Clay till was encountered below the sand and gravel aquifer in KFN- G but the well logs do not contain information whether the clay was frozen or not.

There is no well log available for KFN-C. However, it was reported by a Mr. Ron Buxton that KFN-C is drilled to a depth of approximately 50 m, indicating that it is possibly within the same aquifer as KFN-F and KFN-G. Therefore the soil composition in the area of this well is assumed to be similar to that of KFN-F

One of the two proposed locations for back up wells, MV-A, is in the same vicinity and aquifer as KFN-F (referred to as the Kluane Aquifer for the purpose of this report). It has therefore been assumed that this back-up well location will have similar soils to those found at KFN-F, i.e. course-grained sediments to a depth of 3 to 8 m and clay and silt below to a depth of about 50 m below the surface; permafrost is likely present; water would be drawn from a sand and gravel aquifer below the silt and clay at a depth of about 50 to 60 m below surface.

It has been assumed that the soils in the area of the second proposed well location, MV-B, are similar to those found at KFN-F upgradient from the well, however, with courser material to the north towards Kluane Lake.

On March 21, 2007, EBA completed an elevation survey of top of casing elevations of select water wells and measured groundwater elevations to develop an understanding of the groundwater flow regime (depth to static water elevation, groundwater flow direction, and gradient). Survey and water level data are provided in Table B1 in Appendix B. The groundwater flow direction was confirmed to be north north-easterly from the topographic highs of the Kluane Ranges to the topographic lows of Kluane Lake as indicated on Figure 2 and 3.

The depth to bedrock in the vicinity of Burwash Landing is unknown. The deepest well in the area was drilled to a depth of 365 m (1200 ft) at Quill Creek located approximately 25 km north of Burwash Landing (Gartner Lee Limited, 2003). Bedrock geology mapping (Gordey et al, 2003) shows that the nearest bedrock exposures are on mountain slopes approximately 4 km southwest of the community.

Based on well log information from Quill Creek, Destruction Bay and Haines Junction; the depth to bedrock beneath Burwash Landing may be up to several hundreds of meters. There is the potential for multiple aquifers with variable water chemistry and temperature to exist within these sediments. Historically, some shallow dug wells have been completed in the gravelly beach deposits developed alongside Kluane Lake (Gartner Lee Limited, 2003). Most wells in the Burwash Landing area are completed at depths ranging between 35 and 65 meters below ground level (mbgl) with yields ranging between 3 and 5 US gpm (0.2 to 0.3 L/s). Well locations, depths and yields are summarized in Table 1. In general, water quality, from the Community Wells in Burwash Landing, are good. Water samples reported in EBAs 2004 Assessment report were observed to have slight mineralization and hardness. There have been no exceedences of health-based parameters established by CDWQG;

however, historically, manganese concentrations have exceeded the aesthetic objective at KFN-F.

The yield of the aquifer in the vicinity of KFN-F is limited, as pumping tests indicate that the short-term yield of the well is higher than the long-term sustainable yield. No pumping tests have been completed on KFN-C; however, the yield has reportedly been adequate.

2.4 AQUIFER VULNERABILITY

The level of vulnerability of an aquifer is a measure of its level of risk of being affected by any contaminant introduced at or near ground surface (i.e. spills, leaks, at surface or from underground piping, tanks or septic fields). The vulnerability of the aquifer is taken into account when defining the risk to the aquifer.

There is a significantly thick fine-grained soil unit protecting the confined aquifer (Kluane Aquifer) that has been observed in all well logs that were available for review. This soil layer acts to minimize the risk to the aquifer from contamination from the surface by slowing travel times, which allows for some breakdown and renovation of potential contaminants. EBA estimated the vulnerability of the "Kluane Aquifer" using the semi-quantitative Intrinsic Susceptibility Index (ISI) method presented by the Ontario Ministry of Environment (November, 2001). ISI scores from 0 to 30 indicate high vulnerability; 30 to 80 indicate medium vulnerability, and greater than 80 suggest low vulnerability. The ISI evaluation based on lithology presented in logs for both KFN F and KFN G resulted in scores in the order of 200, which indicates that this aquifer has a very low vulnerability to potential surface sources of contamination (See Appendix B).

However, in areas closer to Kluane Lake the soils may be more course. Based on short term pumping test results for KFN-B, the aquifer in this vicinity is much more permeable than at KFN-F and G. There are no logs available for either of these wells, KFN-B and KFN-C. Based on the fact that the aquifer is more permeable near Kluane Lake, it is presumed that Well KFN-C and potential future well location MV-B are more vulnerable to contamination from the surface than KFN-F and KFN-G, however, there is insufficient information available at this time to accurately assess the vulnerability of these wells.

3.0 STAGE TWO – RISK FRAMEWORK

3.1 RISK APPROACH

The initial step towards a Risk-based AWHPP is to determine the appropriate risk approach for the project. Risk identification can be qualitative (a descriptive assessment of the risk elements; hazards, exposure likelihood and receptor) or quantitative, (based on numerical and probabilistic mathematical analysis of the risk elements). Due to the limited site information and resources available for this project, a qualitative risk approach was deemed sufficient.

3.2 RESPONSIBLE PARTIES

The responsible parties in the context of this Risk-based AWHPP are the Community Well owners: the KFN Chief and Council represent KFN members. INAC also shares responsibility, as having fiduciary responsibility and by providing funding for this project.

3.3 RISK MANAGEMENT TEAM

One of the initial steps to successful development and implementation of an AWHPP is to form a risk management team, comprising representatives from the owner, technical advisors and any key stakeholder groups such as well users in the area. The risk management team for this AWHPP currently consists of a selection of the KFN Chief and Council (the Owner) and EBA (the technical advisor). For the remainder of this report, "KFN Chief and Council" is referred to as KFN.

3.4 RISK TOLERANCE

Risk tolerance is a measure of the acceptable level of risk by the risk management team or water supplier. A risk-tolerant owner would be able to accept or transfer some level of risk, while a risk adverse owner would seek to eliminate even the lowest level of risk to the water supply.

Based on discussions with the Owner (KFN), we consider the Owner to be moderately risk adverse.

4.0 STAGE THREE – RISK ASSESSMENT: GROUNDWATER MODELLING AND CAPTURE ZONE ANALYSIS

4.1 GROUNDWATER MODELLING AND CAPTURE ZONE ANALYSIS

The first technical step in developing an AWHPP is to identify the capture zone**,** which is the geographic area that contributes groundwater to a well. The capture zone is a key element in an AWHPP, since only groundwater within this zone reaches the well. The size and shape of the capture zone depends upon the hydrogeologic setting, and the design and operational characteristics of the water supply well.

The capture zones for the KFN Community Wells were predicted using groundwater modelling software. The groundwater flow model used for capture zone analysis was developed by EBA using the Visual MODFLOW modelling code (Version 3.1.0.86 by Waterloo Hydrogeologic, Inc). Visual MODFLOW is based on the USGS MODFLOW code, which simulates groundwater flow in three-dimensions using the finite-difference method, either in steady-state or transient mode. MODFLOW uses a block centred grid system in which nodes are positioned at the centre of the finite-difference cells. The vertical dimension is simulated by defining layers within the finite-difference mesh. The following sections describe the methodology used to build and calibrate the model.

4.2 CONCEPTUAL AQUIFER MODEL

Prior to development of the numerical (computer) groundwater flow model, a conceptual flow model for the Burwash Landing area was developed. The development of a conceptual model assists in the assignment of appropriate model boundary conditions and validation of modelling results.

Development of the conceptual groundwater flow regime was carried out by reviewing available reports, documents, records, and topographic bedrock geology and surface geology maps.

As noted previously, the groundwater flow direction is north north-easterly from the topographic highs of the Kluane Ranges towards Kluane Lake. The gradient is controlled by topography, recharge area and the elevation of the discharge point (Kluane Lake). The gradient observed on March 21st, 2007 was approximately 0.06 m/m, and for the purpose of the model is presumed to be relatively consistent throughout the year. The "Kluane" aquifer(s) that provide water to KFN-F and KFN-G are likely glaciofluvial deposits and are probably lenticular or linear bearing in a north-south direction similar to the regional slope. Based on the information available, the exact shapes and extents of the aquifer(s) cannot be determined at this time. The water bearing sand and gravel deposits from which KFN-F and KFN-C obtain their water supply are presumed to be hydraulically connected (i.e. one aquifer). For the purpose of determining well capture zones and defining groundwater protection areas, EBA consider these assumptions and the conceptual model to be adequately conservative for the purpose of this study.

4.3 MODEL CONFIGURATION AND CALIBRATION

The model grid is comprised of 80 columns and 120 rows to represent the 1,000 m by 14,000 m model area (see Figure B1 - Appendix B). The model was oriented such that the y axis was parallel to the observed groundwater flow direction. Cell dimensions within the grid range from 5 m in the vicinity of the pumping wells to 50 m near the model extents. This allows for increased resolution and greater accuracy in the vicinity of the KFN Community wells. The model has four layers that were interpreted from the well logs for the area. In the vicinity of KFN F, KFN G and MV-A, the lower layer (layer 4) represents the Kluane aquifer ($K = 1.6 \times 10^{-6}$ m/s) and Layers 1, 2, and 3 represent the confining unit ($K = 1 \times 10^{-8}$ m/s).

In the vicinity of KFN-C and MV-B, Layer 1 ($K = 1 \times 10^{-8}$ m/s) represents the low permeability, permanently frozen unit presumed to exist at surface, while Layer 2, 3 and 4 are a higher permeability unit ($K = 4.7 \times 10^{-3}$ m/s) with a hydraulic conductivity based on former pumping test results from KFN-B.

Constant head cells were positioned at Kluane Lake, the north (top) of the model domain and the meadow areas to the south end of the village south (bottom) of the model domain.

Pumping wells (the Community Wells) were assigned pumping rates equivalent to the predicted future average day demand for each well. These have been estimated to be 38 m^3/day for KFN-F (and back-up wells) and 1.4 m^3/day for KFN-C and KFN-G.

In order to compare actual and simulated groundwater flow, the model was verified by comparing model heads with actual groundwater elevations observed in the field. Model parameters were adjusted within appropriate ranges until acceptable matches between predicted and observed heads were achieved.

To obtain output for the current pumping situation, wells KFN-F, C and G were simulated to start pumping at the same time. The back up wells would only be pumping when KFN-F is not. Therefore, to define the back-up well capture zones, they were simulated to start pumping one at a time, while KFN-C and G were also pumping and KFN-F was not.

4.4 MODEL RESULTS AND DISCUSSION

Once the model was "run" and "calibrated", the "backward tracking particle method" was used to simulate the 1, 5, and 10-year capture zones for each well. In a backward particle simulation, as the name implies, particles are "released" at the well, then tracked backward through time assuming they are transported by the flow field generated by the computer model. Output for model iterations are provided in Appendix B. Figure 2 and 3, attached, also present the 1 year, 5 year and 10 year predicted capture zones for each well at the average day demand flows with some contingency for increased demand in future.

As shown in Figures 2 and 3, the capture zone for KFN-F and back-up wells MV-A and MV-B are larger than the capture zones for KFN-C and G due to the higher rate of pumping. The capture zones for KFN-F and MV-A are elliptical with the y-axis along the direction of groundwater flow. The total area of the 10 year capture zone for KFN-F and MV-A is approximately 3.5 hectares.

The shape of the predicted capture zones for potential well MV-B is more elongated in the direction perpendicular to the groundwater flow direction, and parallel to the lake front in the more permeable sediments and lake - thaw bulb that for the purpose of the model is assumed to exist. The total area of the 10 year capture zone is approximately 2 hectares.

Capture zones for KFN-C and G are smaller because the average day demand is lower for these wells. Well KFN-C has a 10 year capture zone with a total area of less than 0.1 hectares and has its Y-axis parallel to the direction of groundwater flow, while KFN-G has a capture zone of less than 0.2 hectares. The shape of the KFN-G capture zone is influenced by the drawdown from KFN-F.

Groundwater models inherently contain a degree of uncertainty, stemming from a number of simplifying assumptions that need to be made, in order to model a natural system. The conservative assumptions built into the groundwater flow model result in the definition of both reasonable and realistic AWHPPs.

5.0 STAGE FOUR - AREAS OF POTENTIAL ENVIRONMENTAL CONCERN WITHIN THE WELL PROTECTION AREAS

5.1 POTENTIAL RECEPTORS

Potential receptors are the users of the Community wells, as previously noted in Section 2.1 of this plan, namely:

- KFN residents who receive trucked water from Well **KFN- F,** and an adjacent home owner (Sharon Kabanak) as her home is connected to KFN-F. (Note that those who receive water from KFN-F are the same receptors as would consume water from the Back-up Well);
- Users of the Day Care and Teachery, which are supplied water from **KFN – G**; and,
- Staff and users of the KFN Administration Building, the Laundry Facility and the Health and Social Services Building, with water sourced from Well **KFN-C**.

5.2 METHOD OF RISK EVALUATION

In order to access potential risks to the Community Wells and potential Back-up Well, EBA identified potential sources of contamination. EBA then plotted the sources or Areas of Potential Environmental Concern (APECs) on a map in relation to the capture zones.

EBA used several different methods to identify APECs near and within the capture zones, including:

- Meeting with KFN representatives to collect anecdotal information (completed on March 21, 2007);
- Site reconnaissance (completed on March 21, 2007);
- Reviewing current and historical maps for the area;
- Completing a large area search (10 km radius of the Site) for spills records within Environment Canada, Environmental Protection Branch Spills Records that search for spills up to 2001;
- Completing a large area search (10 km radius of the Site) for contaminated sites and spills within the Government of Yukon (YG), Department of Environment, Environmental Programs Branch; and,
- Reviewing previous relevant reports.

5.2.1 Contaminated Sites and Spills Search, Environment Canada

Environment Canada maintained spill records within the Yukon between 1972 and 2001. From 2001 on, the responsibility was transferred to the Government of Yukon (YG). A search of EC records did not identify any recorded spills or contaminated sites within the capture zones. However, Ms. Nathalie Lowry of Environment Canada indicated that there were four spills recorded for the Burwash Landing Yukon area. These spills are listed in Table 2 and shown on Figures 2 and 3, attached. EC reports are included in Appendix C.

5.2.2 Contaminated Sites and Spills Search, Government of Yukon

YG - Department of Environment has maintained the Yukon Spills Report Centre since 2001. A large area search (10 km radius of the Site) was conducted for contaminated sites and spills. The search did not identify any recorded spills or contaminated sites within the well captures zones. This does not exclude the possibility of unreported contamination, but rather; only that YG does not have any recorded contaminated sites information for the capture zone area. It was reported; however, that there were two contaminated sites within the Burwash Landing area and are listed in Table 2 as D4 and SP4 and shown in Figures 2 and 3, attached. The reports are provided in Appendix C.

5.3 SUMMARY OF APECS IDENTIFIED WITHIN THE DEFINED WELL CAPTURE ZONES

Table 2, attached, presents a summary of all APECs identified throughout the area and their distance to each Community Well. Figures 2 and 3, attached, show the spatial distribution of all of the identified APECs in relation to the defined capture zones. The inventory presented in Table 2 and in Figures 2 and 3 should not be considered as a static "one-time" item; rather, it is a framework for on-going management and should be reviewed and revised over time as APECs or the associated risks change. Potential chemical and biological pathogens have been considered in this inventory. Note that only some of the areas identified in Table 2 are located in or near the well capture zones. All sites that were identified as part of this study are shown to assist with future planning and development.

5.4 RISK MATRIX

Estimates of the risk to well users from each hazard have been developed using the Risk Matrix shown in Figure 4 on the following page. The risk estimates are based on several factors including:

- Size and magnitude of the hazard (point source or non-point source);
- Location (i.e., distance from well(s);
- Groundwater travel time to the well(s);
- The likelihood of the contaminant directly affecting water at the well; and,
- The severity of the hazard to water entering the well (or toxicity of PCOC).

Table 3 on the following page shows the exposure likelihood and hazard consequence that help to define the risk for each APEC within the capture zone. At the discretion of the management team, these categories are defined based on the conservative travel time estimates and sophisticated health/toxicity criteria. Secondary effects of contaminated water, such as degradation of stream water quality from discharge well water, are beyond the scope considered here.

TABLE 3: EXPOSURE AND HAZARD CATEGORIES	
Exposure Likelihood	Criteria
Low	Groundwater travel time over 5 years (Zone 3)
Medium	Groundwater travel time 1 to 5 years (Zone 2)
High	Groundwater travel time 1 year or less (Zone 1)
Hazard Consequence	Human Criteria
Low	Exceeds aesthetic objectives in drinking water guidelines
Medium	Short-term health conditions (Lost time: days to months)
High	Chronic to Acute health hazard (Permanent Disabilities or fatalities)

The Risk Matrix shown in Figure 4, below, shows a tool to evaluate the relative risk from each potential hazard scenario. As shown, the risk posed by each potential hazard in Table 4, below, is a combination of the exposure likelihood and hazard consequence. The Exposure Likelihood was assessed taking into consideration the horizontal travel time of the contaminant once it has reached the aquifer and the vertical travel time to reach the aquifer. Based on the knowledge of the hydrogeology of the Burwash Landing area, there is a substantially thick confining aquitard which provides a protective layer for the Kluane aquifer. This protective layer significantly increases the vertical travel time of the contaminant to the aquifer, and therefore decreasing the level of risk.

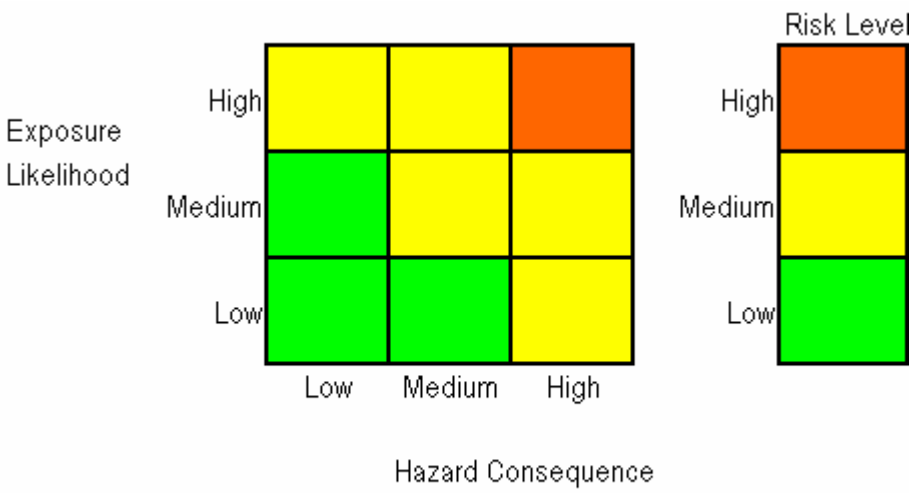

Figure 4: Risk Matrix

Note: Drawing produced in colour; reproduction may not be representative of the original.

The hazard scenarios identified in Table 2, attached, have been assessed using the above Risk Matrix. Figure 5, below, shows the risk posed by each potential hazard that is located within the Capture zones for each of the Community Wells and the two potential locations for the proposed Back-up Well. Based on the hazard location on the risk matrix, an overall risk of "low", "medium", "high", or "very high" has been assigned to each hazard scenario.

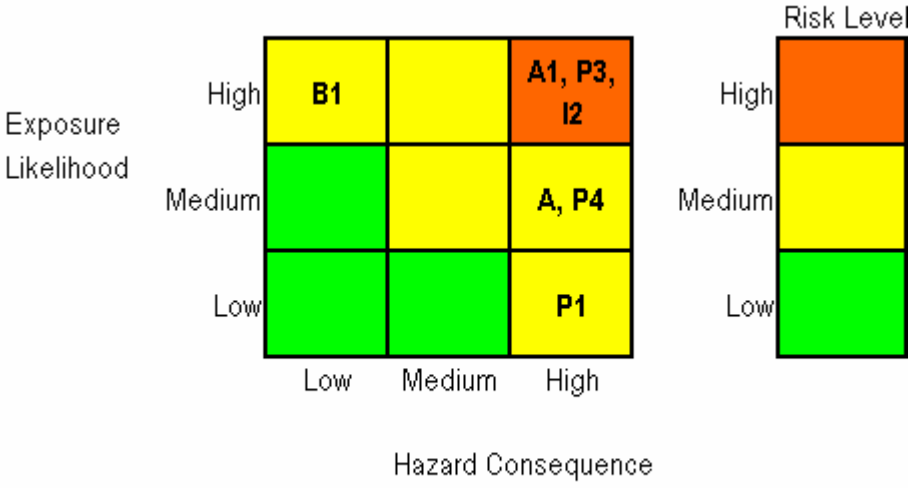

Figure 5a: Risk Matrix for KFN-F

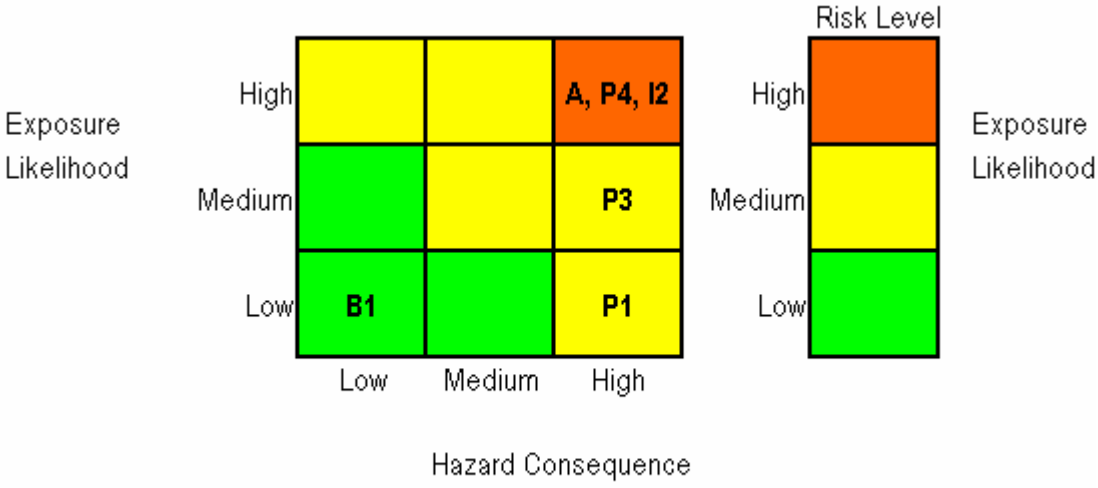

Figure 5b: Risk Matrix for Back-up Well location MV-A

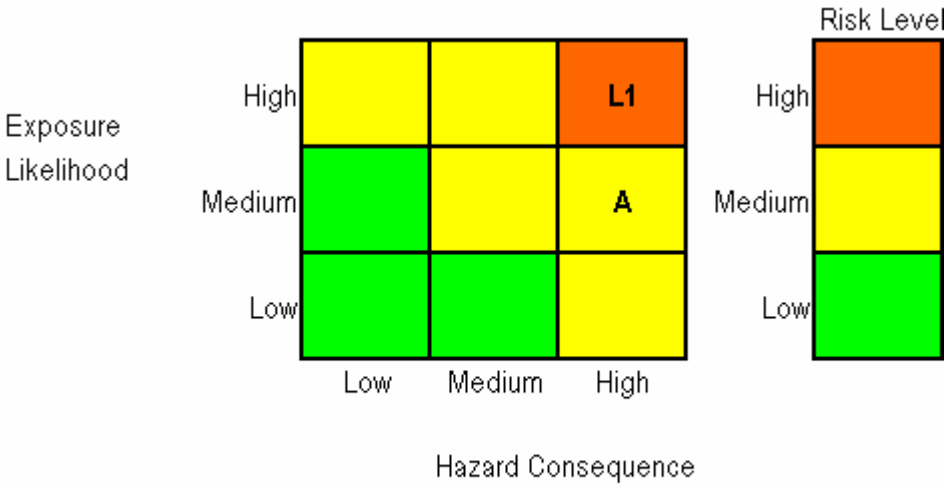

Figure 5c: Risk Matrix for Back-up Well location MV-B

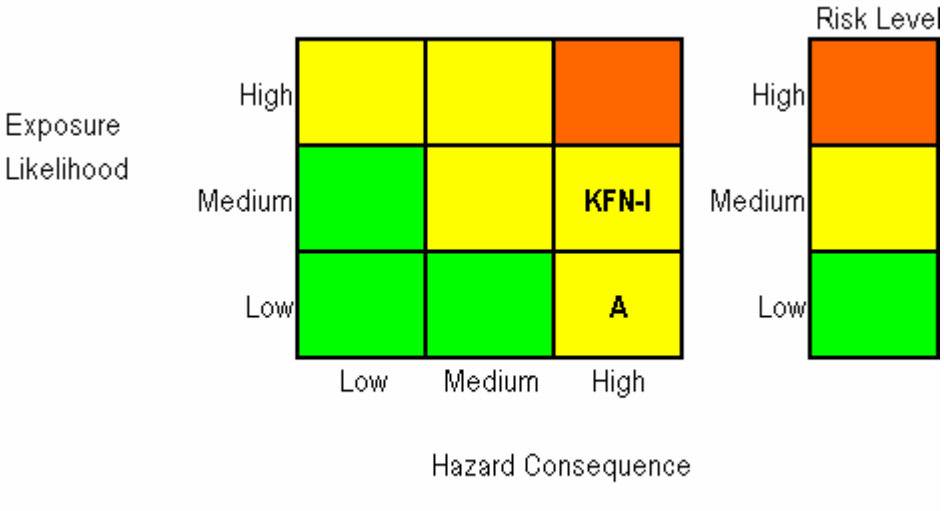

Figure 5d: Risk Matrix for Back-up Well location KFN-C

Note: Drawing produced in colour; reproduction may not be representative of the original.

5.5 RISK DATABASE AND RISK MAPS

Each hazard or threat is evaluated using the above criteria and assigned a degree of resulting risk (Low, Medium, or High). This process aims to fit the specific site conditions and the level of complexity pertinent for each Community Well and potential location for the Back-up Well and takes into account the aquifer characteristics and well usage. Table 4 below is a risk database which summarizes the hazard scenarios within the capture zones identified in Table 2 and the results obtained by plotting the hazard scenarios on the Risk Matrix.

Table 4: Areas of Potential Environmental Concern

I.D.	Hazard Description	Exposure Likelihood*	Hazard Consequence	Risk Rank
	KFN-F			
A1	Spills/Leaks from Heating Oil AST for Water Truck Garage	High	High	High
A	Spills/leaks from other ASTs, Vehicles, etc.	Medium	High	Medium
B1	Leak from Wood Fired Boiler System	High	Low	Medium
P1	Leach Pit near Day Care	Low	High	Medium
P3	Overflow or rupture of Septic Tank for Water Truck Garage	Medium	High	Medium
P4	Overflow or rupture of Septic Tank for Sharon Kabanak Residence	Medium	High	Medium
I2	Potential Development near Water Truck Garage	High	High	High
	MV-A			
A	Spills/leaks from ASTs, Vehicles, etc.	High	High	High
B1	Wood Fired Boiler System	Low	Low	Low
P1	Leach Pit near Day Care	Low	High	Medium
P3	Overflow or rupture of Septic Tank for Water Truck Garage	Medium	High	Medium
P4	Overflow or rupture of Septic Tank for Sharon Kabanak Residence	High	High	High
I2	Potential Development near Water Truck Garage	High	High	High
	MV-B			
A	Spills/leaks from ASTs, Vehicles, etc.	High	High	High
L1**	Horse manure associated with Arnolds Horse Pen located on Lot 17	High	High	High
	KFN-C			
A	**Spills/leaks from ASTs, Vehicles, etc.**	Low	High	Medium
KFN-I	Potential short circuiting of biological/chemicals down improperly decommissioned well	High	High	High

Notes:
High = less than 1 year travel time, Medium = 1 to 5 year, Low = 5 to 10 year
*Assumed that no degradation of chemical or biological parameter of concern occurs during groundwater transport
** According to the National Resources Conservation Service (world wide web, http:/patriotrcd.org/nrchorsepamphlet2002.pdf), pathogens found in horse manure include viruses, parasites and bacteria such as C. Parvum, Giardia, and E.Coli.

Based on the conceptual hydrogeological model, there were no identified APECs found within the capture zone for Community Well KFN-G. However, future revisions, updates of APECs and potential planning and development management strategies still apply.

Understanding, tracking, and managing identified risks is made straightforward and intuitive by using colour-coded Risk Maps included in Figures 2 and 3, attached. The colours of the capture zones shown on Figure 2 and 3 correspond to levels of risk shown in the Risk Matrix (Figures 4 and 5, enclosed). The Risk Maps are the key deliverable and forms the basis for the AWHPP. The Risk Maps are also presented in a Risk Information Poster for the KFN Community.

The Risk Database and Risk Maps represent the current conditions of the well and aquifer and should not be considered as a static item. The Risk Database and Risk Maps should be

updated as new risks are identified and as known risks are managed to low levels and taken off the database.

5.8 RISKS WITHIN WELL CAPTURE ZONES

The AWHPP consists of different zones, which define the level of control required (and thus groundwater resource management strategies) to safeguard a water supply, including:

- The 1-year travel time zone (Zone 1);
- The 5-year travel time zone (Zone 2); and,
- The 10-year travel time zone (Zone 3).

Zone 1 is considered to be at risk for microbial pathogens as well as chemical contaminants. Zone 1 also incorporates the sanitary zone which consists of the area immediately surrounding the wellhead. Zone 2 and Zone 3 delineate zones at risk from varying degrees of chemical contamination.

The following sections discuss the risk evaluation in terms of the defined AWHPP zones. Where an APEC is indicated in Zone 1 and also exists in Zone 2 or 3, it is only indicted in Zone 1.

5.8.1 Zone 1 - One-year Travel Time

A contaminant release within Zone 1 represents a relatively high potential risks to the Community Wells and the proposed Back-up Well locations. Potential sources of environmental concern within Zone 1 are typically ranked as high risks (Table 4). These risks are summarized below:

- Tampering/sabotage of the wells;
- Spills/leaks from the Heating Oil AST for the Water Truck Garage located near KFN-F;
- Spills/leaks from Wood Fired Boiler System for the Water Truck Garage located near FKN-F;
- Spills/leaks from other ASTs and vehicles;
- Potential commercial and industrial development adjacent to west of Community Well KFN-F and potential Back-up Well location MV-A; and,
- Infiltration of leachate from manure piles near potential Back-up Well location MV-B;
- Spills/leaks from septic tanks located near KFN-F and MV-A; and,
- Migration of biological and or chemical contaminants down an improperly decommissioned well (KFN- I, near KFN-C –exact well location is unknown).

It is important to note that although no solid waste sites were observed within the capture zones of the Community Wells and Proposed New Wells, numerous solid waste sites were identified in previous reports and from anecdotal information obtained during the site meeting. It was reported by KFN that in the past, it was common practice to dig a pit in the vicinity of a dwelling and deposit the refuse from that dwelling into the pit[1]. The locations of such pits are unknown and do present a potential source of contamination.

5.8.2 Zone 2 - Five-year Travel Time

A contaminant release within Zone 2 represents a moderate potential risk to the production wells. Potential sources of environmental concern within Zone 2 are typically ranked as medium to high risks (Table 4). In addition to those already summarized in Zone 1, an additional identified risk for Zone 2 was improperly constructed septic systems (APECs P1 and P2) identified near Community Well KFN-F and potential Back-up Well location MV-A).

5.8.3 Zone 3 - Ten-year Travel Time

A chemical release within Zone 3 represents a relatively low potential risk to the production wells due to renovation capacity and dilution. Potential sources of environmental concern within Zone 3 are typically ranked as low to medium potential risks (Table 4, above). All risks identified in Zone 3, have already been described in Zone 1 or 2 above.

Table 5, below, summarizes the location of the potential risks for each well within Zone 1, Zone 2, and Zone 3. For each of the zones discussed above, the degree of risk to each well will depend on what is released, where the release occurs and how the release is managed at the time. Dilution will likely play a part in reducing contaminant levels for chemical contaminants; however, biological pathogens (e.g. *E. coli*) are potentially serious regardless of the concentration.

TABLE 5: SUMMARY OF LOCATION OF RISKS WITHIN THE TRAVEL TIME ZONE

Well ID	Livestock Manure			Release/Spill – AST / Vehicles, etc.			Improperly Constructed Septic Systems			Potential Commercial / Industrial Development			Improperly Decommissioned Well		
Zones	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
KFN-F				X	X	X		X	X		?[A]	?[A]			
MV-A				X	X	X		X	X		?[A]	?[A]			
MV-B	X	X		X	X	X									
KFN-C													?[B]	?[B]	

[1] Joe Bruneau, KFN Maintenance Staff. Anecdotal information collected on March 21, 2001.

6.0 STAGE FIVE – RISK MANAGEMENT

6.1 RISK MANAGEMENT STRATEGY

The risk management strategy integrates information collected during the capture zone delineation and hazard identification steps and provides workable strategies for preventing, detecting, and responding to wellhead protection risks. The following includes examples of such strategies:

- Endorsing and promoting Best Management Practices (BMPs);
- Providing public and landowner information sessions and training; and
- Implementing Action and Management Strategies provided in Table 6, attached.

Most hazard scenarios identified are *potential* rather than existing threats to the KFN Community Wells and proposed Back-up Well. Therefore, based on the capture zone assessment, the most appropriate risk management for this site will be preventative action and contingency planning in the event that one of the potential hazard scenarios occurs.

Water quality results from the Community Wells do not suggest that the improperly constructed septic systems are impacting the water quality of the wells at this time. However, it is considered prudent to have the improper systems remove and replaced with properly constructed septic tanks.

The potential location for the Back-up Well MV-B should be considered carefully based on the proximity of the livestock pen. The livestock pen is considered a high hazard due to the storage of animal manure piles located within zone 1 and 2 of this potential well. Leachate from manure piles contains pathogens and viruses that can be dangerous to human health. If site MV-B is to be considered a potential area for the Back-up Well, it is recommended that the livestock pen be re-located.

In addition, it is in KFN's best interest to consider purchasing land adjacent to KFN-F and the potential Back-up Well location MV-A or form a land development agreement with the owners of the land adjacent to the west of Well KFN-F and MV-A. This will provide KFN the ability to protect and manage the wellhead and capture zones from commercial and industrial development to the west.

In terms of risk communication, the Risk Maps and Risk Information Poster can form a concise and convenient basis for communicating information regarding the status of potential threats to all stakeholders including the risk management team, water system operators, community organizations, or municipal councils. Frequent reporting is important to document progress, improve public perception, reduce potential legal issues and possibly reduce insurance costs.

6.2 RISK REDUCTION PLAN

A Risk Reduction Plan involves pre-planning actions to respond to acute risks situated within the capture zone. For example, this would include emergency response actions and communication should a contaminant release occur within a well capture zone.

6.3 RISK MONITORING

A Risk Monitoring Plan involves periodic review, auditing and updating of the Risk Maps and Risk Database. Once an AWHPP is in place, continued implementation and monitoring of the program is essential to protect the wells and release risks to users. The Risk Monitoring Plan entails periodically inspecting the Community Wells, potential Back-up Well locations and well sites, periodically inspecting the capture zones for new AWHPP hazards, working together with the Community of Burwash Landing to identify and create zoning requirements for the Burwash Landing area and updating the status for each identified risk as risk management actions are implemented. The outcome of this would be revised Risk Maps for display or reporting purposes.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

EBA has developed this AWHPP for the Community Wells and the potential Back-up Well locations within the KFN community located within the Town of Burwash Landing, which includes zones of varying vulnerability: Zone 1 (from the wellhead to 1 year travel time), Zone 2 (1 year to 5 year travel time) and Zone 3 (5-year to 10-year travel time).

Based on the findings of this study, EBA emphasizes the following conclusions:

- To date there has been no identified contamination in groundwater sampled from the Community Wells; however, any release of contaminants within the identified capture zones would represent a potential risk to the aquifer and water quality of the Community Wells;
- Water quality results from the Community Wells do not suggest that the leach pits serving the Teachery and Daycare are impacting the water quality of the wells at this time. However, it is considered prudent to replace these improperly constructed septic systems with properly constructed and approved septic tanks for sewage reduction;
- The highest risks to the Community Well KFN-F and potential Back-up Well location MV-A were potential releases and spills from, or while filling or servicing the AST and the wood fired boiler systems near the Water Truck Garage;
- The highest risk to the potential Back-up Well location MV-B was the livestock pen;
- There were no identified risks found within the capture zones for KFN-G based on the conceptual hydrogeological model. However, future revisions, updates of APECs and potential planning and development management strategies still apply to these wells;
- No solid waste dumps are known to exist within the capture zones of the Community Wells and Back-up Well locations. However, it was reported that in the past, it was common practice to dig a pit in the vicinity of a dwelling and deposit the refuse from that dwelling into the pit. The locations of all of such pits are unknown and do present a potential source of contamination; and,

- Table 4 and Figures 2, 3 and 5 summarize the risk evaluation based on exposure likelihood and hazard consequence of the potential hazards identified through this process.

7.2 RECOMMENDATIONS

EBA recommends that KFN complete the following:

- Ensure that improperly constructed septic systems be replaced with properly constructed septic tanks (APECS P1 and P2);
- Locate and properly decommission KFN-I;
- Endorse and promote hazardous waste minimization and collection programs;
- Relocate the Livestock Pen if a Back-up Well is considered for location MV-B;
- Purchase or form a land development agreement with the owners of the land to the west of KFN-F and MV-A to protect and manage the wellhead and capture zones from commercial and industrial development to the west;
- Implement contingency planning including emergency response actions and communication. KFN council should create an emergency and spill response plan identifying key personnel responsible to respond in the event of an occurrence or spill;
- Complete regular tracking and monitoring of all well risks (either with internal staff resources or outsourced to EBA). Lock wells and pump houses;
- Implement a septic tank monitoring program for tanks within Zone 1 (KFN F and Sharon Kabanak septic tanks). This would consist of monitoring tank levels, taking extra care on pumpouts to ensure that spills do not occur, and developing an awareness program for owners of tanks within zone 1;
- Increase security at wellheads through the installation of keyed alike locks for wells and treatment systems, and fencing around well houses;
- Relocate the AST near KFN-F to the opposite side of the water truck garage;
- Relocate the boiler system to the opposite side of the water truck garage;
- Consider replacing well enclosures for KFN-F and KFN-G;
- Complete some re-grading around KFN-F to promote positive drainage away from well – a swale between the water building and the well house should be constructed to divert flow away from the wellhead;
- Maintain the poster created for this study in a public part of the community, and update the poster as necessary;
- Educate the KFN community members regarding the importance of maintaining a clean environment of the land surrounding their Community Wells;

- Provide protection to the AWHPPs by installing signs identifying entrances to the AWHPP area;
- Review and update the AWHPP on a regular basis. Initially an annual review may be sufficient; however, thought should be given to an "as required" approach; and,
- Incorporate this AWHPP into the KFN community development plan , and develop a Groundwater Protection Program for Burwash Landing. This Groundwater Protection Program should consist of the following:
    - Formal recognition and protection status for identified well protection zones such as those identified in this report;
    - Enforcement of well protection measures;
    - Restrictions on some land use activities within sensitive areas and well protection zones;
    - Hydrogeological assessment as a requirement of development for land use activities considered as higher risk, and including groundwater monitoring on and adjacent to specified sites as a condition of development; and,
    - A response action plan and remedial action plans as a condition of development for some specified higher risk land uses.

8.0 CLOSURE AND LIMITATIONS

This report has been prepared specifically for Kluane First Nation for the purposes described in Section 1 of this report. The report has been prepared in accordance with generally accepted geo–environmental practices. Additional information regarding the use of this report is presented in the Environmental Report - General Conditions, which form a part of this report.

We trust this report is satisfactory. If you have any questions about this report, please contact Ryan Martin at your convenience.

Sincerely,

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ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of EBA's investigation. The client, and any other parties using this report with the express written consent of the client and EBA, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and EBA, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of this report, EBA may have relied on information provided by persons other than the client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of EBA providing the services requested, the client agrees that EBA's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

1. With respect to any claims brought against EBA by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to EBA under this Agreement, whether the action is based on breach of contract or tort;
2. With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless EBA from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by EBA, whether the claim be brought against EBA for breach of contract or tort.

4.0 JOB SITE SAFETY

EBA is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of EBA personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for EBA to properly provide the service, EBA is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform EBA of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of EBA may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect EBA employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay EBA for any expenses incurred as a result of such discoveries and to compensate EBA through payment of additional fees and expenses for time spent by EBA to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by EBA during the performance of the work and other documents prepared by EBA are considered its professional work product and shall remain the copyright property of EBA.

10.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

The Client recognizes and agrees that electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

TABLES

TABLE 1: SUMMARY OF WELL INFORMATION FOR KLUANE FIRST NATION AT BURWASH LANDING

Well Identification		GPS Coordinates			Well Details									WATER QUALITY
Project Well ID	**Description/ Resident**	**Northing (+/- 10 m)**	**Easting (+/- 10 m)**	**Grade Elevation (+/- 10 m)**	**Well Casing Diameter (mm)**	**Year Well Installed**	**Well Log?**	**Well Depth (m bg)**	**Reported Low Permeability Protective Layer?**	**Pump Setting (m bg)**	**Well Capacity - Tested, or Reported by User**	**Static Water Level Below Ground on March 21, 2007 (m-btwc)**	**Groundwater Elevation (March 21, 2007)**	
KFN - B	Abandoned Well on Kluane Lake Shore	6804186	607544	793	150	After 1985	no	47.7	Likely based on depth and geology (confined)	no well installed	Greater than 1.6 L/s (Pacific Hydrology)	4.48	780.93	-
KFN-C	KFN Health and Social Services Building	6804140	607465	794	150	unknown	no	48.8 m (reported by Ron Buxton)	Likely based on depth and geology (confined)	Unknown	Adequate supply since installation.	NA	N/A	Mn > AO
KFN-F	Water Truck Garage	6803835	607584	805	150	1987	yes	61	Yes -approx. 50 m of clay, silt and or till (likely frozen). Confined	50.0	Can produce at 1.15 L/s (not sustainable). Capacity less than 1.46 L/s based on pump test.	NA	N/A	Mn > AO
KFN-G	Daycare	6803787	607654	799	150	1976	yes	49.3	Yes - 40 m of clay till (frozen). Confined	? - drill record recommended pump to be set at 44 m bg.	Has provided adequate supply to daycare and teacherage since installation.	3.874	792.56	All below MAC and AO
KFN-H	Hockey Rink	6803638	607665	805	130	1997	yes	65	Yes - permafrost, and likely till (> 40 m). Confined	Unknown	Adequate supply since installation.	2.485	792.5	Fe > AO, As > MAC
KFN - I	Abandoned Well near H&SS Building (Former Wash House)	Approx: 6904096	Approx: 607507	Approx: 797	150	unknown	no	Reported by Joe as approx. 49 m	Likely confined based on geology	Unknown	Unknown	NA	N/A	Unknown

Table 2: Areas of Potential Environmental Concern (APECs)
Kluane First Nation, Burwash Landing, YT

					Approximate Distance From Well (m)							
I.D.	APECs	Easting	Northing	Time Period	KFN-C	KFN-F	KFN-G	MV-A	MV-B	Notes	Inside AWHPP zone (Yes/No)	Potential Contaminants of Concern
	Solid Waste Disposal											
D1	Former Dump north of House 28	607716	6803914	60s - 70s	340	125	130	150	170	Based on Anecdotal information	NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
D2	Former Dump - Dump Road, West of Fire Break Line	608103	6803829	70s	700	485	435	515	450	Tanks at Dump are the former septic tanks from the Burwash Garage and old school (Now Health Center).	NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
D3	Former Community Dump	608518	6803563	70s - 90s	1300	1050	1005	1100	1050		NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
D4	Contaminated Site Listed as Former Dump (YG HF040)	606612	6804227	50s - 80s	855	1070	1125	1030	1110	Former Military Dump	NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
D5	Former Dump (Lot 19)	607597	6854094	90s	135	250	305	250	115	Based on Anecdotal information	NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
D6	Current Dump (used by both Burwash Landing and Destruction Bay	613123	6798745	00s - current	>1500	>1500	>1500	>1500	>1500	1/2 way between Copper Joe and Louis Creek	NO	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
	Livestock											
L1	Arnolds Horse Pen (Southwick St # 17)	607674	6804086	Summer time use	200	250	295	260	25		Yes (MV-B)	Biological (bacteria, viruses, protozoa), Chemicals (nitrates, phosphates)
	Service Stations											
SS1	Burwash Garage and Service Station	606946	6803947	Current	550	670	730	640	775		NO	Hydrocarbons (fuels, oils, lubricants), and metals
SS2	Former Service Station	607081	6804125	50s - 60s	385	600	670	575	640	Based on Anecdotal information	NO	Hydrocarbons (fuels, oils, lubricants), and metals
	Pipelines											
PL 1	Former Fairbanks and Haines Pipeline	-	-	50s	930	840	810	820	1080	Reported that agent orange and DDT was used along right of way	NO	Hydrocarbons (fuels, oils)
PL 2	Proposed Pipeline	-	-	Future Potential	>1500	>1500	>1500	>1500	>1500		NO	Natural Gas Hydrocarbons (fuels, oils)
	Spills											
SP1	Environment Canada SPILL - 0134 - Heating Tank for Burwash Resort	607080	6804307	23-Jul-01	415	710	770	675	675	Furnace Oil Leakage (7000 L)	NO	Hydrocarbons (fuels, oils)
SP2	Environment Canada SPILL - 9830 - Old fire hall BLDG next to Kluane Lake near Burwash Resort	607179	6804265	10-Jun-98	350	605	670	580	565	unknown volume	NO	Hydrocarbons (fuels, oils)
SP3	Environment Canada SPILL - 9846 - Burwash Landing Garage - fuels	606929	6803978	10-Nov-98	560	695	750	650	790	Valve left on 10000 gallons fuel storage tank spilled approx. 1000 US gal	NO	Hydrocarbons (fuels, oils)
SP4	Environment Canada - 0321 / YG - 03-21 - Golden Hills Venture - anecdotal report & Permit to remove soils	607208	6803699	08-Jul-03	395	340	380	310	515	Unsure whether or not soils were ever actually removed	NO	Hydrocarbons (fuels, oils)
	Cemeteries											
C1 C2	Existing Burwash Landing Cemeteries	607838 607944	6804040 6804022	50s	380 and 490	300 and 375	315 and 370	330 and 405	125 and 240		NO NO	Biological (bacteria, viruses, protozoa), Chemicals (nitrates, phosphates), phenols and metals
	Boiler System											
B1	Wood fired Boiler near KFN F	-	-	-	300	4	100	50	300		YES (KFN-F, MV-A)	Glycol, Hydrocarbons (fuels, oils)
	Aboveground Storage Tanks (ASTs)											
A	closest to well	-	-	-	20	10	20	10	40		YES (All)	Hydrocarbons (fuels, oils)
UA	closest upgradient from well	-	-	-	20	10	20	10	40		YES (All)	Hydrocarbons (fuels, oils)
	Underground Storage Tanks (USTs)											
UST1	Former Golden Hill Venture Camp	607247	6803727	60s	465	380	410	350	575	Reportedly tank still in place - unknown location	NO	Hydrocarbons (fuels, oils)
UST2	Former Fire Hall	607195	6804268	50s	350	605	670	580	565	Reportedly tank still in ground - east of building	NO	Hydrocarbons (fuels, oils)
	Leach Pits											
P1	Day Care (Old Allen St # 19)	607658	6803817	-	375	45	30	80	255	in winter, pumped out 1 per week	YES (KFN-F, MV-A)	Biological (bacteria, viruses, protozoa), and chemicals (household cleaning agents, nitrates, phosphates)
P2	Teachery (Old Allen St. # 17)	607680	6803797	-	410	85	35	125	275	in winter, pumped out 1 per week	NO	Biological (bacteria, viruses, protozoa), and household chemicals (cleaning agents)
	Septic Tanks within Capture Zones											
P3	Waste and water House (Well KFN-F)	607611	6803836	-	335	5	85	25	240	Currently on Site	YES (KFN-F, MV-A)	Biological (bacteria, viruses, protozoa), and chemicals (household cleaning agents, nitrates, phosphates)
P4	Residential (Old Allen St # 22) - east of Well KFN-F	607586	6803811	-	340	20	80	15	255	Currently on Site	YES (KFN-F, MV-A)	Biological (bacteria, viruses, protozoa), and household chemicals (cleaning agents)
	Septic Fields											
P5	Former Golden Hill Venture Camp	607271	6803795	not used	395	340	380	310	515	Currently on Site	NO	Biological (bacteria, viruses, protozoa), and chemicals (household cleaning agents, nitrates, phosphates)
P6	Dukes Store	607129	6803484	1999 - 2006	720	575	585	555	810	Currently on Site	NO	Biological (bacteria, viruses, protozoa), and household chemicals (cleaning agents)
	Former Military Generation Station											
I1	Former Military Generator Station	606702	6804320	50s	780	1025	1080	980	1030	No debris left (except for cement block where Generator was housed)	NO	Hydrocarbons (fuels, oils, lubricants), chemicals (herbicides, pesticides), PCBs and metals
I2	Potential Development adjacent to Water Truck Garage (Industrial and/or Commerical Activity)	-	-	-	115	5	100	5	170	-	YES (KFN-F, MV-A)	Waste leachate, biological (bacteria, viruses, protozoa), hydrocarbons (fuels, oils, lubricants), chemicals (pesticides, herbicides, cleaning agents) and metals
	Abandoned Wells											
KFN-I	Abandoned well reported to exist south of Community Hall	?	?	?	<50	?	?	?	?	May still have pump in well. Not properly decommissioned.	Possibly (KFN-C)	Could provide potential conduit for any biological or chemical contaminant to travel to aquifer.

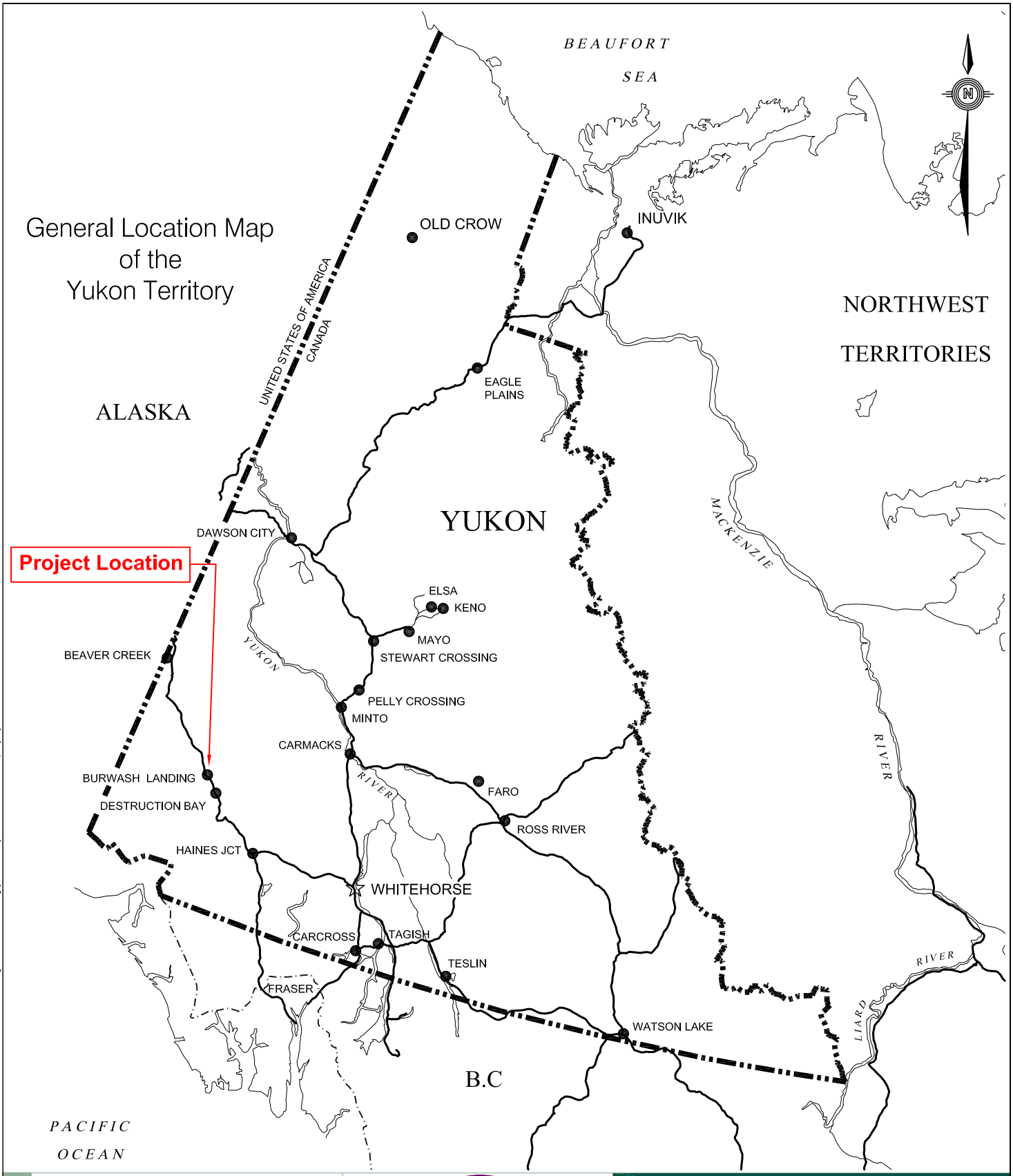
Note:

All APECs are shown on Figure 2

Green highlighting	indicates that potential contaminant source is within capture zone of existing well.
Yellow highlighting	indicates that potential contaminant source is within capture zone of proposed new well.

TABLE 6: PROTECTIVE AND PREVENTATIVE MANAGEMENT STRATEGIES	
Action	• Relocate Water Truck Garage's AST to other side of building; • Relocate livestock pen in the event that site MV-B is selected; • Locate and properly decommission abandoned well KFN-I; • Replace improperly constructed septic systems with properly constructed septic tanks (APECs P1 and P2); • Implement a septic tank monitoring program; monitor levels, extra care on pump-outs; develop owner awareness programs of septic tanks; • Purchase or form a land development agreement with the owners of the land to the west of KFN-F and MV-A so as to protect and manage the wellhead and capture zones from commercial and industrial development to the west; • Consider replacing well enclosures for KFN-F and KFN-G; • Complete some re-grading around KFN-F to promote positive drainage away from well – a swale between the water building and the well house should be constructed to divert flow away from the wellhead; • Initiate guidelines or by-laws to control and mitigate potential development activities; • Lock all wells and pump houses; • Fence around wellheads and pump houses; • Post signs around wellhead area; and, • Prepare and make readily available a spill contingency plan and contact list.
Management	• Educate maintenance staff and community members regarding risks; • Incorporate AWHPP into KFN Community Development Plan; • NO septic fields; • NO residential, commercial and industrial development; • NO installation of USTs; • NO livestock operations and manure pile storage; • NO landfills or sewage lagoons; • NO storage of commercial and industrial chemicals (fertilizers, pesticides, salt, cleaning products, fuels, lubricants, etc); • NO storage of contaminated soils and/or water; • Minimize commercial and industrial activity; and, • Minimize or restrict pesticide and herbicide use.

FIGURES



0 50 100 200 400

BAR SCALE (km)

CLIENT

KLUANE FIRST NATION WELLHEAD PROTECTION PROGRAM - BURWASH LANDING, YT

SITE LOCATION MAP

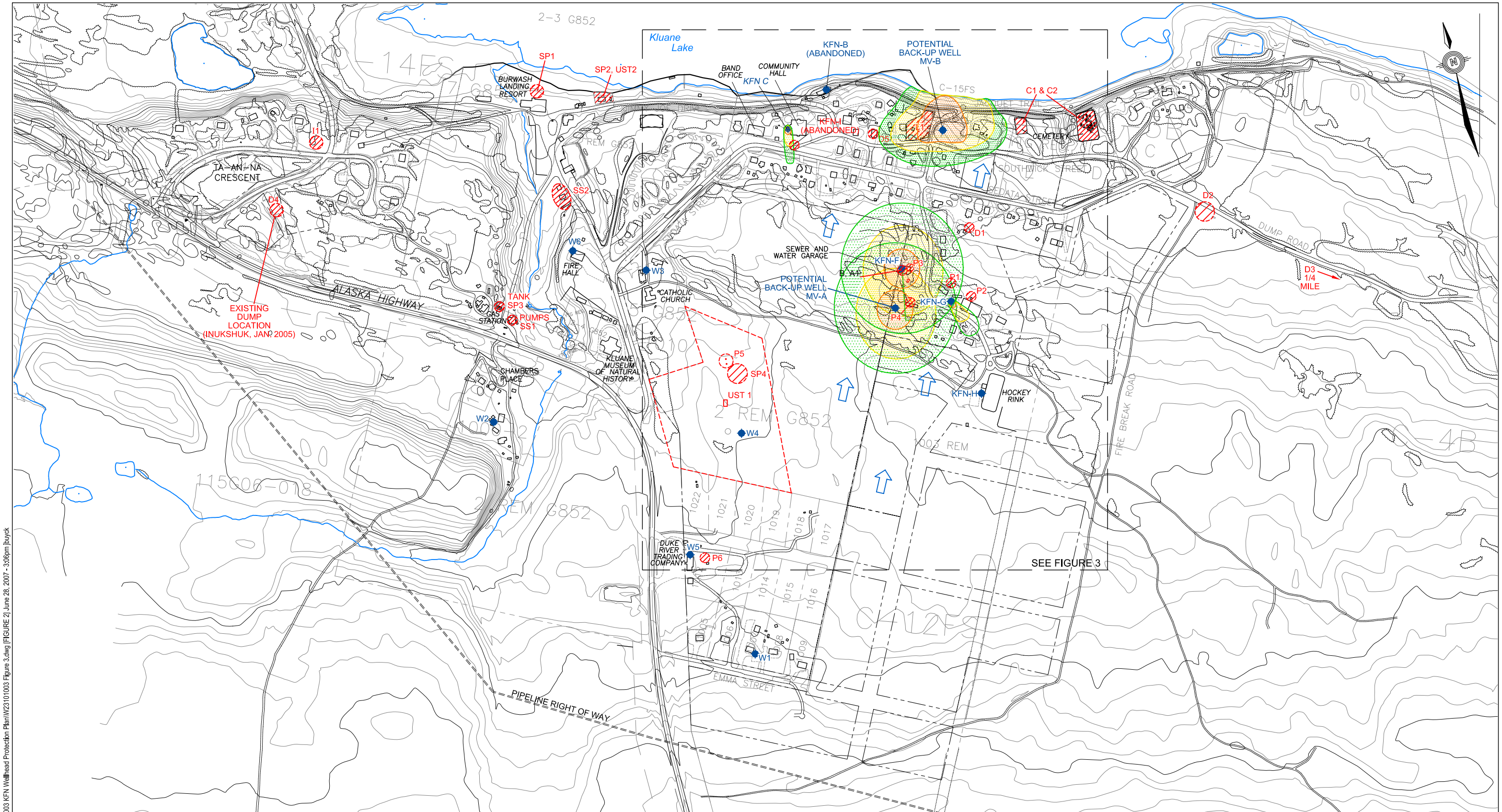
EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	JSB	RMM	0

OFFICE	DATE
EBA-WHSE	April 20, 2007

Figure 1

Q:\Whitehorse\Data\0201drawings\Burwash\W23101003 KFN Wellhead Protection Plan\W23101003 Figure 1_Site Plan.dwg [KEY PLAN] June 28, 2007 - 3:08pm jbuyck



LEGEND:

- GROUNDWATER FLOW DIRECTION BASED ON March 21, 2007 Survey by EBA
- WELL LOCATION
- AREAS OF POTENTIAL ENVIRONMENTAL CONCERN
- LAKE (POND).....
- STREAM.....
- MARSH, SWAMP.....
- ROAD
- CADASTRAL.....
- WOODED AREA.....
- CAPTURE ZONE 1 (1 YR. TRAVEL TIME)
- CAPTURE ZONE 2 (5 YR. TRAVEL TIME)
- CAPTURE ZONE 3 (10 YR. TRAVEL TIME)

NOTES:
1. WELL DETAILS ARE SUMMARIZED IN TABLE 1.
2. DRAWING ADAPTED FROM ORIGINAL OBTAINED FROM INUKSHUK PLANNING & DEVELOPMENT "INFILL & POSSIBLE GROWTH DIRECTIONS" - JANUARY 2005
3. DRAWING HAS BEEN PRODUCED IN COLOR, ANY REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

Date: 1990
COMPILED: September, 1997
DATUM: NAD '83
REVISED: December, 2002
CONTOUR INTERVAL = 2 metres

0 100 200 300 400 m
SCALE 1:6000

CLIENT

KLUANE FIRST NATION WELLHEAD PROTECTION PROGRAM - BURWASH LANDING, YT

SITE PLAN SHOWING EXISTING WELL SITES, AREAS OF POTENTIAL ENVIRONMENTAL CONCERN AND AQUIFER CAPTURE ZONES

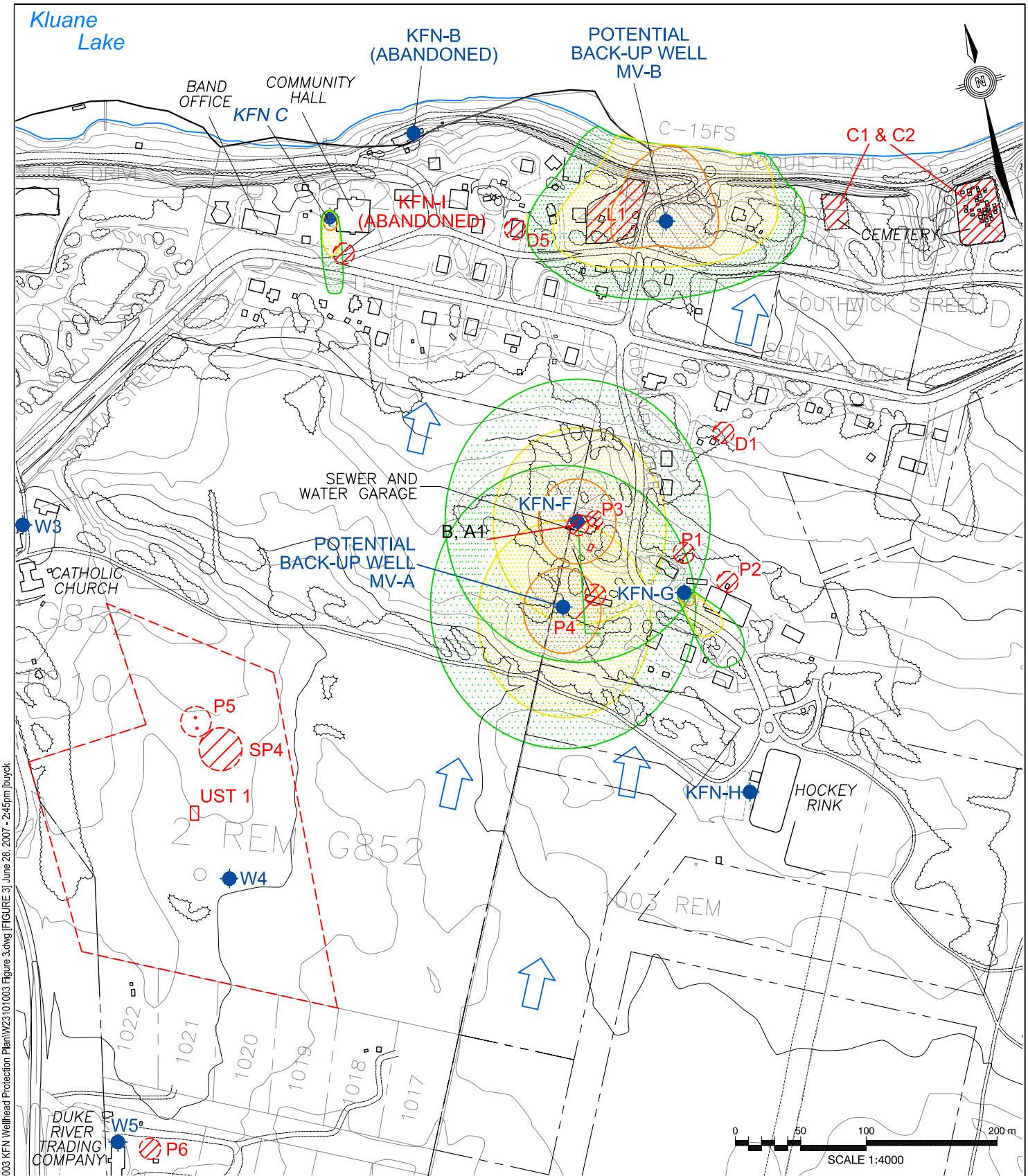
EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	JSB	JC/RMM	0

OFFICE	DATE
EBA-WHSE	April 24, 2007

Figure 2

C:\Wellehorse\Data\2201drawings\Burwash\W23101003 KFN Wellhead Protection Plan\W23101003 Figure 3.dwg [FIGURE 2] June 28, 2007 - 3:06pm jbuyck



LEGEND:

- GROUNDWATER FLOW DIRECTION BASED ON March 21, 2007 Survey by EBA
- WELL LOCATION
- AREAS OF POTENTIAL ENVIRONMENTAL CONCERN
- CAPTURE ZONE 1 (1 YR. TRAVEL TIME)
- CAPTURE ZONE 2 (5 YR. TRAVEL TIME)
- CAPTURE ZONE 3 (10 YR. TRAVEL TIME)

CLIENT

KLUANE FIRST NATION WELLHEAD PROTECTION PROGRAM - BURWASH LANDING, YT

SITE PLAN SHOWING CENTRAL BURWASH

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	JSB	JC/RMM	0
OFFICE: EBA-WHSE	DATE: May 23, 2007		

Figure 3

Q:\Whitehorse\Data\0201drawings\Burwash\W23101003 KFN Wellhead Protection Plan\W23101003 Figure 3.dwg [FIGURE 3] June 28, 2007 - 2:45pm jbuyck

PHOTOGRAPHS

Photograph 1
Water Truck Garage; Septic tank located in front of Garage (March 21, 2007)

Photograph 2
Community Well KFN-F well enclosure (right) (March 21, 2007)

Photograph 3
AST adjacent to Water Truck Garage and KFN-F (March 21, 2007)

Photograph 4
200 L fuel drums adjacent to the west die of the Water Truck Garage; no secondary containment. (March 21, 2007)

Photograph 5
Livestock pen located to the west and within the capture zone of MV-B (March 21, 2007)

Photograph 6
Former solid waste dump located on the west end of Burwash Landing (March 21, 2007)

Photograph 7
Community Well KFN-C (March 21, 2007)

Photograph 8
Community Well KFN-G (March 21, 2007)

APPENDIX

APPENDIX A KLUANE FIRST NATION COMMUNITY WELL LOGS (KFN-F AND KFN-G)

MIDNIGHT SUN DRILLING CO. LTD.
PH. 667-6144
WHITEHORSE Y.T.
P.O. Box 4391

FIELD REPORT

(107071003)

Started Aug. 27 1981
Completed Aug. 28 1981

ACONS

KFN-F

NAME AND ADDRESS OF CLIENT	DESCRIPTION OF WORK	LOCATION OF WORK
Kluane Tribal Brotherhood	W/W.	Burwash Landing

FORMATION LOG FROM	TO	FORMATION
0'	4'	silt fine sand
4'	8'	Gr.
8'	10'	clay Gr.
10'	32'	till Frost at 12' to 177
32'	39'	clay silt
39'	140'	Gr-ly. till cobbles
140	157	Gr-ly till cob.
157	174	silt some Gr.
174	192	silty Gr.
192	200	Gr.

DESCRIPTION OF WORK	TIME DATE	FROM	TO	HOURS
MOVE				
Travel to Burwash	Aug 27	12:30	1:00	0.5
move on set up	"	2:00	3:00	1
	"	3:00	9:00	6.
	Aug 28	8:00	10:30	2.5
setting screen	"	10:30	11:30	1 ←
Develop	"	11:30	12:30	1 ←
move off.	"	12:30	1:30	1 ←
travel to whitehorse.	"	2:00	6:00	4

Rcrd. of Casing & Pipe Size	Type	Size	Type
6			
Feet	Inch	Feet	Inch
196			

Remarks:
1- drive shoe.
2-riser lead packer
bottom of 20 slot screen 200'
5 7/8" bit pin
about 30 G.P.M.

STATIC LEVEL		Total Rig Time	hrs.
Ground level	115 rising	Total Standby	hrs.
Top of casing		Drilling Mud	sacks

SIGNATURES

MIDNIGHT SUN.....
TITLE.....

George Johnson
841-4274

CLIENT. John Clark .....
TITLE.....

MIDNIGHT SUN DRILLING CO. LTD.
PH: 668-2434
WHITEHORSE Y.T.
P.O. Box 4391

FIELD REPORT

(107071004)

Started June 21 ..... 19. 76

Completed .. June. 24 ..... 19. 76

KFN-G (1)

NAME AND ADDRESS OF CLIENT	DESCRIPTION OF WORK	LOCATION OF WORK
Dept. of Indian Affairs and Northern Dev.	Water Well	Indian village Burwash landing

FORMATION LOG

FROM	TO	FORMATION
0'	6'	sand, gravel brown silt
6'	24'	coarse gravel silt
24'	70'	clay till (Frozen)
70'	148'	clay till
148'	154'	brown silty clays
154'	157'	sand gravel
157'	162'	clay till

DESCRIPTION OF WORK	TIME			
	DATE	FROM	TO	HOURS
MOVE Travelling	June 21	8:30pm	1:30am	5
moving on site set up	June 22	10:am	9:pm	11
Ran 70' of 8" casing	June 23	7:am	11:pm	14
Ran 152'8" of casing jetting and bailing				
pressurising, bailing	June 24	8:)am	6:30	10.5
moving off site Travelling		9:30pm	2:30am	5

Rcrd. of Casing & Pipe

Size	Type	Size	Type
8"		6"	
Feet	Inch	Feet	Inch
25	2½"	12'	
25	1¼"	20	10
20		20	10
		20	10
		20	10
		20	10
		20	10
		15	8

Remarks: Welded 6" telescoping screen oto the bottom of 6 5/8" casing. Stainless steel 40 slot Bailed at 2.5 G.P.M. Recommend setting bottom of pump at 145'

STATIC LEVEL Not recorded because
Ground level of slow recovery
Top of casing

Total Rig Time 45.5 hrs.
Total Standby hrs.
Drilling Mud 18 sacks

SIGNATURES

MIDNIGHT SUN.....
TITLE.....

CLIENT.....
TITLE.....

KFN-G (2)

MIDNIGHT SUN DRILLING CO. LTD.
PH: 668-2434
WHITEHORSE Y.T.
P.O. Box 4391

FIELD REPORT

Started June 21 1976
Completed June 24 1976

NAME AND ADDRESS OF CLIENT	DESCRIPTION OF WORK	LOCATION OF WORK
Indian Affairs	water well	Burwash

FORMATION LOG FROM	TO	FORMATION	DESCRIPTION OF WORK	TIME DATE	FROM	TO	HOUR
			MOVE				
			Pressurizing	June 24	8:00	10:30	2½
			bailing	"	10:30	12:00	1½
			"	"	1:00	5:00	4
			moving off site	"	5:00	6:30	1½
			Traveling	"	9:30	2:30	5

Rcrd. of Casing & Pipe Size	Type	Size	Type
Feet	Inch	Feet	Inch

Remarks:

Welded 6" telescoping screen to the bottom of 6 5/8" casing. Stainless steel 40 slot
Bailed at 2.5 G.P.M.
Recommend setting bottom of pump at 145'

STATIC LEVEL (Note to Record)	Total Rig Time 14½ hrs.
Ground level Because of	Total Standby hrs.
Top of casing slow Recovery	Drilling Mud sacks

SIGNATURES

MIDNIGHT SUN.....
TITLE.....

CLIENT.....
TITLE.....

APPENDIX

APPENDIX B GROUNDWATER MODEL CONFIGURATION AND CALIBRATION

Table B1: Well Survey Information

Survey Location	Intermediate Fore Site (IFS)	Back Site (BS)	Fore Site (FS)	Height of Instrument	Elevation	Depth to Groundwater below Casing (m)	GW Elevation[A] (m-asl)
KFN-H casing		1.217		799.217	798	2.485	**795.52**
TP1			1.493	799.217	797.724		
TP1		1.435		799.159	797.724		
TP2			1.334	799.159	797.825		
TP2		1.38		799.205	797.825		
KFN-G	1.395			799.205	796.43	3.874	**792.56**
TP3			0.645	799.205	798.56		
TP3		1.296		799.856	798.56		
TP4			1.202	799.856	798.654		
TP4		1.061		799.715	798.654		
KFN-F concrete	1.217			799.715	798.498		
KFN-F casing	0.716			799.715	798.999	11.87	**787.13**
TP5			1.745	799.715	797.97		
TP5		0.194		798.164	797.97		
TP6			4.06	798.164	794.104		
TP6		0.14		794.244	794.104		
TP7			2.705	794.244	791.539		
TP7		1.476		793.015	791.539		
TP8			1.51	793.015	791.505		
TP8		0.333		791.838	791.505		
TP9			4.835	791.838	787.003		
TP9		0.208		787.211	787.003		
TP10			2.247	787.211	784.964		
TP10		1.457		786.421	784.964		
KFN-B	1.015			786.421	785.406	4.48	**780.93**
TP11			4.685	786.421	781.736		
TP11		0.83		782.566	781.736		
Kluane Lake	1.78			782.566	780.786	0	**780.79**
TP7		1.476		793.015	791.539		
TP12			0.75	793.015	792.265		
TP12		2.405		794.67	792.265		
TP13			0.06	794.67	794.61		
TP13		2.168		796.778	794.61		
TP14			2.305	796.778	794.473		
TP14		2.379		796.852	794.473		
Firehall Floor	1.377			796.852	795.475		
Firehall Well casing	-1.065				794.41	6.69	**787.72**
TP15			1.601	796.852	795.251		
TP15		2.875		798.126	795.251		
TP16			0.445	798.126	797.681		
TP16		1.855		799.536	797.681		
Survey Post	1.86			799.536	797.676		
TP17			0.22	799.536	799.316		
TP17		1.157		800.473	799.316		
GHV Well	0.212			800.473	800.261	0.82	**799.44**
TP18			0.795	800.473	799.678		
TP18		2.575		802.253	799.678		
TP19			1.619	802.253	800.634		
TP19		0.655		801.289	800.634		
TP20			2.462	801.289	798.827		
TP20		1.724		800.551	798.827		
CLS Pin	1.37			800.551	799.181		
TP21			2.221	800.551	798.33		
TP21		0.774		799.104	798.33		
KFN-H			1.111	799.104	797.993		

Note: A) Elevations are relative to KFN-H which was assumed to be 798.00 masl based on topography maps.

Table B2 - Kluane Aquifer Vulnerabilty - Instrinsic Susceptibility Index for Confined Aquifer at KFN-F

Interval		Effective Thickness (a)	Description	K factor (b)	(a*b)
from	to				
0.0	1.2	1.2	SILT, fine sand	4	4.9
1.2	2.4	1.2	GRAVEL	1	1.2
2.4	47.9	45.4	Till gravelly, permafrost	3	136.3
47.9	53.0	5.2	SILT, trace gravel, permafrost	4	20.7
53.0	58.5	5.5	silty GRAVEL, permafrost	2	11.0
58.5	61.0	2.4	GRAVEL	1	2.4
					177

Table B3 - Kluane Aquifer Vulnerabilty - Instrinsic Susceptibility Index for Confined Aquifer at KFN-G

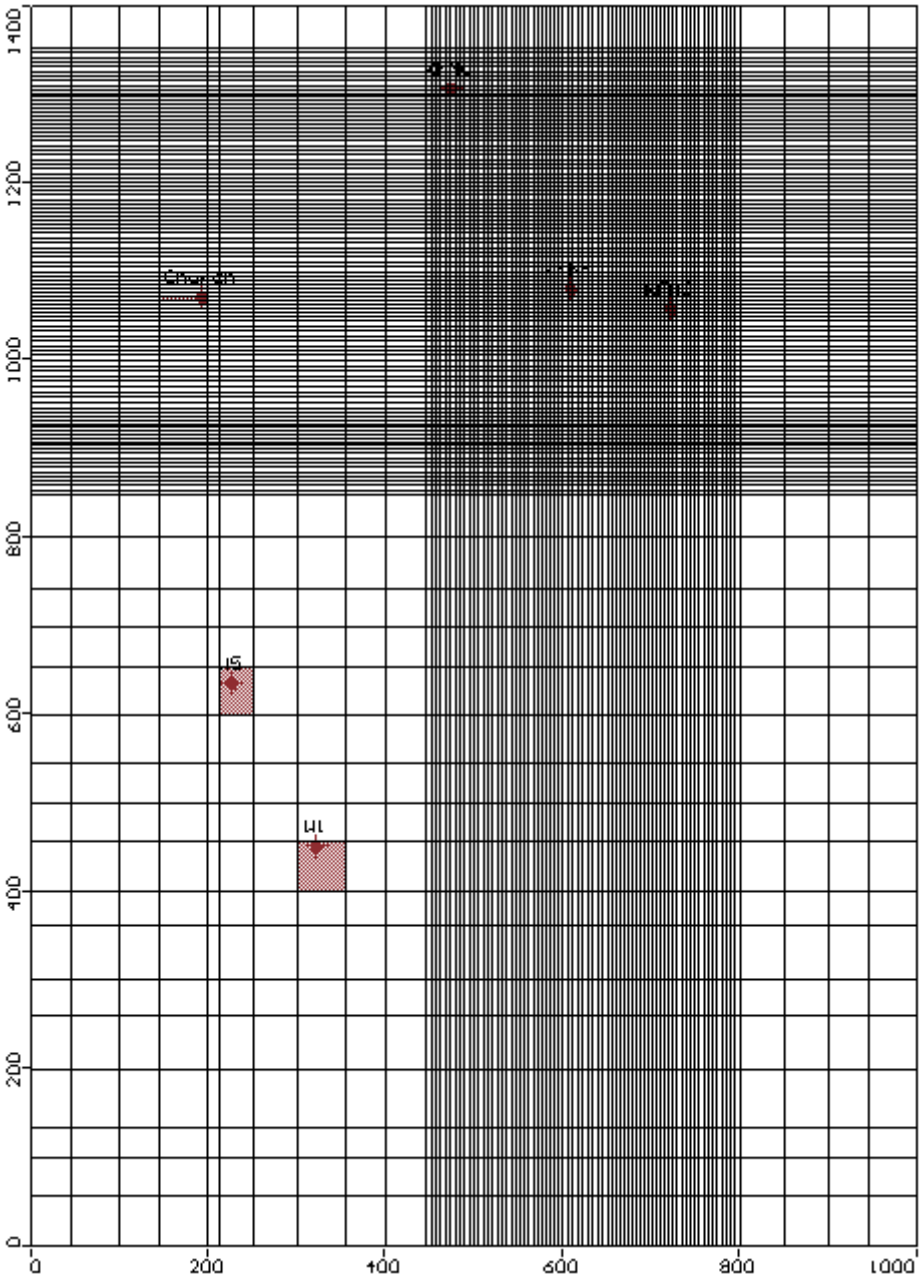
Interval		Effective Thickness (a)	Description	K factor (b)	(a*b)
from	to				
0.0	1.8	1.8	SAND, GRAVEL, SILT	2	3.7
1.8	7.3	5.5	GRAVEL, SILT	2	11.0
7.3	45.1	37.8	clay Till, permafrost	5	189.0
45.1	47.0	1.8	CLAY	8	14.6
47.0	47.9	0.9	SAND and GRAVEL	1	0.9
					219

Notes:

Low (> 80), Medium(30 to 80), high (0 to 30)

KFN Aquifer Intrinsic Vulnerability is very low.

ISI Method from Ontario Minisrtry of Environment (November, 2001)



CLIENT

KLUANE FIRST NATION
BURWASH LANDING

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Plan View of Model Domain

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B1

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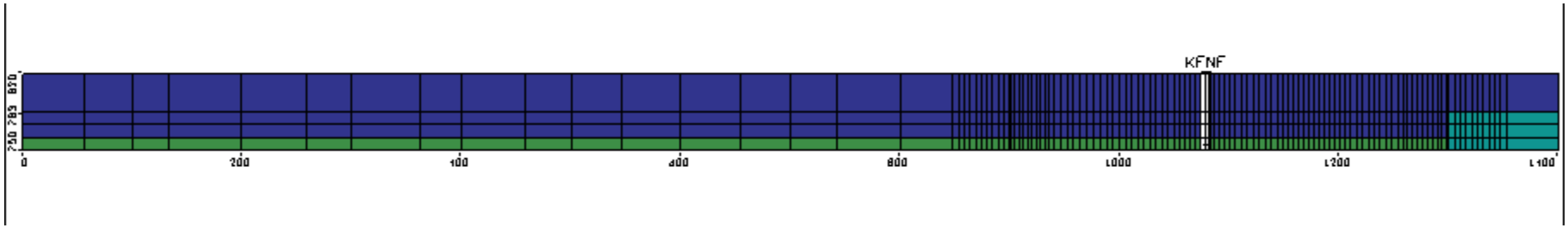

CLIENT

KLUANE FIRST NATION
BURWASH LANDING

EBA Engineering Consultants Ltd.

eba

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Profile view of column 42

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1

OFFICE	DATE
EBA-Whitehorse	June, 2007

Figure B2

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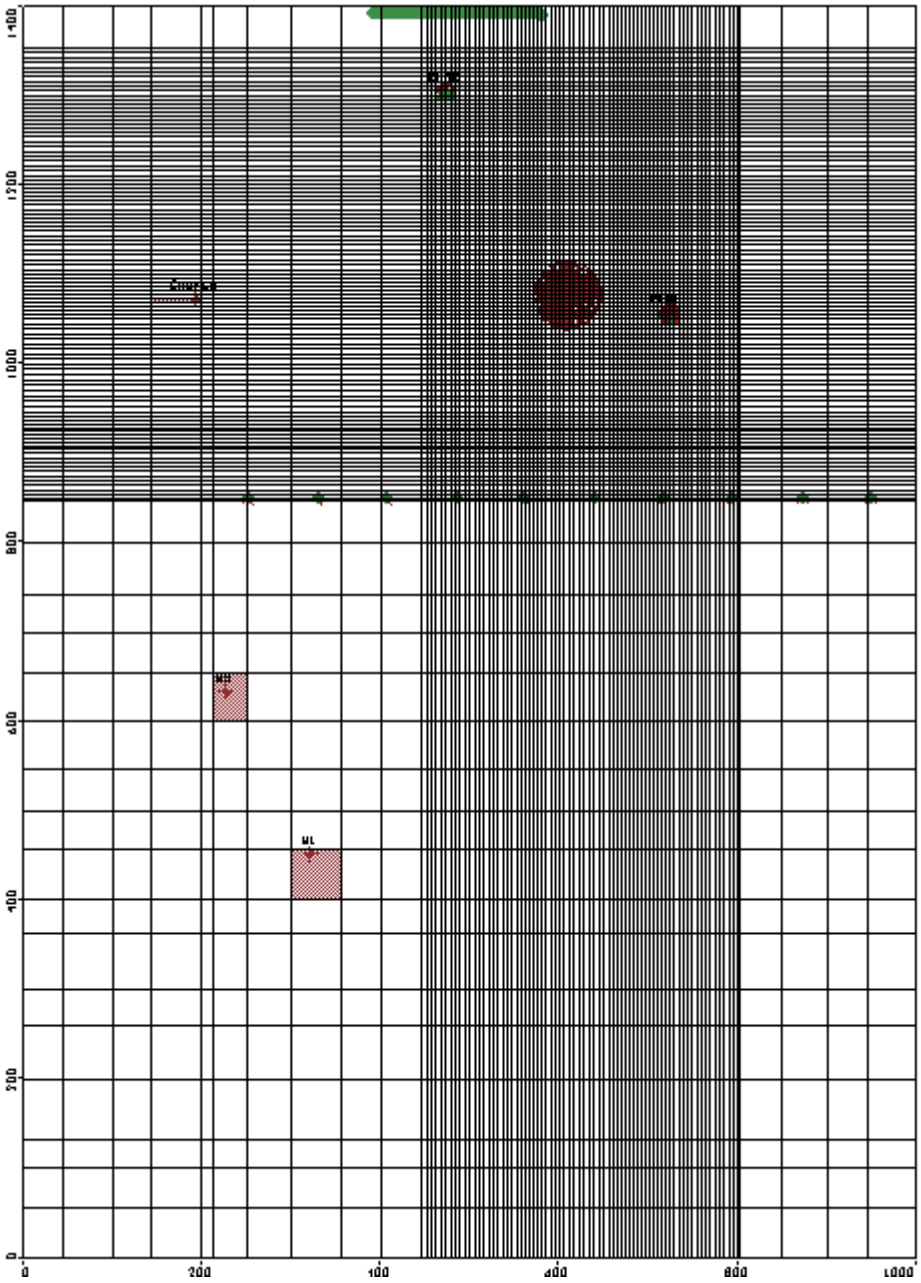

CLIENT

Kluane First Nation Burwash Landing

EBA Engineering Consultants Ltd.

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
KFN F, C & G
1 Year

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1

OFFICE	DATE
EBA-Whitehorse	June 2007

Figure B3

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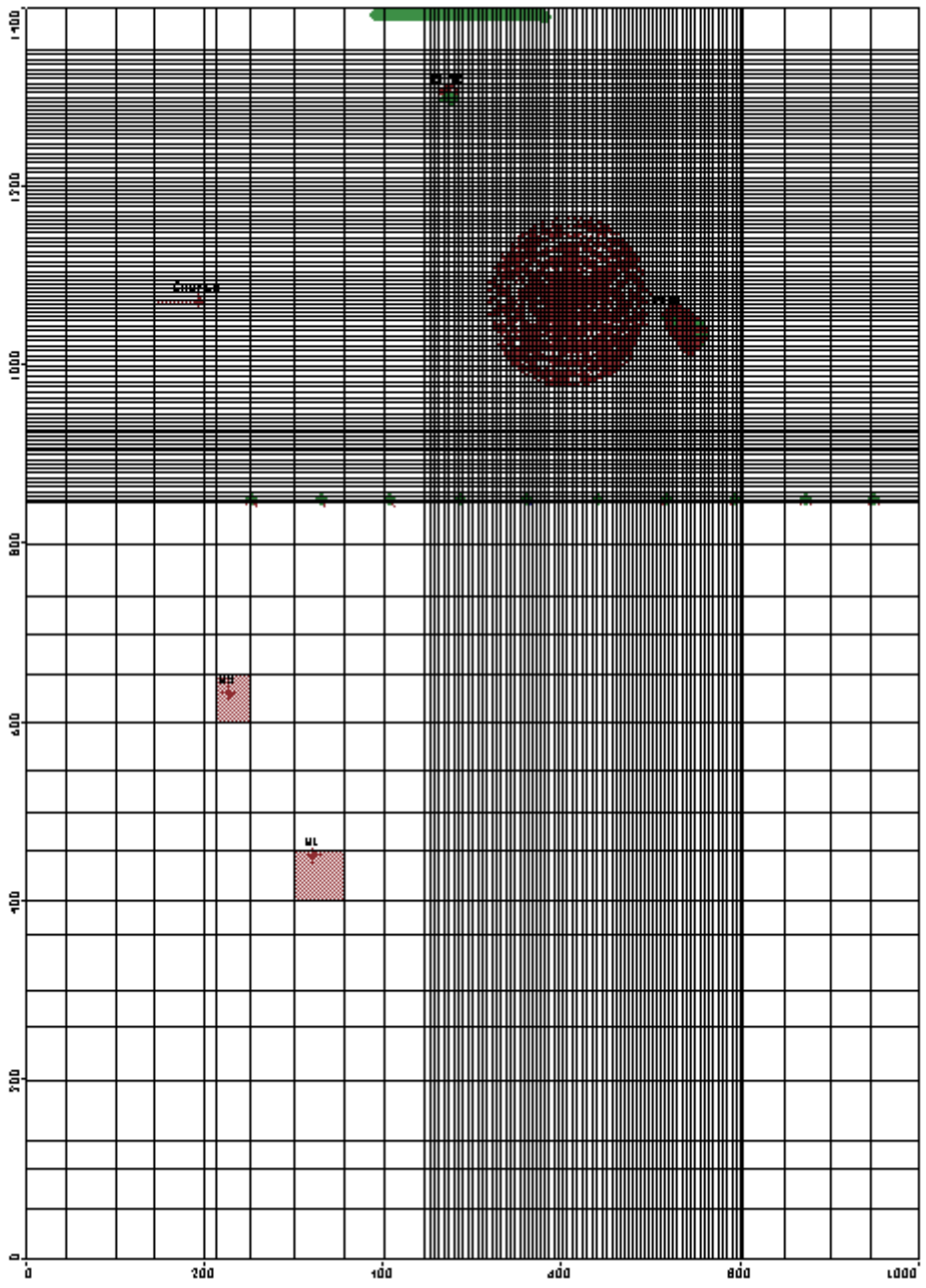

CLIENT

Kluane First Nation Burwash Landing

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
KFN F, C & G
5 Year

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B4

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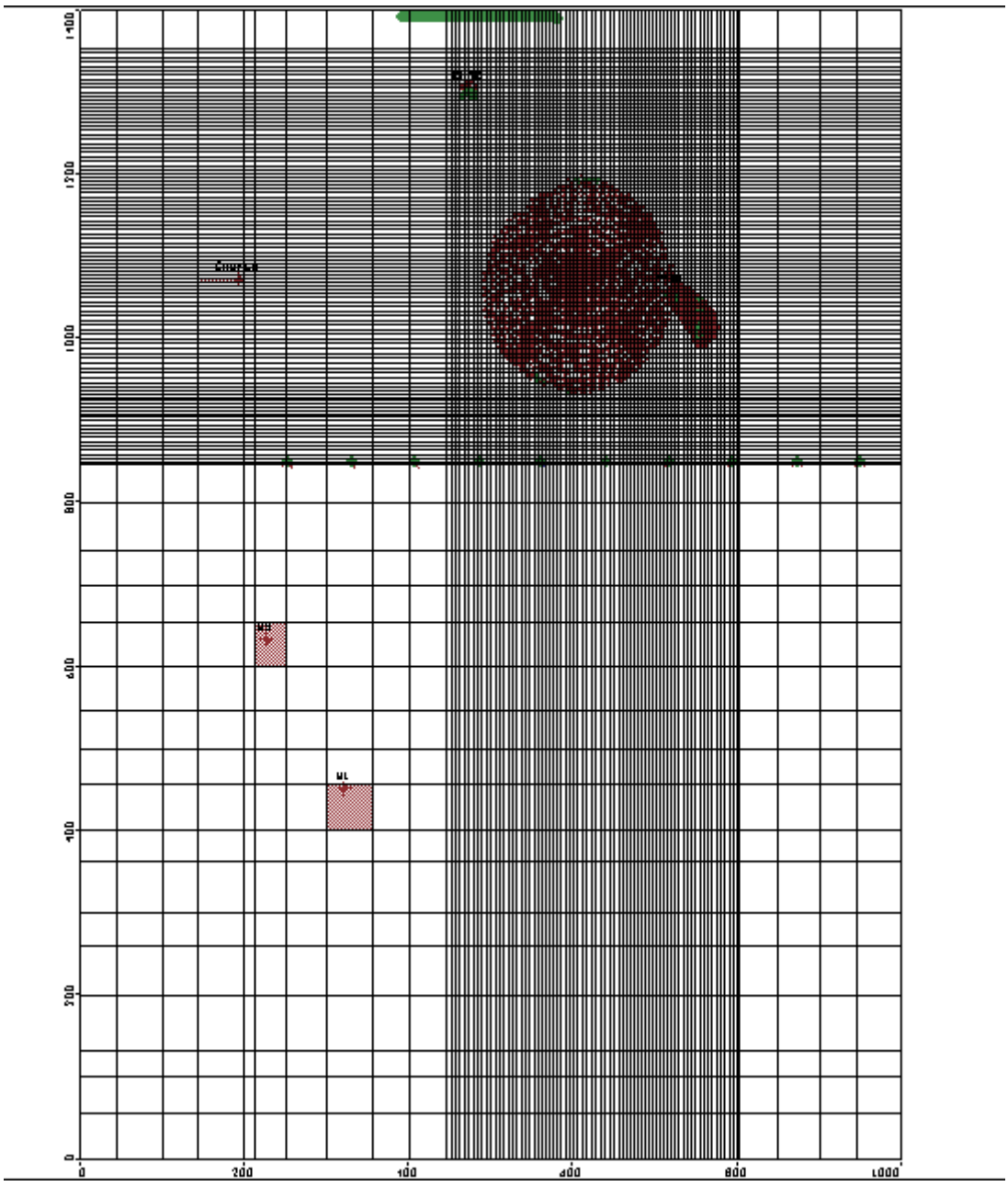

CLIENT

KLUANE FIRST NATION
BURWASH LANDING

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
KFN F, C & G
10 Year

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B5

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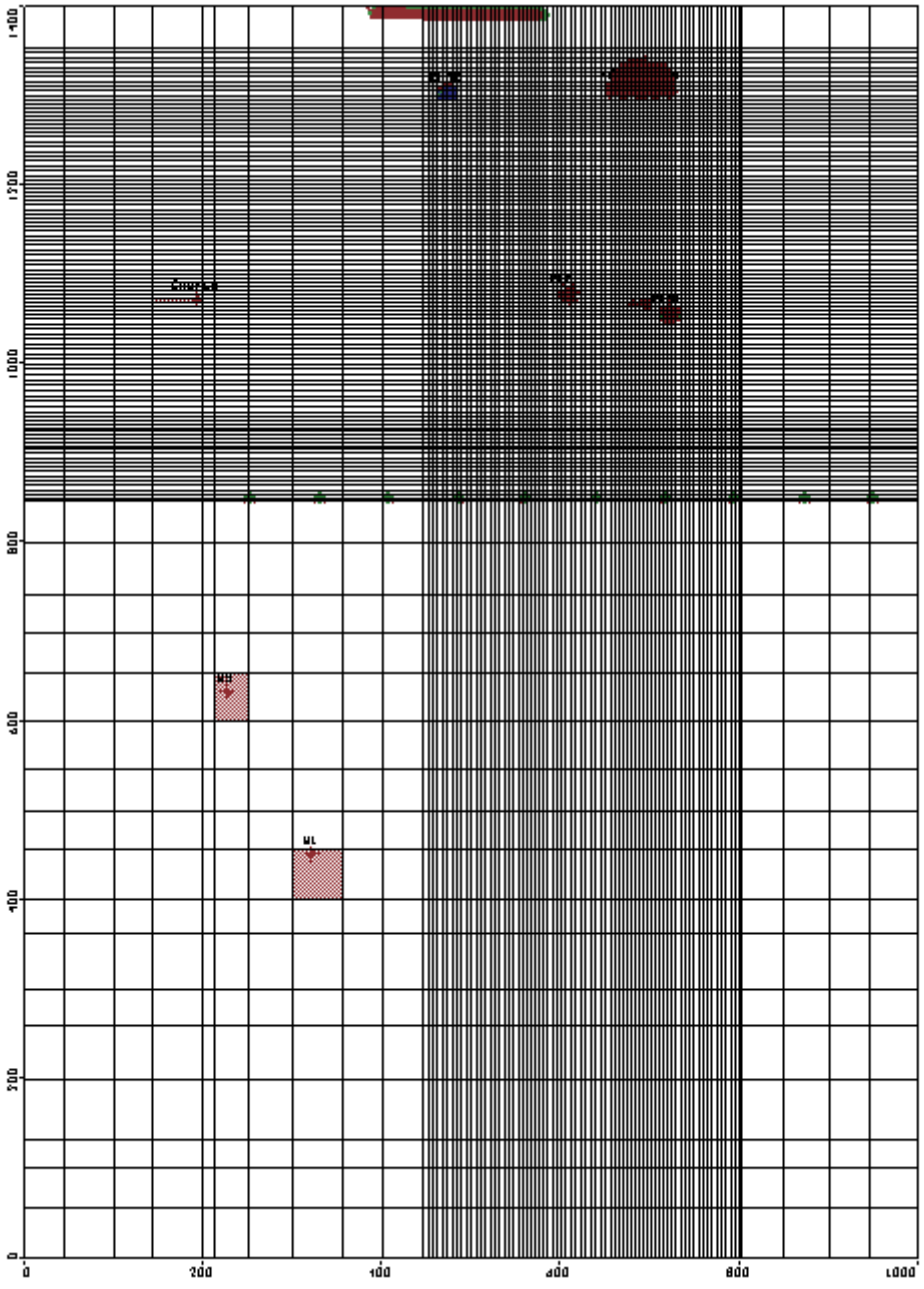

CLIENT

KLUANE FIRST NATION
BURWASH LANDING

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
MV-B
1 Year

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B6

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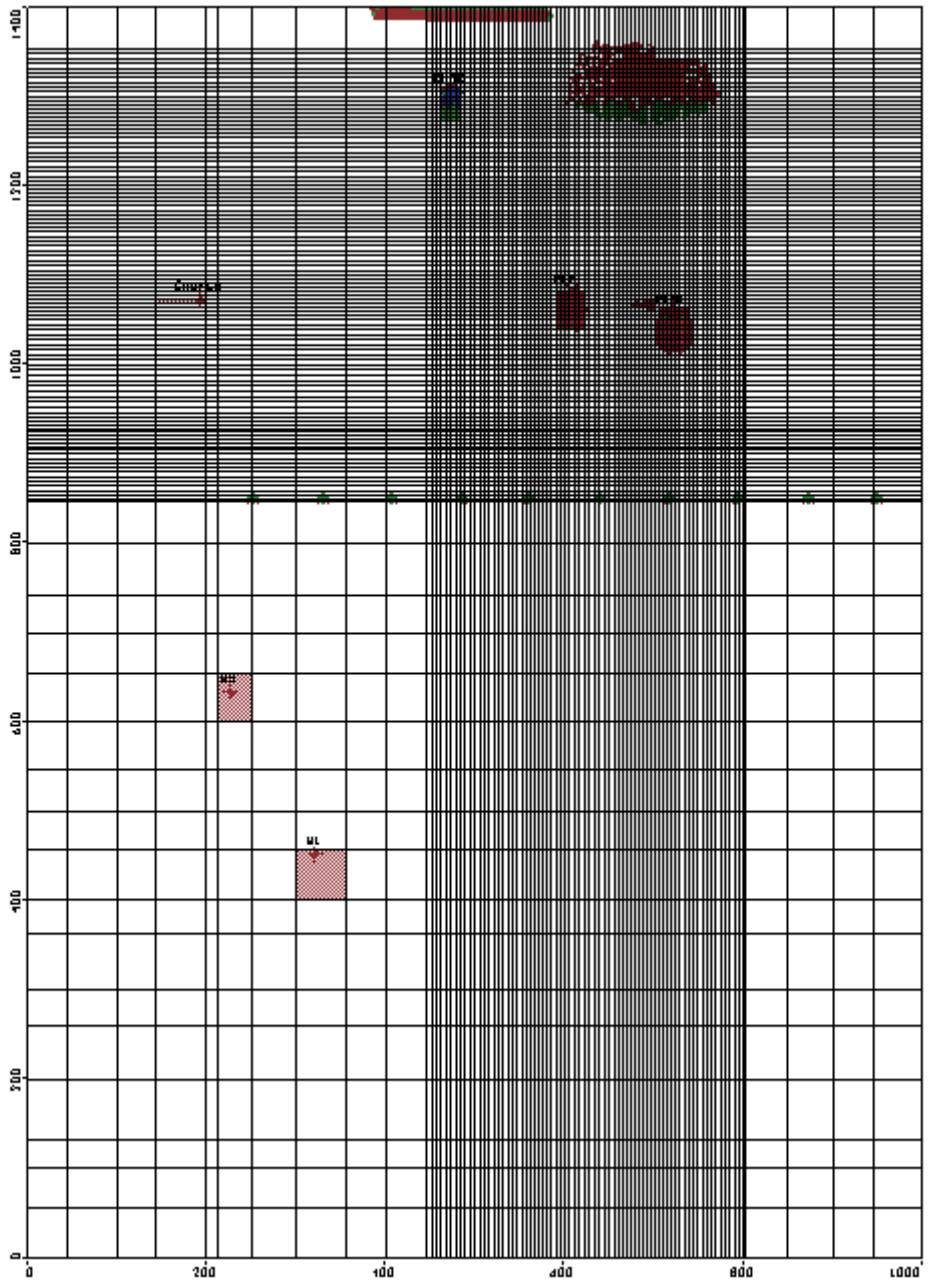

CLIENT

KLUANE FIRST NATION
BURWASH LANDING

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
MV-B
5 Year

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B7

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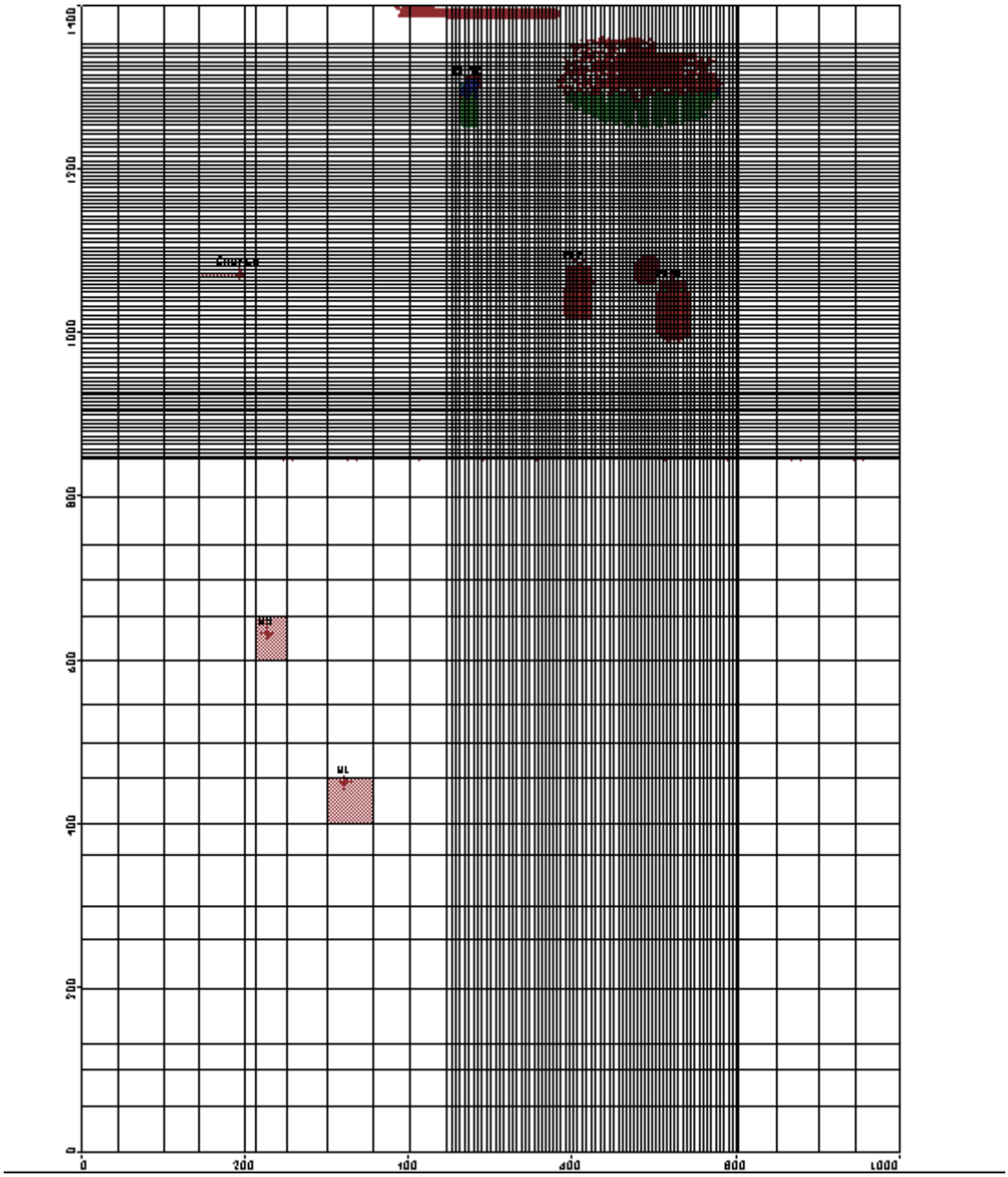

CLIENT

KLUANE FIRST NATION
BURWASH LANDING

EBA Engineering Consultants Ltd.

Aquifer and Wellhead Protection Plan
Kluane First Nation, Burwash Landing, YT

Model Output
MV-B
10 Year

PROJECT NO.	DWN	CKD	REV
W23101003	RMM	RMM	1
OFFICE: EBA-Whitehorse	DATE: June 2007		

Figure B8

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APPENDIX

APPENDIX C CONTAMINATED SITE AND SPILL SEARCH RESULTS

Search results from:

1) Marlene Sparks of Yukon Government for AST/UST search within Burwash Landing, YT.
2) Nathalie Lower of Yukon Government for Spill Records search up to 2001 in Burwash Landing, YT.
3) Matthew Nefstead of Yukon Government for CSR and Devolution Search in Burwash Landing, YT.

Tammera Kostya

From: Marlene.Sparks [Marlene.Sparks@gov.yk.ca]
Sent: Wednesday, February 07, 2007 8:39 AM
To: Tammera Kostya
Subject: RE: AST/UST search_Burwash Landing, YT

Hello Tammera

I do not have any permits listed under Kluane First Nation at the locations you have listed.

Marlene

-----Original Message-----
From: Tammera Kostya [mailto:tkostya@eba.ca]
Sent: Wednesday, January 31, 2007 2:35 PM
To: Marlene.Sparks
Subject: AST/UST search_Burwash Landing, YT

Hi Marlene,

I am conducting a Wellhead Protection Plan for the Kluane First Nation Community Wells in Burwash Landing which require an Environmental Assessment of the area surrounding the wellheads. Locations of the wells are listed below:

Well KFN-C: E 607433 N 6804108
Well KFN-F: E 607529 N 6803778
Well KFN-G: E 607584 N 6803753
Well KFN-H: E 607711 N 6803597

I unfortunately do not have civic addresses however I have the legal of all lots I would like searched. You will find the excel file of the lots attached. I would appreciate a list of Above Ground Storage Tanks and Underground Storage Tanks on all the listed properties. If you need any further information please feel free to contact me at the below number.

Please note that your response will be included with the final report, for record keeping.

Thanks,

<<KFN_Lots and CLSR locations.xls>>

Tammera Kostya, BSc
Junior Hydrogeologist
p. 867.668.2071 x63 • f. 867.668.4349 • c. 867.334.4595
e. tkostya@eba.ca

EBA Engineering Consultants Ltd.

Calcite Business Centre, Unit 6, 151 Industrial Road
Whitehorse, Yukon Y1A 2V3 • CANADA

Tammera Kostya

From: Lowry,Nathalie [PYR] [Nathalie.Lowry@ec.gc.ca]
Sent: Wednesday, February 07, 2007 9:37 AM
To: Tammera Kostya
Subject: Spill Records search - Burwash Landing

Spill Report Information.snp

<<Spill Report Information.snp>> Hi Tammera,

Attached are spill report summaries for incidents reported in Burwash Landing up to and including 2001. For information after 2001 please contact Matthew Nefstead at Yukon Government Environmental Programs (667.5076).

Nathalie Lowry, B.Sc., M.G.I.S.
Environmental Emergencies Program - Yukon Environment Canada - Environmental Protection Operations
91782 Alaska Hwy, Whitehorse, YT Y1A 5B7
Phone: 867.667.3405 Cell: 867.333.9917 Fax: 867.667.7962
Email: Nathalie.Lowry@ec.gc.ca

Environment Canada Environnement Canada

Emergencies Program - Yukon Section
91782 Alaska Highway, Whitehorse, YT Y1A 5B7
PH: 867.667.3400 FAX: 867.667.7962

Spill Report Information

Spill #	0134
Jurisdiction	Yukon
Community	Burwash Landing
Address	
Highway	
Milepost	
Feature	Burwash Landing
Location / Cause	heating tank for Hotel
Incident Date	7/23/2001
Lead Agency	Yukon Government - Environmental Programs
Other Agency	
Major Contaminant	Furnace Oil
2nd Contaminant	
3rd Contaminant	
4th Contaminant	
Amount	7000
Units	Litres
Concentration	
Units	
Quantity	Estimate
Addl Quanitity Info	
Phase	Liquid
Release	Leaked
Outcome	Sunday had 2500 L - ordered 5900 L - this Sunday tank empty - lost all the fuel - tank being dug out - looking for place to put it - no further information on file

Environment Canada Environnement Canada

Emergencies Program - Yukon Section
91782 Alaska Highway, Whitehorse, YT Y1A 5B7
PH: 867.667.3400 FAX: 867.667.7962

Spill Report Information

Spill #	0321
Jurisdiction	Yukon
Community	Burwash Landing
Address	
Highway	
Milepost	
Feature	Burwash Landing
Location / Cause	Burwash Landing campsite - Alaska Hwy N - right side - Golden Hill Ventures construction camp - leaking spout on fuel truck
Incident Date	7/8/2003 5:00:00 AM
Lead Agency	Yukon Government - Environmental Programs
Other Agency	
Major Contaminant	Diesel
2nd Contaminant	
3rd Contaminant	
4th Contaminant	
Amount	650
Units	Litres
Concentration	
Units	
Quantity	Estimate
Addl Quanitity Info	
Phase	Liquid
Release	Spilled
Outcome	delivery spout on truck was not latched properly - clean-up equipment on way to site - no further information on file

Environment Canada Environnement Canada

Emergencies Program - Yukon Section
91782 Alaska Highway, Whitehorse, YT Y1A 5B7
PH: 867.667.3400 FAX: 867.667.7962

Spill Report Information

Spill #	9830
Jurisdiction	Yukon
Community	Burwash Landing
Address	
Highway	
Milepost	
Feature	Burwash Landing
Location / Cause	old fire hall building next to Kluane Lake - near Burwash Resort - possible LUST
Incident Date	6/10/1998
Lead Agency	Yukon Government - Fire Marshall
Other Agency	Environment Canada - Environmental Protection Service
Major Contaminant	Furnace Oil
2nd Contaminant	
3rd Contaminant	
4th Contaminant	
Amount	
Units	
Concentration	
Units	
Quantity	Unknown
Addl Quanitity Info	
Phase	Liquid
Release	Leaked
Outcome	lake shore showing signs of contamination ~20 ft from UST - 40-50 ft to Kluane Lake - 5 m to nearest water well - Fire Marshall tested tank - not leaking - their file closed

Environment Canada Environnement Canada

Emergencies Program - Yukon Section
91782 Alaska Highway, Whitehorse, YT Y1A 5B7
PH: 867.667.3400 FAX: 867.667.7962

Spill Report Information

Spill #	9846
Jurisdiction	Yukon
Community	Burwash Landing
Address	
Highway	
Milepost	
Feature	Burwash Landing
Location / Cause	Burwash Landing Garage - Burwash Fuels - valve left on on 10,000 ga fuel storage tank
Incident Date	11/10/1998
Lead Agency	Yukon Government - Fire Marshall
Other Agency	
Major Contaminant	Diesel
2nd Contaminant	
3rd Contaminant	
4th Contaminant	
Amount	1000
Units	Gallons (US, liquid)
Concentration	
Units	
Quantity	Estimate
Addl Quanitity Info	
Phase	Liquid
Release	Spilled
Outcome	fuel running down road 1/4 mile towards Lodge - not threatening lake - Ollie to put 'speedy dry' on spill tomorrow - is on frozen ground - YG-FM to investigate further

Tammera Kostya

From: Matthew.Nefstead [Matthew.Nefstead@gov.yk.ca]
Sent: Thursday, February 01, 2007 1:50 PM
To: Tammera Kostya
Subject: RE: CSR and Devolution Search_Burwash Landing, YT

Tammera,

I have information on the following sites that appear to be within the area in question. Please note that a lack of information on any of the sites in question does not necessarily indicate that the sites are free of contamination. You may wish to also contact Nathalie Lowry at Environment Canada, as they maintain a separate spills database and may have information we do not.

Coordinates for all sites are approximate.

HJ040: “Old Dump Site, Burwash, AES#27”, E 606494 N 6804326. Information attached. The 1997 PEI report noted in the attached document is on file.

Spill 03-21: Occurred on July 8, 2003. 650 L diesel spilled at the Golden Hill Ventures construction camp at Burwash Landing, km 1759 Alaska Highway. The affected soil was stockpiled. A relocation permit (4202-23-059) was issued on Oct 3, 2003 to Golden Hill Ventures Ltd. which, among other sites, authorized the relocation of 60 cubic metres of hydrocarbon-contaminated soil from the Burwash Camp. Confirmation of the volume relocated and the analytical results for the soil are not on file.

Please contact me if you have any questions or need further information in the future. If you’d like to come by this afternoon or any time tomorrow, I’ll have our files for both of your requests ready for you.

Matthew Nefstead
Contaminated Sites Analyst
Yukon Department of Environment (V-8)
(867) 667-5076

-----Original Message-----
From: Tammera Kostya [mailto:tkostya@eba.ca]
Sent: Wednesday, January 31, 2007 2:35 PM
To: Matthew.Nefstead
Subject: CSR and Devolution Search_Burwash Landing, YT

Hi Matthew

I am conducting a Wellhead Protection Plan for the Kluane First Nation Community Wells in Burwash Landing, Yukon which requires an Environmental Assessment of the area surrounding the wellheads, as discussed yesterday by phone. I unfortunately do not have civic addresses however I have the legal of all lots I would like searched. You will find the excel file of the lots attached. Location of the wellheads are:

Well KFN-C: E 607433 N 6804108
Well KFN-F: E 607529 N 6803778
Well KFN-G: E 607584 N 6803753
Well KFN-H: E 607711 N 6803597

The lots listed are the surrounding areas around each well system which basically consists of Burwash Landing. I am not sure if you search by individual lots or by area search based on geographical location

with a search radius of 1.5 km? So I've supplied both.

I would like to confirm that these sites (listed in the excel file attached) are not designated as contaminated sites and to note if there have been any spills on or adjacent to any of these sites.

I would also appreciate a search of any devolution sites within the Burwash Landing area. My concern is more for any sites that are located within Burwash Landing and south of the Town towards the Alaska highway. Could you please conduct a search area encompassing the Burwash Landing and surrounding area with a search area defined by:

Corner	Easting	Northing
NE	607149	6806016
NW	606012	6805912
SW	605770	6803994
SE	607351	6804064

Thank you for your assistance. If you need any further information, please feel free to contact me at the number below. Please note that your response will be included with the final report, for record keeping.

<<KFN_Lots and CLSR locations.xls>>

Tammera Kostya, BSc
Junior Hydrogeologist
p. 867.668.2071 x63 • f. 867.668.4349 • c. 867.334.4595
e. tkostya@eba.ca

EBA Engineering Consultants Ltd.
Calcite Business Centre, Unit 6, 151 Industrial Road
Whitehorse, Yukon Y1A 2V3 • CANADA

Yukon Contaminated Site

Report printed on 01 Feb 2007

Information last modified on 05 Jan 2005, 14:51:04

CSR File Number:
Site ID Number: HJ040
Site Name: Old Dump Site, Burwash, AES#27
Public Registry:

Location and Access

Latitude: 61° 21' 30" N **UTM** **Easting:** 606493.7791 **NTS sheet:** 115 G/06
Longitude: 139° 0' 30" W Zone 7V **Northing:** 6804325.8822 **District:** Haines Junction

Legal Description:

Civic Description:

Traditional Territory
Kluane
White River

Site Access: Road **Name of access route:** Alaska Highway

GENERAL ACCESS: SEE ASSESSMENT# A-27-96; ON BOTH SIDES OF OLD ACCESS ROAD TO BURWASH LANDING JUST NORTH OF ALASKA HIGHWAY.

Contaminated Site Regulation (CSR) Status

Land Uses	Water Uses	CSR Status	Orders issued
		05 Jan 2005 Test results available	☐

Federal Status

Devolution Site Status: Sites Not Requiring Remediation

Date	Follow-up action plan details
14 Jun 1999	In accordance with CCME Assessment Criteria, this site does not represent an environmental hazard or health risk. Only aesthetics are affected and no action is required.

Description

General Description

WWII LOCATION OF A PAN AMERIACAN CONSTRUCTION BUILDING WITH A BORROW PIT ACROSS THE ROAD. ACCESS ROAD NOW A RESIDENTIAL STREET IN BURWASH LANDING. LABERGE FALL 1996 NOTE A SOUTHERN CLEARING WITH NEW CONSTRUCTION WASTE, OLD DUMP WITH SOME METAL WASTE VISIBLE. SOIL SAMPLES INDICATED PCB AND ORGANOCHLORINE PESTICIDE BELOW DETECTION LIMITS, HYDROCARBONS PRESENT BUT BELOW CCME CRITERIA. VEGETATION: WILLOW, GRASS AND WHITE SPRUCE. SEE ASSESSMENT #A-27-96

Distance to Residence: 0 - 500 m **Visual Impact:** Low
actual distance (m):

Distance to Surface Water: high water mark - 5 **Area of site (m²):** 00,000
Depth to Ground Water (m):

Land Tenure

Owner	End date
Federal DIAND	

Site Occupants

Occupant	From date	To date	Activity 1	Activity 2	Activity 3
Military	23 Apr 1905		Active Dump		

Potential Concerns

Solid waste landfill? N

Yukon Contaminated Site

Report printed on 01 Feb 2007

Information last modified on 05 Jan 2005, 14:51:04

CSR File Number:
Site ID Number: HJ040
Site Name: Old Dump Site, Burwash, AES#27
Public Registry:

Contaminants	Hazards	Structures	Waste Material
Hydrocarbons		Excavations - Basement	Buildings Scrap Metal Contaminants

Documentation

Reports

Year	Author	Title	Location	Reference num
1997	Laberge Evironmental Services	PEI at Sites 1(WL066), 2(WL067), 27(HJ040) & 29(HJ042)	AES, DIAND	c1997_21

Maps and Photos

Type	Year	Description	File name
Map	1997	Site plan	HJ040b01
Photo	1997	metal waste	HJ040a01
Airphoto	1947	Old dumps near Burwash Landing II	HJ040c02
Airphoto	1987	Old dumps near Burwash Landing I	HJ040c01

Monitoring and Inspections

Date	Inspected by	Observations	Next visit
01 Sep 1997	LABERGE ENVIRONMENTAL SERVICES		

Comments and Recommendations

LABERGE 1997 RECOMMENDS THAT THE HYDROCARBON LEVELS ARE LOW, BELOW CCME CRITERIA. MINOR LANDSCAPING COULD BE ACCOMPLISHED.

Jan. 5/05: Reviewed for CSR status. Laberge 1997 report found only low levels of hydrocarbons.

Laberge
ENVIRONMENTAL SERVICES

P.O. BOX 5111
WHITEHORSE, YT
Y1A 4S3

OFFICE PHONE (403) 668-6838
CELL PHONE (403) 668-1043
FAX (403) 667-6956

PRELIMINARY ENVIRONMENTAL INVESTIGATIONS

AT SITES 1(WL066), 2(WL067), 27(HJ040), AND 29(HJ042)

FOR

A.E.S. ACTION ON WASTE

BY

LABERGE ENVIRONMENTAL SERVICES

JANUARY,1997

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 EXECUTIVE SUMMARY

Laberge Environmental Services (L.E.S.) conducted preliminary environmental investigations at four Arctic Environmental Strategy (A.E.S.) waste sites along the Alaska Highway. All four sites originated during the World War II military construction era and range from complete abandonment with restoration to continued use.

These investigations took the form of a reconnaissance level site assessment combined with judgemental sampling to confirm the presence and/or extent of a contaminant profile. Archival research and interviews were used to determine the potential contaminant profile and to refine field screening and sampling protocols. The field program employed a high sensitivity metal detector, organic vapour analyzer, visual cues, hand dug pits, backhoe trenching and sampling of soil, sediment, ground and surface water and vegetation. The laboratory program used a highly respected Canadian Association of Environmental Laboratories (C.A.E.L.) approved lab, Norwest Labs, to carry out analyses recommended by Canadian Council of Ministers of the Environment (C.C.M.E.) for potentially contaminated sites.

The results of this investigation can be summarized as follows:

There was no evidence of presence or contamination by persistent organics in the form of organochlorine pesticides or polychlorinated biphenols (P.C.B.s) Samples were taken from potential sources along exposure pathways, and at local control sites. All samples were below the limit of detection in all matrices.

A limited amount of hydrocarbon contaminated soils were detected in the immediate area of buried or backfilled waste sites. In all cases the concentration of hydrocarbons was low to moderate and confined to a small area. Only total hydrocarbon was analyzed with split samples retained for profiling of the carbon unit if this proved necessary. It was decided that due to the low concentrations the extra analysis cost was not warranted.

Site No. 1 at Iron Creek, Waste Site Number WL066 in the A.E.S. Waste Site Inventory, has some solid waste that is regarded as a low priority housekeeping issue. Hydrocarbon in soil here is well below clean-up criteria.

Site No. 2 at Lower Rancheria, Waste Site Number WL067, has some moderate hydrocarbon concentration in the immediate backfilled dump site area which does not warrant further attention.

Site No. 27 at Burwash Landing, Waste Site Number HJ040, has low concentrations of hydrocarbon, below clean-up criteria.

Site No. 29 at old milepost 1120 near Swede Johnson Creek, Waste Site Number HJ042, has very low concentrations of hydrocarbon, below clean-up criteria. The old dump here was very poorly located on top of saturated sands very near a year round creek, but does not appear to be causing any detectable contamination.

It is recommended that all four sites either be deleted from the waste site inventory, or given the lowest of priorities for clean-up. It is important to note the precise locations of these sites so that future land users are aware of them.

Small amounts of reclamation may be considered for Iron Creek (housekeeping) and Burwash Landing (landscaping). Also, an interpretive walking trail may be a useful consideration at Lower Rancheria to compliment the existing rest stop. Otherwise no further action or assessment of these sites is recommended.

2.0 INTRODUCTION

L.E.S. submitted a Proposed Assessment Plan for Sites 1; Iron Creek camp, east of Watson Lake, 2; Lower Rancheria Construction camp Km 1106, 27; Old dump at Burwash Land and 29; Old dumps near Swede Johnson Creek at old milepost 1120, in August 1996, and subsequently performed preliminary environmental investigations according to the plan under a Call -up Against a Standing Offer 96-6133-1. This Report details the site assessments, sampling strategy, findings and conclusions drawn about each of the four waste sites. The report is organized according to S.W.10) of contract No. 96-6133. The methods used to plan and carry out the assessments are described in section 3, and results are presented in section 4 and interpreted in section 5. A preliminary environmental risk assessment for each site is presented in section 6, followed by site specific recommendations in section 7. A complete list of references is included, and archival documents, photos, air photographs, site plans, test pit logs, analysis reports,and site photographs are appended.

All four sites originated during the WWII military construction era and are located along the Alaska Highway Corridor. Prior research and investigations have shown that former military sites can contain a certain group of persistent contaminants(1), (2). The approach taken in this assignment was to research archival materials and interview people acquainted with these sites in order to design an effective field program to determine the presence and/or extent of this group of contaminants. Although this assignment was at the reconnaissance level of assessment, every effort was made to collect enough data to verify the presence and extent of the selected analyses so that these sites could either be "put to bed" or slated for further assessment and clean-up.

3.0 METHODOLOGY

A comprehensive desk top review of archival and recent information was carried out before going ahead with a modified field and lab program for each site. The desk top review included examination of available information on file with government agencies, review of materials and photographs at the Yukon Archives, and interviews with people directly acquainted with each site. During this review, a potential contaminant profile was identified as well as the most probable locations of buried waste. A field screening method was selected and a sampling and analysis protocol selected on the basis of the desk top review (3). A description of the methods used in the investigation follows:

3.1 Review of Existing Data

First, the A.E.S. Waste Site Inventory files were reviewed and the sites discussed with Action on Waste inspectors.. Next, reports and documents concerning waste sites with military origins were reviewed. Materials at the Archives were examined, in particular, a collection of documents that were assembled for the fiftieth anniversary of the Alaska Highway (4). Air photographs dating from the 1940's and 1960's were examined at the Archives as well (5). Topographic maps and stereo pairs of the most recent air photographs were obtained. The air photos proved quite useful, so enlargements of the waste site areas were ordered from the National Air Photo Library for use in field work and site plans.

Finally, people with direct experience at these sites were interviewed by phone and in person. The Kluane First Nation provided helpful assistance in regard to the Burwash Landing and Swede Johnson sites (6).

3.2 Field Work Program

During the desk top review potential contaminants that may be present at the sites were identified as well as probable locations of buried waste. Site conditions and likely

migration pathways were inferred from the air photos. From these, the field screening technique and overall assessments were finalized. The potential contaminant profile was narrowed down to persistent organochlorine pesticides, chlorinated biphenols, metals, and hydrocarbon products because they had been detected at other military waste sites. To detect these, it was decided that metal detector scanning, soil vapour surveys, test pitting, visual cues, crude topographic surveying, photo documentation, and verification sampling of various matrices would all be used at each site. To save on analysis costs, some duplicate samples were retained for further screening if certain analyses were detected in a given sample.

Local control samples were collected at each site to ensure the validity of soil sample results. Standard protocols were followed in sample collection, preservation, shipping, and handling to further ensure data quality.

The use of various geotechnical surveying methods was considered, especially ground penetrating radar, but it was decided that test pitting by backhoe at locations identified by screening methods would be more cost effective for the particular sites and conditions.

3.3 Laboratory Program

Norwest Laboratories was selected as the analytical lab, and sampling kits were obtained for the range of potential contaminants and matrices. Norwest is a C.A.E.L. approved lab with an excellent QA/QC program.The methods of analysis were selected on the basis of those recommended by the C.C.M.E. National Contaminated Sites Remediation Program (3).

4.0 RESULTS OF THE STUDY BY SITE

4.1 SITE NUMBER 1- IRON CREEK CAMP, OLD M.P. 596

This site originated in 1943 as a construction camp for the final alignment of the Alaska Highway administered by the U.S. Public Roads Administration. As such, it was used by the American Military as well as private road contractors. The American Military turned all of the Northwest Highway System over to the Department of National Defense (D.N.D) on April 1, 1946. The camp originally contained about 29 frame structures. After the road was completed, the camp was abandoned and scavenged for several years. Former D.N.D. and Public Works (D.P.W.) employee, Basil Dowd, recalled that the camp was overgrown and hardly noticeable by the early 1950's (7). After the Canadian military turned the camp over to Public Works, it eventually came back into use as a Grader station operated under contract first to D.P.W., and after 1972, to the Government of The Yukon. A stereo pair of air photos taken in 1947 shows that many of the structures were already gone (see Appendix Two - air photo enlargement 11347-438). A plan of the site made in 1953 shows only about a dozen buildings still standing at that time (see Appendix One Camp Mile 596).

4.1.1 Site Description and Inventory

The site is open to the Alaska Highway along the north and straddles the B.C./Yukon border to the south. A private property abuts the site to the west, which is currently occupied by the Iron Creek Highway Lodge and facilities. A pothole lake curves around the south and west sides of the site.(see Appendix Two - air photo enlargement 28106-70). The original military camp area is now occupied by the road maintenance contractor and contains a metal shop, several out buildings, and two residential trailer units. There are several areas of accumulated solid waste of varying vintage consisting of wrecked road maintenance equipment, old vehicles, a wrecked trailer and miscellaneous wood and metal waste. These are shown on Plan One, Appendix Three. It is likely that the common garbage dump used by the military was over an embankment along the lake shore, which

is now private property. Metal waste and scattered garbage was found in this area dating from the 1940's. The area directly to the south of the clearing was used for waste disposal when the site came back into use for road maintenance and now contains an unused sewage disposal pit, junked road maintenance equipment, a backfilled garbage dump, and a modest amount of metal and wood waste along the southernmost boundary parallel to the border.

About 25 percent of the original military camp clearing is revegetated by mature trees and understorey dominated by poplar. Areas apparently logged when the construction camp was built are similarly revegetated. Modest revegetation exists in the clearing to the south of the camp, composed of pioneer species and dominated by willow and aspen. This growth is about 20 years old and is progressing slowly due to poor soil matrix.

4.1.2 Site Conditions

The surface features in the site area are glacial in origin and the topography is gently sloped from north to south. The site itself is flat to gently sloped and drains to the south and west towards the pothole lake, which is approximately 20 meters below the average elevation of the site. The lake itself is about 11 hectares in size and 18 meters deep at its deepest point. The bottom material is accumulated organic sediments overlaying glacial till.

A topographic low traverses the southeast corner of the site from a northeasterly direction. The entire site is vegetated except for the clearing currently in use for road maintenance. The surface soil common throughout is a thin layer of organics and loam on top of sandy gravel or glacial till The site is well drained with no naturally standing water. The unused sewage disposal pit contains about 0.1 meters of standing water.

4.1.3 Subsurface Soil Conditions

Seven test pits were dug at the site using a small rubber tired backhoe. The resulting soil

profiles are indicated in Appendix Four, Test Pit Logs. Generally, the soil profile seems to be either sandy silts and till or sands and gravels underlain by dense glacial till. Buried waste has apparently been paced onto dense till and backfilled with local coarse grained soils.

4.1.4 Groundwater Conditions

Saturated soil was only encountered in one test pit, at a depth of 2.2 meters, otherwise only vadose water was encountered. The saturated soil in test pit #1 was likely a local perched aquifer resulting from local recharge through coarse backfill. It is expected that the underground drainage follows the surficial topography and trends towards the southwest towards the pothole lake.

4.1.5 Contaminant Considerations

An area of buried waste was noted with a metal detector and examined by test pitting and soil vapour testing.This turned out to be the only place where contaminants were detected, in the form of modest amounts of hydrocarbon in soil. The site was walked in a dense grid with a metal detector, and several pits dug by hand to the "B" horizon soil and checked with the organic vapour analyzer. This did not turn up any further indications of buried waste. A total of 12 soil samples were collected and analyzed for hydrocarbons, organochlorine pesticides, and PCB's. Two sediment samples were collected from the lake and analyzed for organochlorine pesticides and PCB's. One vegetation sample was collected from the border clearing and analyzed for pesticides. All of these samples were below the level of detection for all the parameters except for the hydrocarbons in soil detected at the buried waste site. Sample locations are indicated on the site plan. The results of analyses are presented in Table One.

Table One - IRON CREEK ANALYTICAL RESULTS

Sample I.D.	Matrix	Depth (m)	Organo chlorine pesticide scan (ppm)	PCBs (ppm)	Hydro-carbons (ug/g)
Local Control	soil	0.1	<0.05	<0.10	<10
P-1	soil	0.2	<0.05	<0.10	<10
P-2	soil	0.2	<0.05	<0.10	<10
T.P.I 1	soil	2.3	<0.05	<0.10	126
T.P.I 2	soil	0.6	NA	NA	<10
T.P.1 2	soil	1.5	<0.05	NA	96
T.P.I 3	soil	1.4	NA	NA	<10
T.P.I 4	soil	1.0	NA	NA	<10
T.P.I 4	soil	4.2	<0.05	<0.10	<10
T.P.I 5	soil	3.0	NA	NA	<10
T.P.I 6	soil	1.7	NA	<0.10	<10
T.P.I 7	soil	1.1	NA	NA	<10
S.I. 1	sed	12	<0.05	<0.10	NA
S.I. 2	sed	0.5	<0.05	<0.10	NA
B.C. 1	veg	-	<0.05	NA	NA

4.2 SITE NUMBER 2 - LOWER RANCHERIA CONSTRUCTION CAMP Km 1106

This site was also a military construction camp and was operated only from 1943 to 1946. The site was inventoried and declared surplus by D.N.D in 1955, and any useable materials were removed over the years leaving a few collapsed buildings noted by C.E. Edey during an assessment study in 1976 (8), and by Environment Canada during a survey of old waste sites in 1982 (9). The garbage dump used by the camp was apparently used by a service station that operated on the west side of the river until the late 1960's (7).

4.2.1 Site Description and Inventory

The site is bordered on the south by the Alaska Highway and on the west by the Lower Rancheria River. The old construction camp itself is located on a flat river terrace while the garbage dump is situated 1 Km east on a slightly higher bench.The old dump was backfilled about 20 years ago and has revegetated with pioneer species dominated by alder. The camp buildings were burned and buried at the same time and are only distinguished by revegetated mounds. The camp area is entirely revegetated by mature conifers with mature poplar, grasses and sedges in open areas. There is a negligible amount of old debris scattered around, composed mainly of metal waste. There is a small amount of recent garbage and litter at the old dump site and along a trail parallel to the river. There is a Government of Yukon rest stop situated at the entrance to the old camp. The buried waste on site consists of the burned and dozed camp buildings and a backfilled garbage dump. The majority of waste at the dump was likely put there during the post war period.The old dump site is revegetating slowly due to poor soil matrix.

4.2.2 Site Conditions

The site is flat to gently sloping in a northwesterly direction on a glaciofluvial lowland. The area is forested with conifer stands of lodgepole pine and black and white spruce. There is a carpet of mosses and lichens throughout the undisturbed area. Former roads,

clearings and building sites are revegetating with a mix of deciduous and conifers with shrubs and grasses underneath. Surface soils are medium to fine textured and well drained.

4.2.3 Subsurface Soil Conditions

Two test pits were dug at the old dump site, and several hand dug pits to the "B" horizon were made at the old camp site and below the toe of the old dump. The dump site is situated in coarse morainal soil on a bench above the old camp. The soil profile consisted of sandy gravels to a depth of 2.8m, while backfill material in two separate layers was mainly mixed sandy surface soils and organic debris. All of the hand dug pits revealed either sandy gravels or gravelly sand except for one of the backfilled building sites which was covered with sandy silt.

4.2.4 Groundwater Conditions

No saturated soils were encountered. The soils were coarse and rapidly drained throughout. It is expected that groundwater drains westward towards the river normal to the topographic relief.

4.2.5 Contaminant Considerations

The camp area and old dump site were screened with a metal detector and organic vapour analyzer, resulting in targets for test pitting and soil sampling. A total of five soil samples were collected. No organochlorine pesticides or PCB's were detected. Hydrocarbons in soil were found in at the old dump site and at the site of the old power house. Concentrations were all less than 500 ppm total hydrocarbons. Sample and test pit locations are shown in Appendix Three, Plan Two. Results of analyses are presented in Table Two.

Table Two - LOWER RANCHERIA ANALYTICAL RESULTS

Sample I.D.	Matrix	Depth (m)	Organo chlorine pesticide scan (ppm)	PCBs (ppm)	Hydro-carbons (ug/g)
Local Control	soil	0.1	<0.05	<0.10	<10
T.P.R-1	soil	2.5	<0.05	<0.10	453
T.P.R-2	soil	2.7	NA	NA	283
T.P.R-3	soil	2.3	NA	NA	361
P-1	soil	0.3	NA	NA	<10
P-2	soil	0.05	NA	NA	122

4.3 SITE NUMBER 27 - OLD DUMP SITES, BURWASH LANDING

This site is situated on both sides of the old access road to Burwash Landing just north of the Alaska Highway. A cleared area on the north side of the access road was the former location of a Pan American Construction building, with an old borrow pit across the road which eventually was used as a casual disposal place over the years (6). Pan American was the construction company that built the Burwash Landing airfield.

4.3.1 Site Description and Inventory

The site is composed of two clearings separated by the old access road, now upgraded as a residential street. The southern clearing is the location of an old dump that has been recently covered with end dumped soil and wood debris resulting from construction of a residential subdivision in the immediate area. The eastern edge of the old dump still has

some metal waste showing, otherwise there is no surface evidence of a dump having been located here. The dump site is revegetating rapidly with grasses and shrubs. The southern clearing contains a small casual borrow pit, and is otherwise empty and heavily revegetated with willow and grasses. There is no evidence of the old Pan American building remaining.

4.3.2 Site Conditions

The area is forested with white spruce and shrubs. There are open meadows in the area with willow, sedges, and grasses dominant. The site is now surrounded by a residential subdivision, but none of the lots are located on the waste site area investigated.

There is a thin layer of reddish brown organics and loess developing on glacio-lacustrine soils. The terrain is moderately sloping northward towards Kluane Lake.

4.3.3 Subsurface Soil Conditions

Four test pits and three hand dug pits to the "B" horizon soil were dug at the site. Generally, the soil profile consisted of a thin layer of reddish brown sandy topsoil and loess, underlain by light coloured sandy silt. The silt layer overlies either sandy gravel or dense grey silty till. No water table was encountered. Permafrost was encountered in one pit at 2.0m. Test pit locations are shown on the site plan and test pit logs for the Burwash site are attached in Appendix Four.

4.3.4 Groundwater Conditions

No water table was encountered at this site, and all soils were dry with no evidence of seasonal water table. It is expected that groundwater drainage generally follows the topographic relief and is affected by local zones of permafrost and buried peat layers.

4.3.5 Contaminant Considerations

A total of eight soil samples were collected at this site. No organochlorine pesticides or PCB's were detected . The only contaminant detected was hydrocarbons in soil, at very low concentrations at depth at the old dump site. Soil sample locations are shown in Appendix Three, Plan Three. Analytical results for the Burwash site are presented below in Table Three.

Table Three - BURWASH LANDING ANALYTICAL RESULTS

Sample I.D.	Matrix	Depth (m)	Organo chlorine pesticide scan (ppm)	PCBs (ppm)	Hydro-carbons (ug/g)
Local Control	soil	0.1	<0.05	<0.10	
T.P.B1	soil	1.0	NA	NA	56
T.P.B2	soil	3.7	<0.05	<0.10	12
T.P.B3	soil	1.8	NA	NA	<10
T.P.B4	soil	2.7	NA	<0.10	<10
P-B1	soil	0.2	NA	NA	23

4.4 SITE NUMBER 29 - OLD DUMP SITE NEAR SWEDE JOHNSON CREEK

This site is located 1.7 km west of the Swede Johnson creek crossing at old milepost 1120 on the south side of the Alaska Highway. The old dump sites originated with construction of the highway, and subsequent use by the Donjek pumping station on the Haines - Fairbanks pipeline situated 6 km west of the site. Garbage that could not be

burned in the incinerator at the pumping station was hauled to this dump (2). Sometime during the 1970's the main dump site was backfilled, and a pit dug 150 m west which is still in use as a household garbage dump by area residents (6).

4.4.1 Site Description and Inventory

An old casual garbage dump dating from construction of the road and pipeline is located down a steep embankment directly across from a gravel quarry. This area contains a negligible amount of scattered metal waste, cans and the like, and is barely visible. A main waste site is accessed by a 200m road from the highway and is located on a gravelly clearing next to a tributary stream of Swede Johnson creek. The old dump has been backfilled with gravelly sand and organics and is covered with revegetation in the form of willows and grasses. It appears as though the dump originated as a casual borrow pit excavated into steep south facing hillside.

4.4.2 Site Conditions

The area is located on moderately sloping morainal terrain on the height of land between the Kluane River and the Donjek River. The old military garbage dumps are very modest in size and are totally revegetated by conifers and shrubs.The main buried waste dump is situated in a cleared area and has been backfilled with a mixture of coarse soils and fine grained organic soils. Old roads and access dating from the 1940's has totally revegetated with white spruce and shrubs. The toe of the old dump is covered with willow and alder. The furthest extent of the dump is within 5m of the aforementioned creek. The undisturbed surface soils are rapidly drained silty sands.

4.4.3 Subsurface Soil Conditions

Two test pits and four hand dug pits to the "B" horizon were dug at the site. The test pits were located along the edge of the old waste dump. The generalized soil profile at the old dump site consists of one meter of silty sand fill underlain by a thin peat layer and a

zone of saturated white sand.The original ground in the surrounding area is made up of silty sands and gravel.

4.4.4 Groundwater Conditions

The old dump site is situated on top of a saturated sand layer at 2.0m. The elevation of the water table is 0.48m below the water surface elevation of the creek at test pit S-1, suggesting that the creek is exfluent towards the dump at this point. The general groundwater drainage in the area is expected to be from north to south following the moderately steep well drained topography.

4.4.5 Contaminant Considerations

Eight soil samples, two groundwater samples, two sediment samples and two surface water samples were collected at the site. The field of analyses was extended to dissolved metals and oil and grease in water, to determine if there was any affect on the creek cased by leachate from the old dump. No organochlorine pesticides or PCB's were detected in any matrix. None of the water samples had detectable oil and grease. Metals analyses indicate typical levels for both groundwater and surface water, and do not show any change in water quality in the reach of stream passing by the toe of the old dump site. Sample locations are shown in Appendix Three, Plan Four. The water analysis report is contained in Appendix Five, Analysis Reports. Results of analysis are presented below in Table Four.

Table Four - SWEDE JOHNSON ANALYTICAL RESULTS

Sample I.D.	Matrix	Depth (m)	Organo chlorine pesticide scan (ppm)	PCBs (ppm)	Oil & Grease (mg/L)	Hydro-carbons (ug/g)
Local Control	soil	0.2	<0.05	<0.10	NA	<10
TPS-1	soil	1.4	NA	NA	NA	<10
TPS-1	soil	2.0	NA	NA	NA	<10
TPS-1`	soil	2.5	<0.05	<0.10	NA	<10
TPS-2	soil	1.4	NA	NA	NA	44
PS-1	soil	0.1	<0.05	NA	NA	21
PS-2	soil	0.2	<0.05	NA	NA	<10
PS-3	soil	0.2	NA	NA	NA	<10
U/S sed	sed	0.3	<0.05	<0.10	NA	NA
D/S sed	sed	0.3	<0.05	<0.10	NA	NA
T.P.S-1	G.W.	2.3	NA	NA	<0.2	NA
T.P.S-2	G.W.	2.3	NA	NA	<0.2	NA

sed=sediment, G.W.=groundwater

For ICP scan refer to Appendix Five, Water Analysis Report

5.0 INTERPRETATION OF RESULTS

The desk top review suggested that a possible contaminant profile in the form of persistent chlorinated organics, hydrocarbon products, or landfill leachate may have been present at any of the four sites. Contamination at the four abandoned military sites could not be ruled out because experience has shown that poor disposal and handling practises has led to contamination of various matrices at similar sites. The information reviewed and data collected has confirmed with reasonable confidence that, apart from localized hydrocarbon contaminated soils, there are no significant contaminants present or migrating off site at any of the four sites studied. The following are interpretations of information and data by site:

Site Number One - Iron Creek Camp

Air photo interpretation and review of an old site plan indicated an extensive construction camp, which was replaced after a dormant period by the current highway maintenance facilities. Most likely waste disposal areas were examined and sampled after field screening. Samples were collected both at the potential sources and along the potential migration pathways. All surface and test pit soil samples were below the level of detection for PCB's and organochlorine pesticides both in the immediate area of abandoned waste and along the site boundaries. Sediment samples from the pothole lake were also free of these contaminants, as was the local control sample. Because of the location of sample sites it can be reasonably assumed that none of these contaminants are present in significant quantity or are migrating off the site.The small amount of hydrocarbons in soil were confined to the backfilled dump site and are not migrating to any significant degree. Solid waste in the form of junked equipment, scrap metal and litter is present in significant quantity. The fuel transfer area at the present maintenance garage shows soil staining and, and judging from soil vapour readings, there is a modest amount of locally contaminated soil in this area - typical of fuel transfer areas at industrial sites.

Site Number 2 - Lower Rancheria

Air photo interpretation and examination of old site plans indicated a fairly large construction camp on the river terrace probably associated with bridge and road construction. The camp garbage dump was used by a service station for some time during the post war period. Both the camp site and dump were cleaned up by burn and bury methods in the 1970's. Sampling of soils revealed hydrocarbon contaminated soils at the old backfilled dump and at the former site of the camp power plant. The concentration of hydrocarbons in soil was moderate and localized. There were no PCB's or organochlorine pesticides detected in any of the soil samples or in the local control sample. There was a negligible amount of scattered solid waste and some recently disposed wood and metal waste at the site.

Site Number 27 - Old Burwash Landing Dump

Interviews and review of air photos indicate that the site was used first by a construction company during the war years and later by local residents as a casual waste disposal site, and was recently backfilled with material stripped during development of a subdivision. Very low levels of hydrocarbons were detected below grade in the immediate area of the old dump. No PCB's or organochlorine pesticides were detected in any of the soil samples or in the local control sample.

Site Number 29 - Old Dumps Near Swede Johnson Creek

Interviews and air photo interpretation indicated that the site was used first as a casual garbage disposal site by road construction crews and as a dump site for the nearby Haines Fairbanks pipeline pumping station. The garbage dump was backfilled, and a new pit excavated about 10 to 15 years ago. The casual dumps along the roadway contain negligible amounts of litter and waste such as old cans and containers. The backfilled dump is situated on top of a saturated sand layer only a few meters from a creek, and appears to contain a typical mixture of metal waste, empty containers and other non

burnable garbage. All soil and sediment samples were free of PCB's or organochlorine pesticides. The creek water quality does not appear to be affected by leachate. The water surface elevation of the creek was higher than the water table during the site survey, suggesting that groundwater was flowing towards the dump at that time. A small amount of localized hydrocarbon contamination was noted below grade at the former crest of the buried dump.

6.0 PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

A sufficient number of samples was collected and site information compiled to state confidently that all four sites were found to present very low to negligible environmental risk. No persistent chlorinated organics were detected along any exposure pathways, and only modest amounts of hydrocarbons in soil were detected. Backfilled waste sites contained hydrocarbons in all cases but soil contamination was found to be very limited in extent. There were no cases of contaminants migrating off site.

The Iron Creek site contained the largest inventory of solid waste. This material does not present a significant physical hazard. The remaining three sites have negligible amounts of solid waste which present no physical hazard.

7.0 RECOMMENDATIONS

Although split samples were retained to profile any hydrocarbon contamination, the extra analyses were not considered worthwhile in light of the low levels present, absence of other contaminants, and very limited extent of soil contamination. No remediation or further site assessment is recommended unless the sites change in land use designation.

Clean up of the solid waste at the Iron Creek site is recommended at a low level of priority, and is regarded as a housekeeping issue. It may be necessary to delineate the extent of soil contamination at the present fuel transfer area sometime in the future,

especially if the land is transferred or changes use. The highest concentration of hydrocarbons was 126 ug/g, well below clean-up thresholds even if all of the hydrocarbon was volatile.

The Lower Rancheria site is already a rest stop, and consideration should be given to establishing an interpretive trail through the old camp site. Due to low readings on the organic vapour analyzer, the hydrocarbon present is likely well below clean-up threshold.

The Old Dump site at Burwash landing could benefit from additional fill and site grading, combined with burial of the remaining metal waste. This would restore the area to its former level of utility. No residential development should take place on top of the old dump because of obvious problems associated with underground utilities. Hydrocarbon concentrations were well below clean-up thresholds.

The old dump site near Swede Johnson Creek does not require remediation at this time. Further assessment should only be considered if the land is to be disposed or if the current garbage dump expands considerably. Hydrocarbon concentrations were well below clean-up thresholds.

All four waste sites should be removed from the A.E.S. Inventory of Waste Sites.

8.0 REFERENCES

1. Laberge Environmental Services, June 1993. *Use, Disposal and Transportation of Selected Contaminants in Yukon*. DIAND.

2. K. Bisset and Associates, April 1995. *Research of Former Military Sites and Activities in the Yukon*. For AES - Action on Waste, DIAND.

3. C.C.M.E. (Canadian Council of Ministers of the Environment), December 1993. *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volumes I, II, and III.*

4. Department of National Defense, 1955. *Survey of Abandoned Camps Along the Alaska Highway*. Yukon Archives Retrieval A46.

5. Nation Air Photo Library, 1945 - 1964. Stereo pairs of four sites, located at Yukon Archives Reference room.

6. Charles Eikland, Grace Johnson, 1996. Personal Communication, oral interviews.

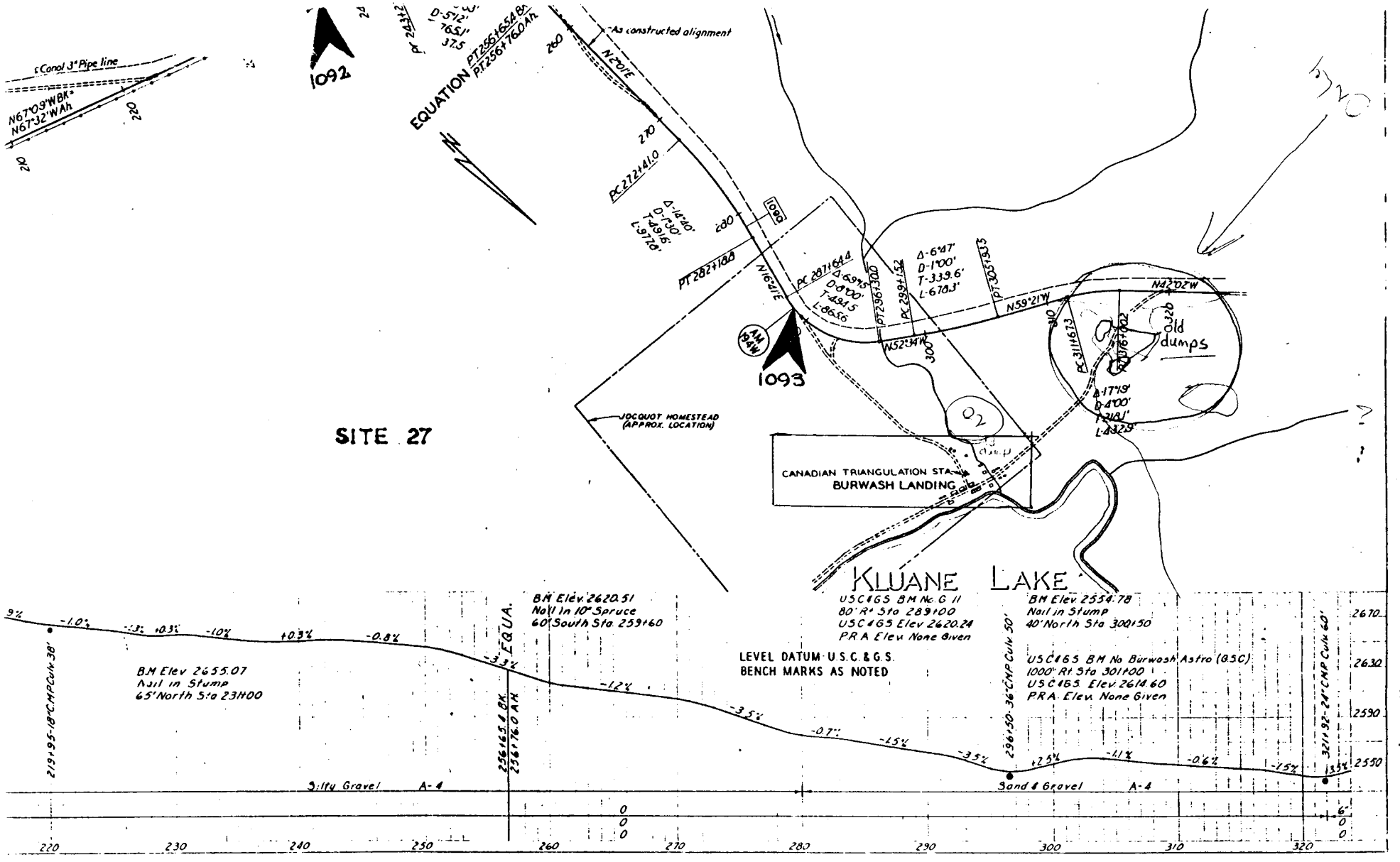
7. Basil Dowd, 1996. Personal Communication, telephone interview.

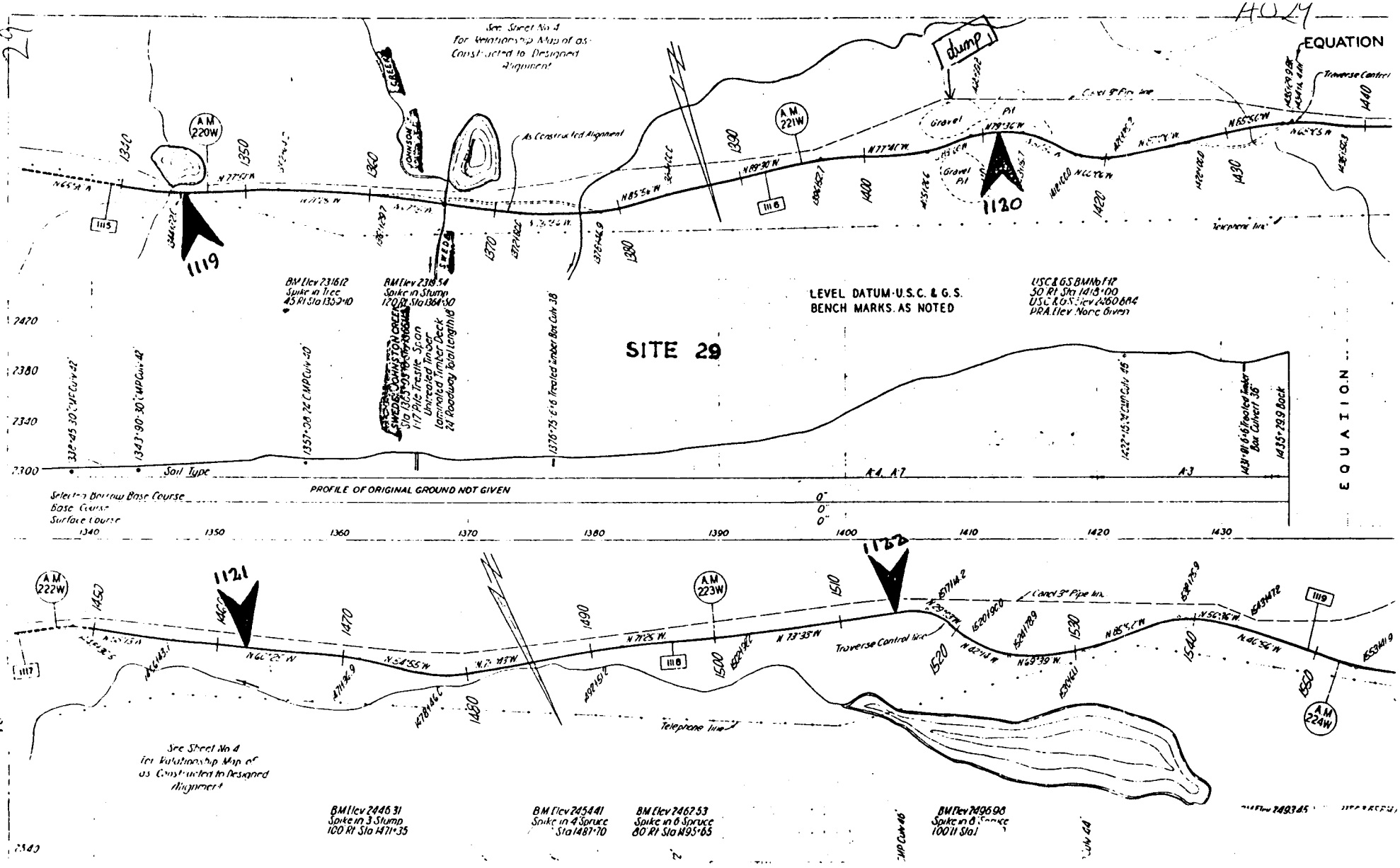
8. Edey, C.E. 1976. *Alaska Highway - Haines Road Clean Up Assessment Study 1976*. Prepared for Land Use Section, DIAND.

9. Reger, M. 1983. *Compilation of Listing of Known and Probable Abandoned Waste Disposal Sites Throughout the Yukon Territory*. EPS, DSS File No. 065B. KE603-3-0282 (3 volumes).

APPENDIX ONE

ARCHIVAL DOCUMENTS


SITE 27
KLUANE LAKE
JOCQUOT HOMESTEAD (APPROX. LOCATION)
CANADIAN TRIANGULATION STA.
BURWASH LANDING
1092
1093
EQUATION
As constructed alignment
Canol 3" Pipe line
N67°09'WBK
N67°32'WAh
N16°41'E
N59°21'W
N42°02'W
N52°34'W
Old dumps
BM Elev 2655.07
Nail in Stump
65' North Sta 231+00
BM Elev 2620.51
Nail in 10" Spruce
60' South Sta 259+60
LEVEL DATUM U.S.C. & G.S.
BENCH MARKS AS NOTED
USC&GS BM No. G 11
80' Rt Sta 289+00
USC&GS Elev 2620.24
P.R.A. Elev. None Given
BM Elev 2554.78
Nail in Stump
40' North Sta 300+50
USC&GS BM No Burwash Astro (B.S.C)
1000' Rt Sta 301+00
USC&GS Elev 2614.60
P.R.A. Elev. None Given
Silty Gravel A-4
Sand & Gravel A-4
9%
-1.0%
+0.3%
-10%
+0.3%
-0.8%
-12%
-3.5%
-0.7%
-4.5%
-3.5%
+2.5%
-1.1%
-0.6%
-1.5%
13%
220
230
240
250
260
270
280
290
300
310
320
2670
2630
2590
2550


See Sheet No 4 for Relationship Map of as Constructed to Designed Alignment
EQUATION
dump
Gravel Pit
Gravel Pit
Traverse Control
As Constructed Alignment
Telephone line
A M 220W
A M 221W
A M 222W
A M 223W
A M 224W
1119
1120
1121
1122
1115
1116
1117
1118
1119
BM Elev 231.612
Spike in Tree
45 Rt Sta 1352+10
BM Elev 238.54
Spike in Stump
120 Rt Sta 1364+50
USC & GS BM No F 17
50 Rt Sta 1415+00
USC & GS Elev 2460.884
PRA Elev None Given
LEVEL DATUM U.S.C. & G.S.
BENCH MARKS AS NOTED
SITE 29
EQUATION
Soil Type
A-4, A-7
A-3
PROFILE OF ORIGINAL GROUND NOT GIVEN
Selected Borrow Base Course
Base Course
Surface Course
0"
0"
0"
See Sheet No 4 for Relationship Map of as Constructed to Designed Alignment
BM Elev 2046.31
Spike in 3 Stump
100 Rt Sta 1471+35
BM Elev 2454.41
Spike in 4 Spruce
Sta 1487+10
BM Elev 2462.53
Spike in 6 Spruce
80 Rt Sta N95+65
BM Elev 2496.98
Spike in 8 Spruce
100 Lt Sta I
2420
2380
2330
2300
2340
1340
1350
1360
1370
1380
1390
1400
1410
1420
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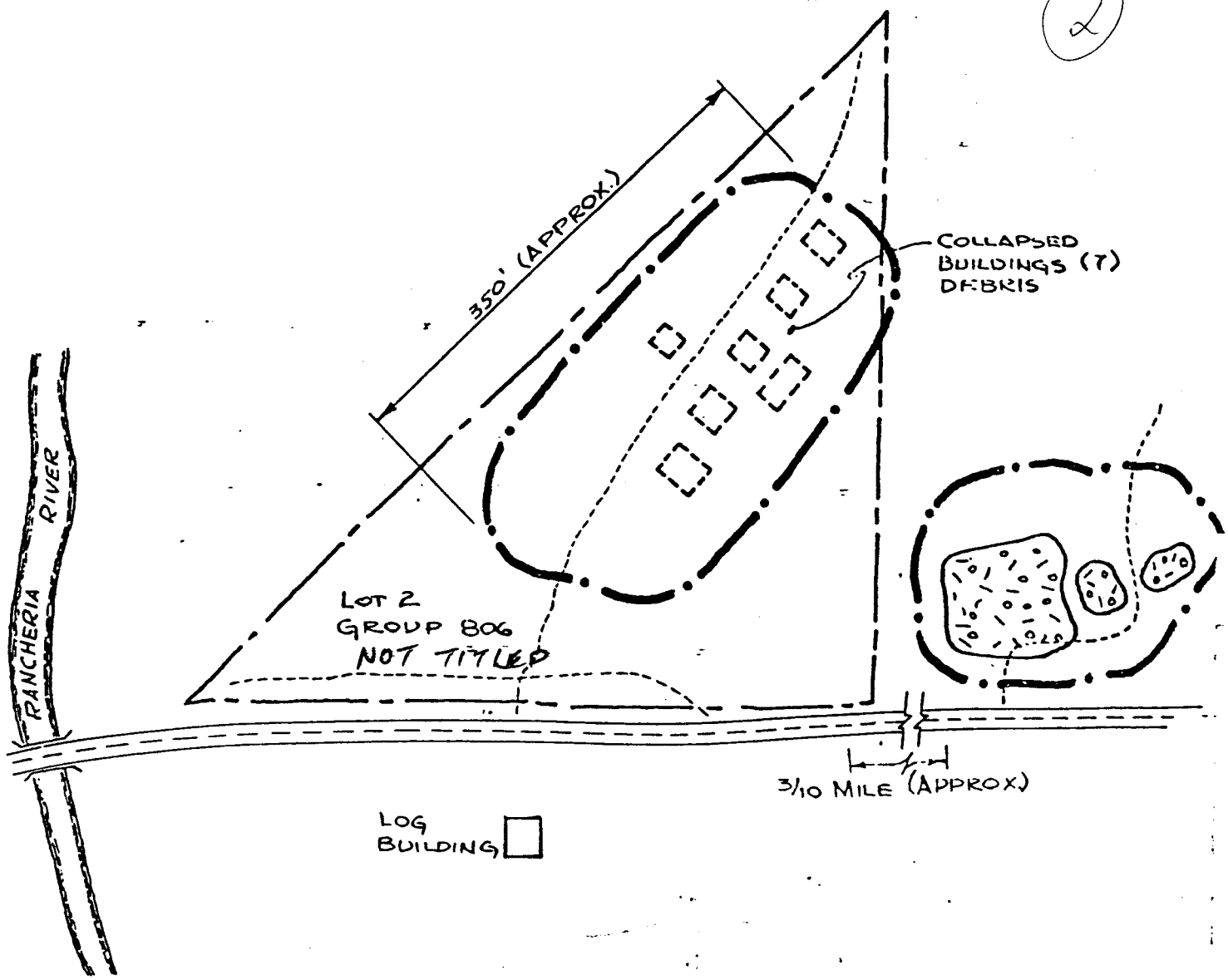
1500
1510
1520
1530
1540
1550

(2)



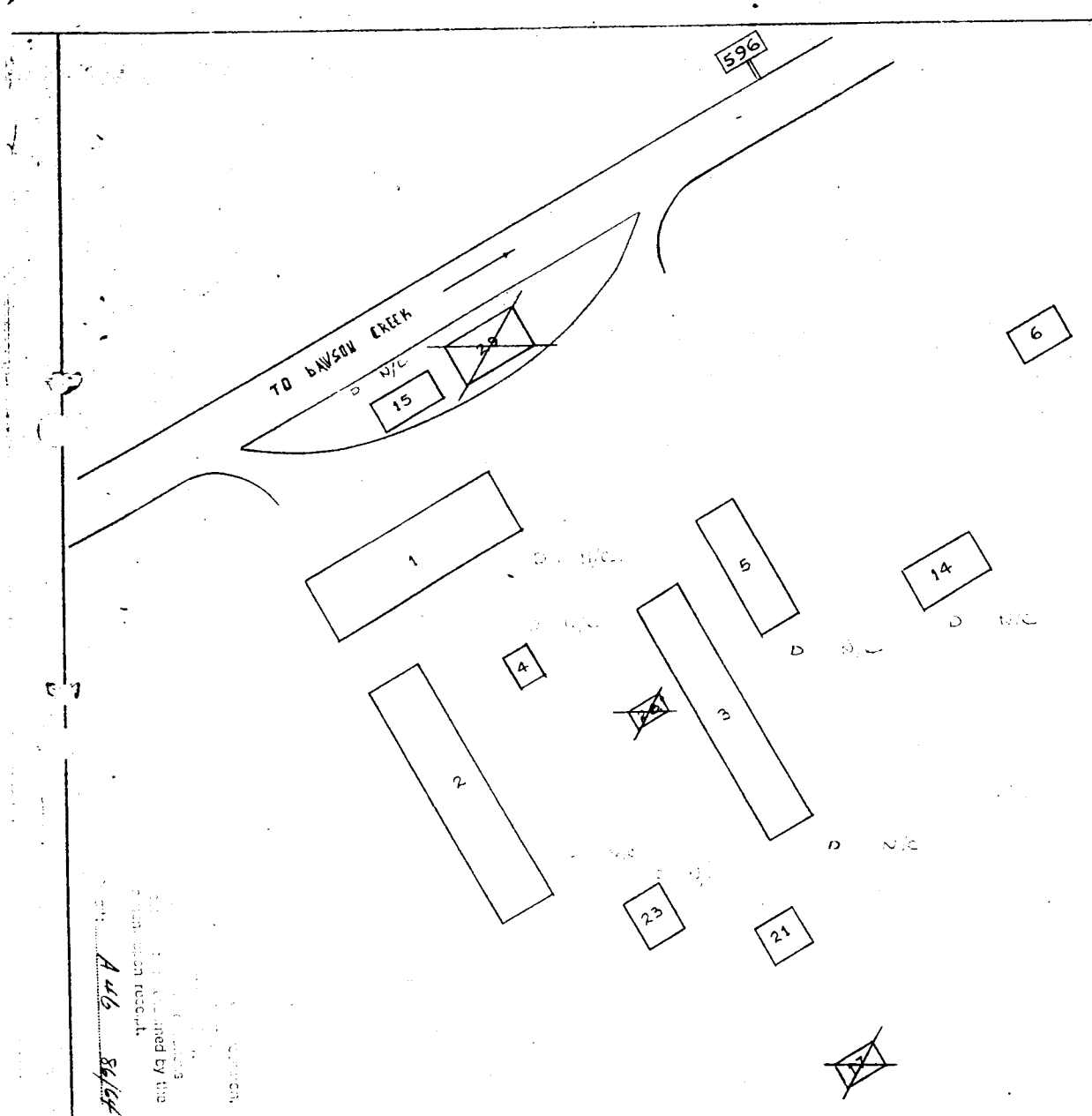
SITE 2

NORTH

ALASKA HIGHWAY
MILE - 687.0

FIGURE 4

KEDE-1, C.B. 1976



SCHEDULE of BUILDINGS

Nº	SIZE	SQ. FT	TYPE	REMARKS
1	36'x96'	3.456	FRAME	LOG SIDING
2	30'x120'	3.600	"	PAPER "
3	30'x150'	4 500	"	" " MESS
4	12'x16'	192	"	" "
5	20'x60'	1.200	"	" "
6	15'x24'	360	"	" "
14	20'x36'	720	"	" "
15	15'x30'	450	"	LOG SIDING
16	20'x50'	1000	"	" "
~~17~~	~~12'x20'~~	~~240~~	~~"~~	~~" "~~
21	20'x20'	400	"	TENT FRAME
23	26'x26'	676	"	ICE HOUSE
25	8'x8'	64	"	LATRINE
~~28~~	~~9'x17'~~	~~153~~	~~"~~	~~PAPER SIDING~~
~~29~~	~~20'x30'~~	~~600~~	~~TIMBER~~	~~LOADING PLATFM~~

CHECKED
CHECKED

DEPARTMENT OF NATIONAL DEFENCE (ARMY)

NORTHWEST HIGHWAY SYSTEM

WHITEHORSE YUKON TERRITORY

CAMP MILE 596

SITE 1

DRAWN BY M.J.C.
CHECKED BY
SCALE 1" = 50'-0"
DATE OCT. 1953

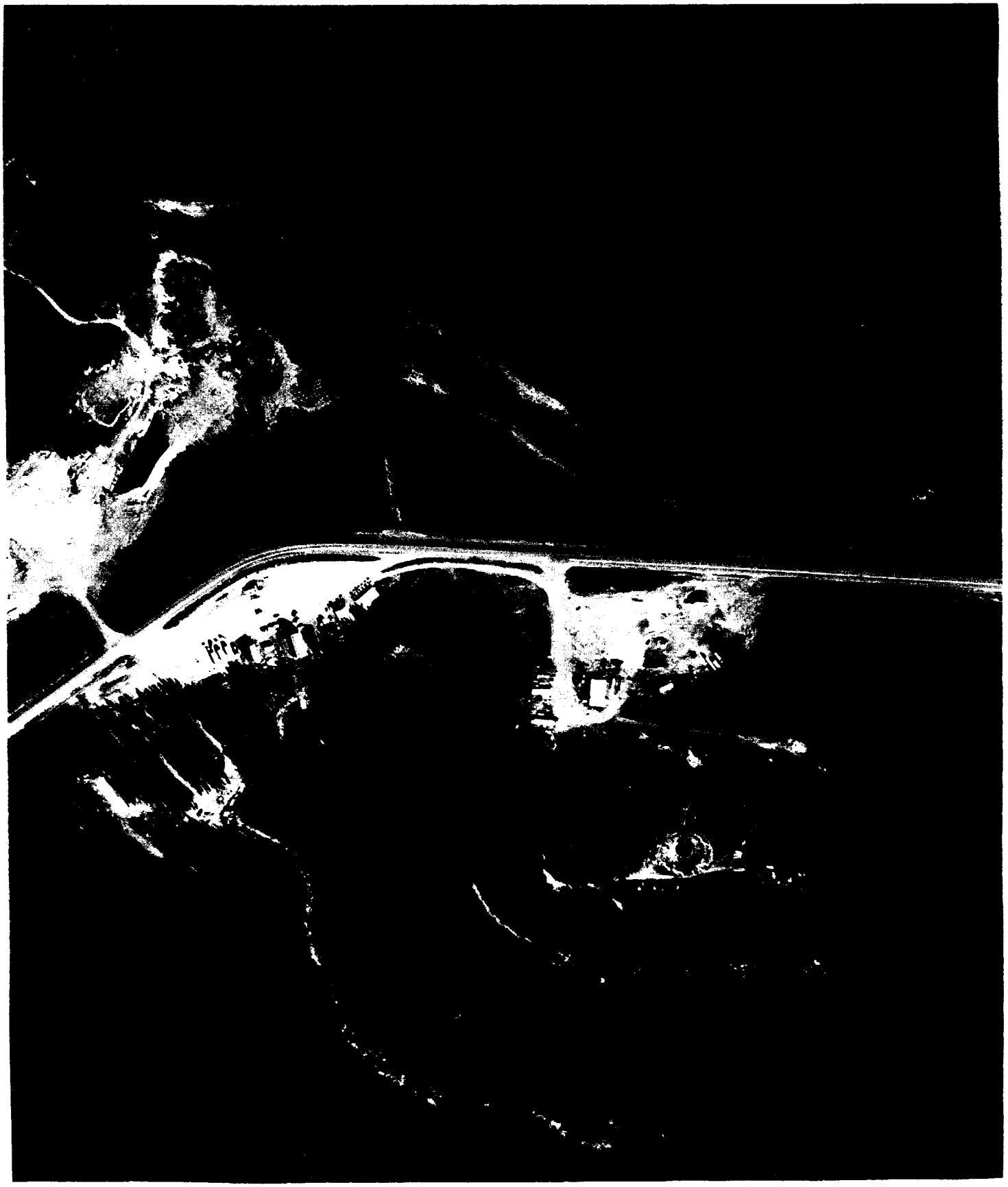
APPROVED BY

No. A.C. 596

Aug 8/54

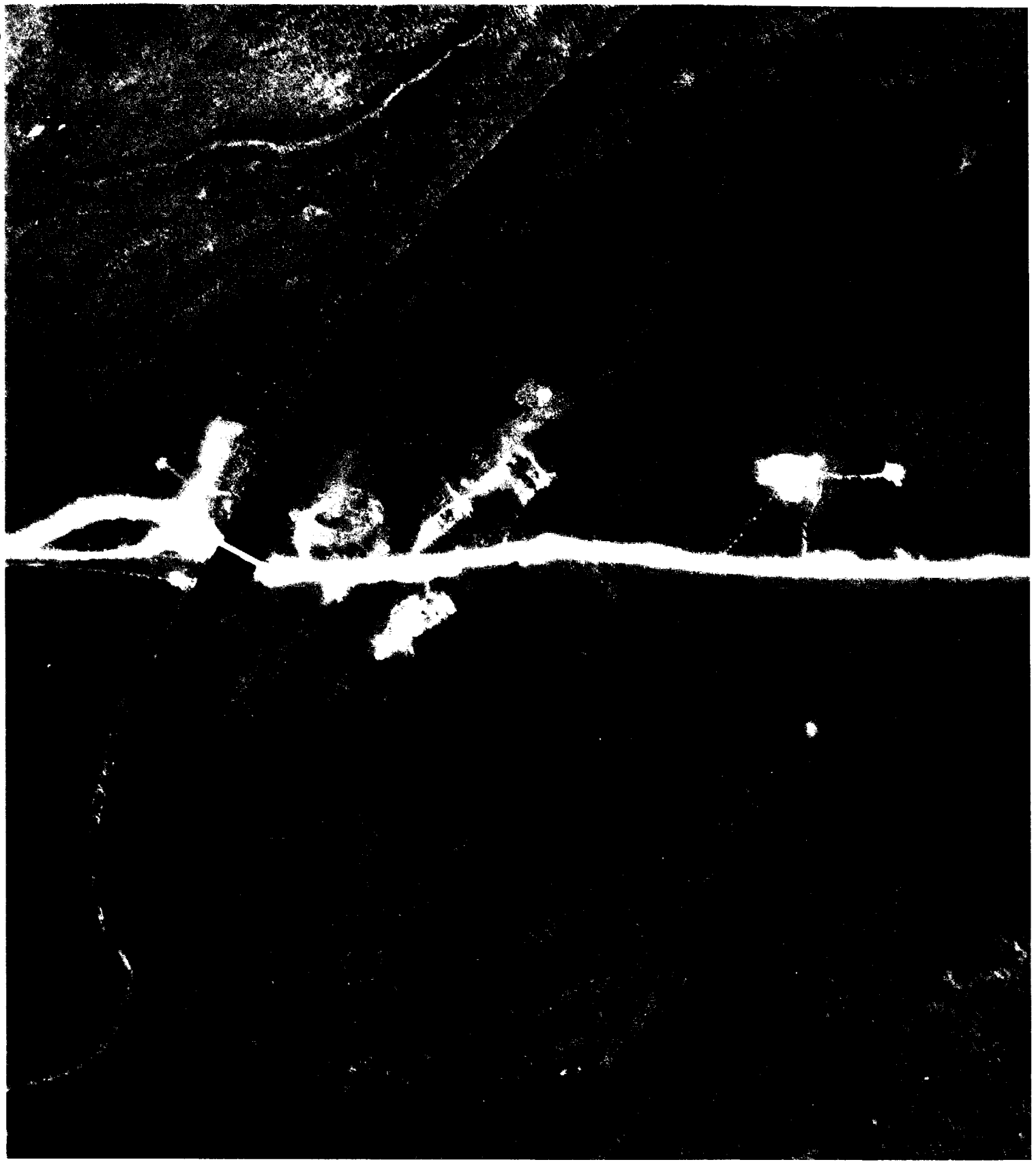
APPENDIX TWO

AIR PHOTOGRAPHS



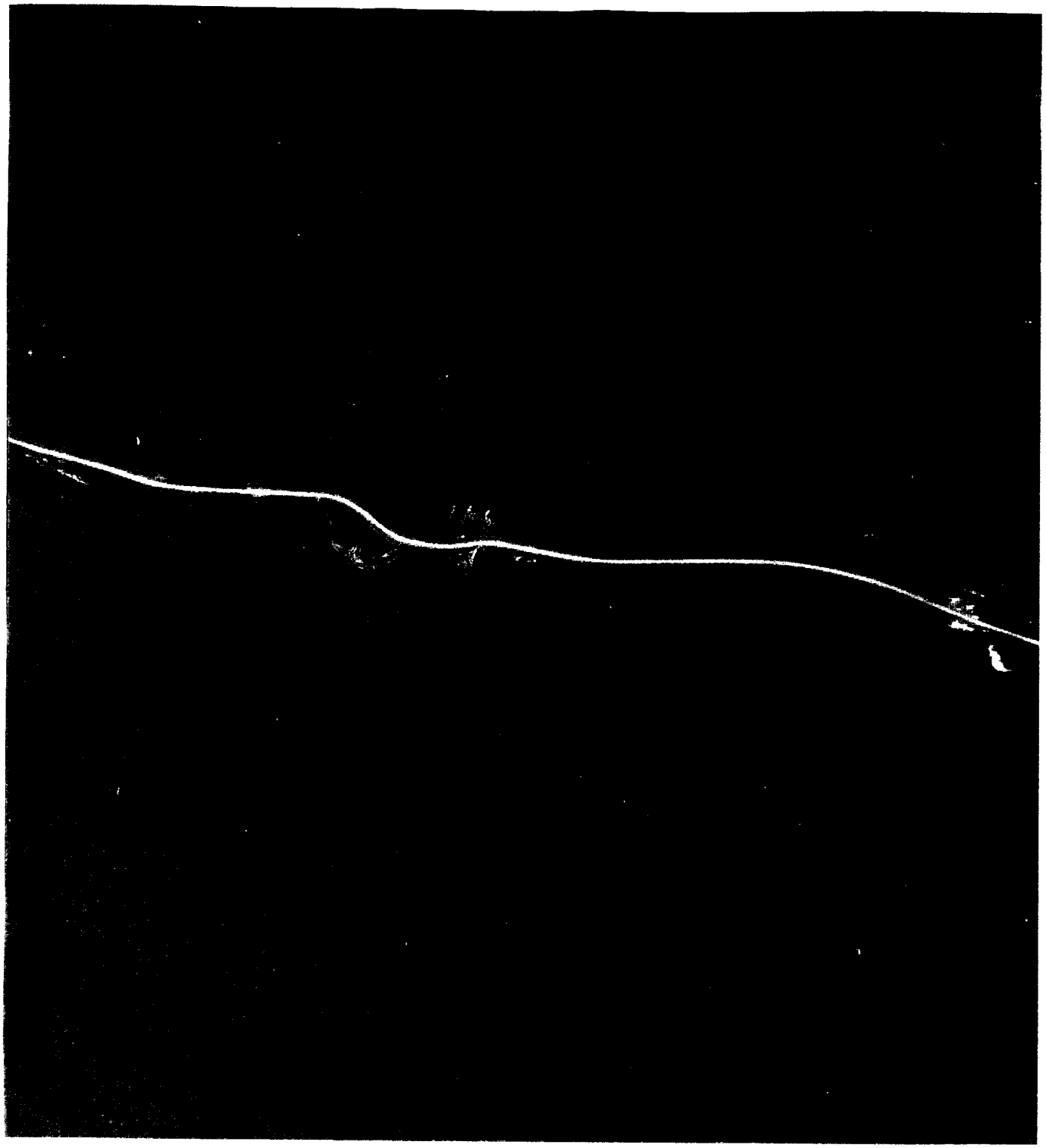
A28106-70 August 1994 Scale 1:2000

Site No. 1 - Iron Creek Camp, old Mile Post 596



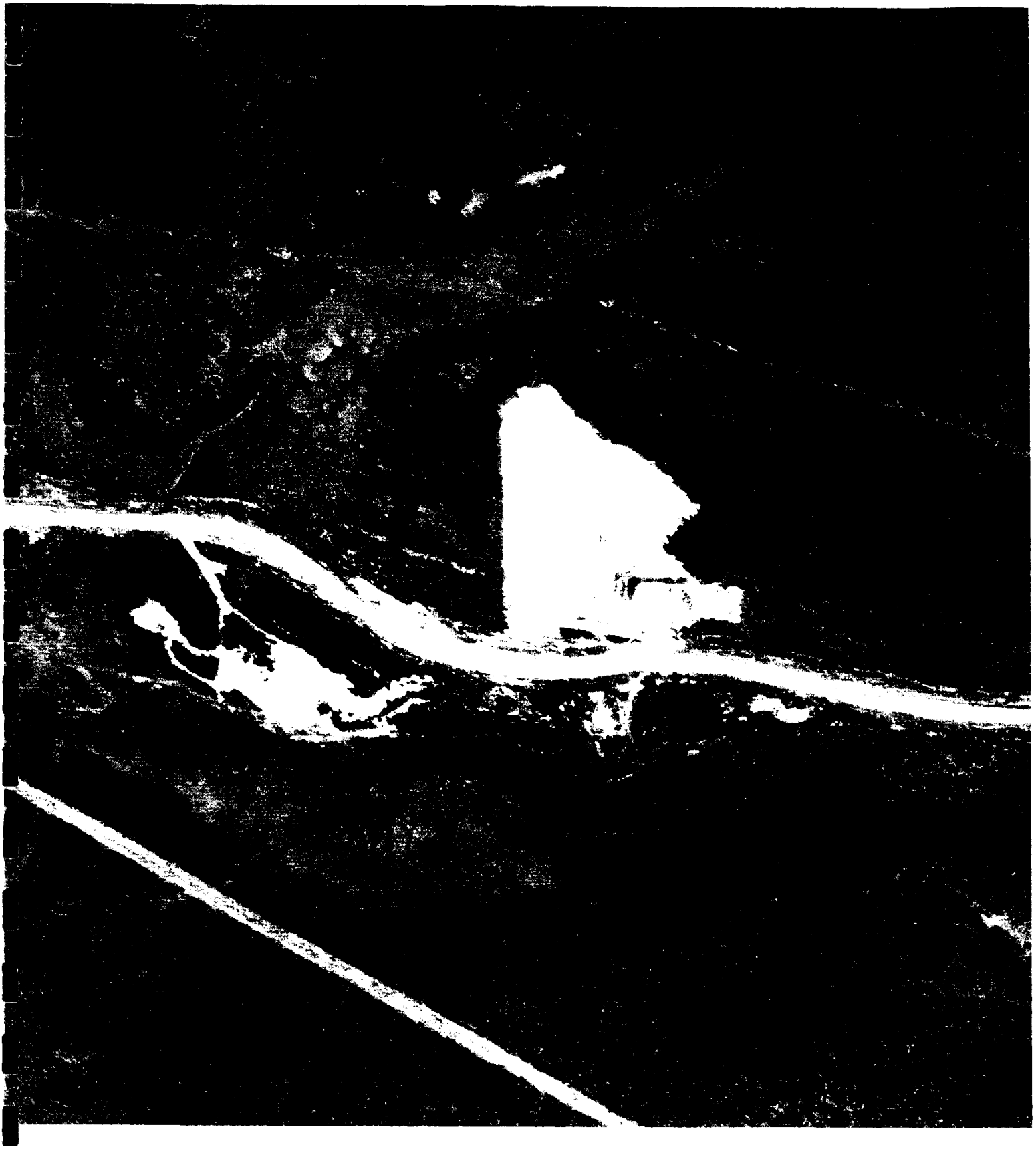
A11370-409 RCAF 1947 Scale 1:8000

Site No. 2 - Lower Rancheria Camp



A22997-62 1947 Scale 1:8000

Site No. 29 - Old dumps near Swede Johnson Creek, old Mile Post 1120

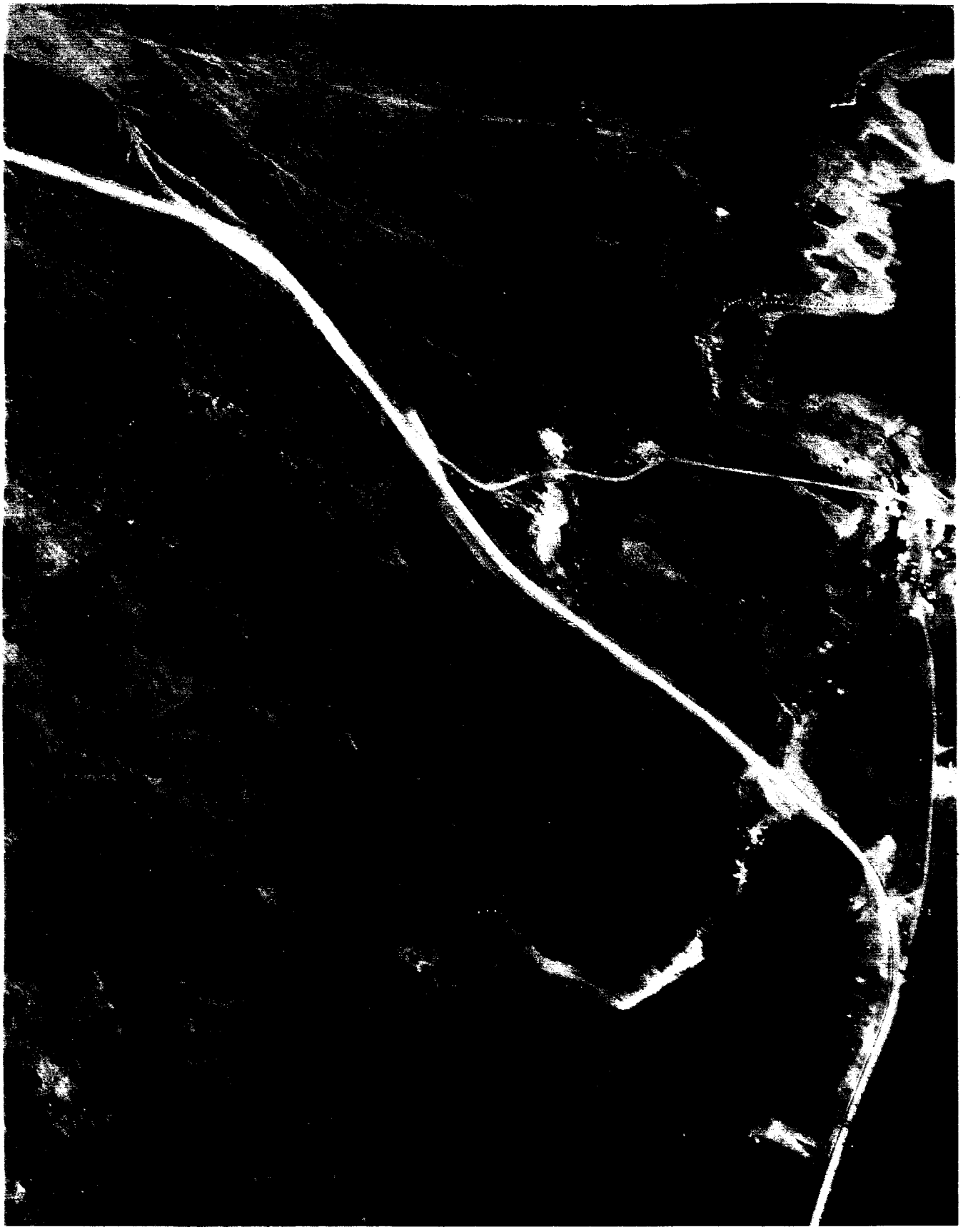


A27475-87 1989 Scale 1:4000

Site No. 29 - Old dump near Swede Johnson Creek, old Mile Post 1120

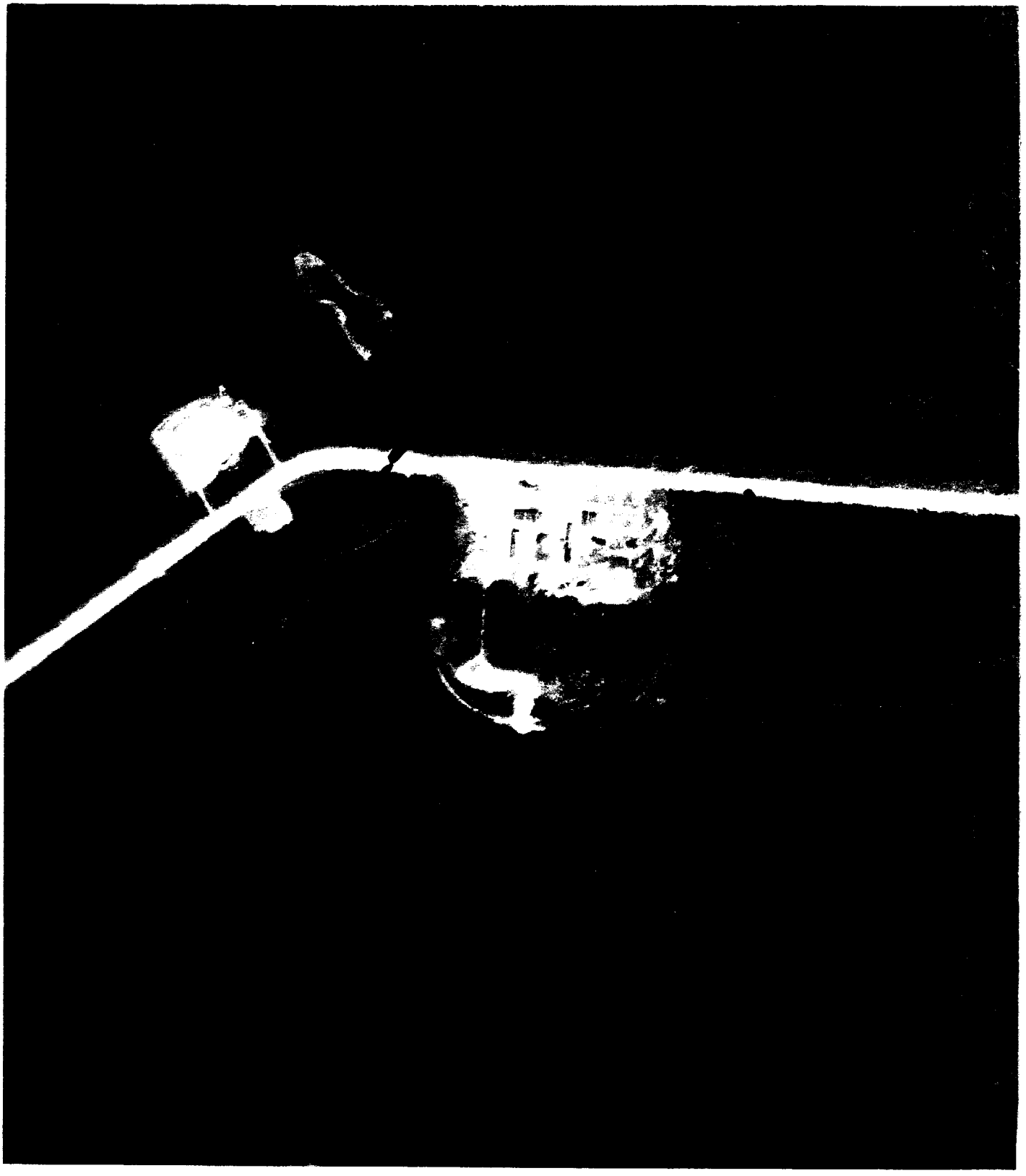
A27218-266 1987 Scale 1:4000

Site No. 27 - Old dumps near Burwash Landing



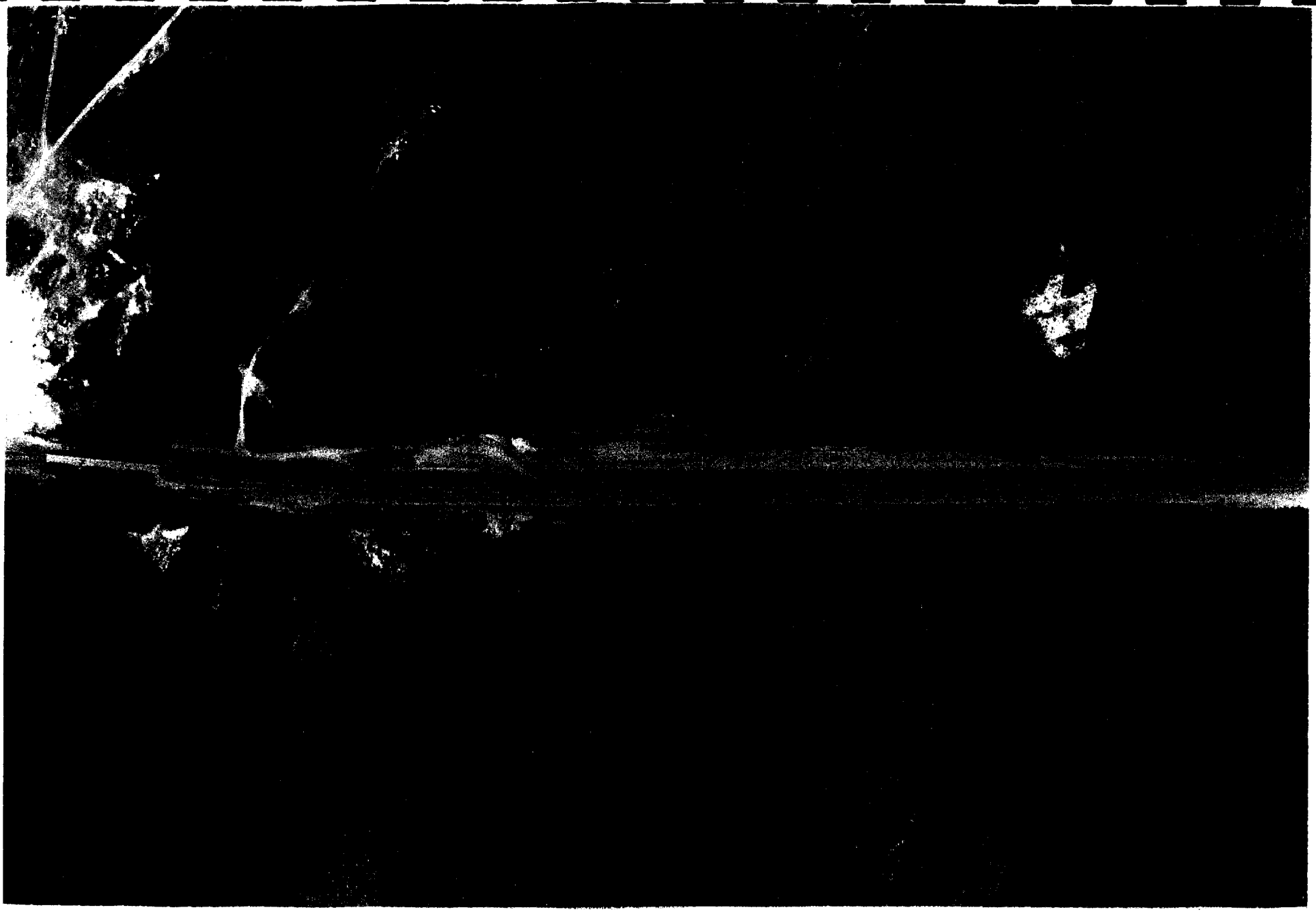
A13476-102 RCAF 1947 Scale 1:8000

Site No. 27 - Old dumps near Burwash Landing



A11347-438 RCAF 1947 Scale 1:8000

Site No. 1 - Iron Creek Camp, old Mile Post 596



A27829-110 June 1992 Scale 1:4000

Site No. 2 - Lower Rancheria Camp

APPENDIX THREE

SITE PLANS

APPENDIX FOUR

TEST PIT LOGS

TEST PIT LOG

VERTICAL SCALE: ~

DATE: Sept. 9, 1996

EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.1		organics, root zone, brown sandy SILT.	
1.1		silty sand, GRAVEL, dry.	
2.3		gravelly SAND fill, metal and plastic waste, water table at 2.2 m	
3.4		dense, silty, TILL. piezometer installed at 3.4m 1" Ø PVC hand slotted.	1" PVC
		END OF PIT 3.4 m sampled at 0.6, 2.3 m eastern limit of old back-filled garbage dump.	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: site Assessment, A.E.S.

Location: Iron Creek Camp

Pit No. T.P. I-1

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 9, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.2		silty SAND, brown, organics.	
0.5		dense sandy, silty, TILL.	
1.5		dense, sandy, TILL, grey. cold, dry.	
		END OF PIT 1.5 m pit located below old loading ramp, oily stain on surface sampled at 0.6, 1.5 m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessment, H.E.S.
Location: Iron Creek Camp
Pit No. TPI-2

TEST PIT LOG

VERTICAL SCALE: –
DATE: Sept. 9, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.10	–	sandy brown GRAVEL, organics, root zone.	
1.5		metal waste in sandy, GRAVEL	
		END OF PIT 1.5 m pit located in centre of old backfilled dump sampled at 1.4 m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessment, AES.
Location: Iron Creek Camp
Pit No. TP I-3

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 9, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.35		reddish brown, gravelly SAND, organics, root zone	
1.0		silty, gravelly, SAND. mottled at 0.8m	
3.0		sandy, gravelly, SILT. sandy GRAVEL. water table (seasonal, now dry)	
4.2		sandy, GRAVEL.	
		END OF PIT 4.2 m pit near old hopper 25m North of B.C. border sampled at 1.0m and 4.2m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessment A.E.S.
Location: Iron Creek Camp
Pit No. TP I-4

TEST PIT LOG

VERTICAL SCALE

DATE:

EQUIPMENT TYPE:

DEPTH	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.2		gravelly, SAND. organics, rootzone.	
1.0		silty, sandy, GRAVEL. dry.	
3.0		gravelly, SAND. dry.	
		END OF PIT 3.0 m pit located beside old grader hulk. sampled at 3.0 m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments, A.E.S.

Location: Iron Creek Camp

Pit No. TP I-5

TEST PIT LOG

VERTICAL SCALE ~

DATE: Sept. 10, 1996

EQUIPMENT TYPE: backhoe

DEPTH	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.2		reddish brown silty, sand, organics. root zone.	
		sandy ~~silt~~, Stoney, GRAVEL dry.	
1.7		END OF PIT AT 1.7m pit located at south west corner of site boundary sampled at 1.7m	

Laberge Environmental Services

Box 5111, Whitehorse, YT Y1A 4S3

Tel: (403) 668-6838

Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments AES.

Location: Iron Creek Camp

Pit No. TP I-6

TEST PIT LOG

VERTICAL SCALE —

DATE: Sept. 10, 1996

EQUIPMENT TYPE: backhoe

DEPTH	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.2		peat, decomposed organics, trees.	
1.0		woody debris in gravelly, TILL.	
2.9		very dense sandy, silty, TILL, frozen at 2.8m	
		END OF PIT 2.9m pit located near old U.S. Army pit 50m. South of highway sampled at 1.1m, just above permafrost.	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments, AES.

Location: Iron Creek Camp

Pit No. TPI-7

TEST PIT LOG

VERTICAL SCALE

DATE:

EQUIPMENT TYPE:

DEPTH	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.2		silty, sandy, ORGANICS. FILL. root zone	
1.0m		recent metal waste in sandy GRAVEL fill. dry.	
2.0		gravelly, sandy, SILT, fill. dry.	
3.2		old garbage (1940's beer cans), in organic silty, SAND, fill. original ground at 2.8m dry.	
		END OF PIT 3.2 m sampled at ~~2.8m~~ 2.5m pit located at crest of old garbage dump backfilled ~~at~~ about 1978.	

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Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessment AES.

Location: Lower Rancheria

Pit No. TPR-1

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 10 1996
EQUIPMENT TYPE: backhoe

DEPTH	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.1		silty, sandy, GRAVEL. organics, root zone.	
2.7		sandy, GRAVEL, fill. recent waste near surface. old stuff at bottom, mixed mostly metal waste. more beer cans circa 1940.	
		END OF PIT 2.7 pit located at crest of old dump site, northern limit. Sampled at 2.7 m	

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Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessments A.E.S.
Location: Lower Rancheria
Pit No. TP R-2

TEST PIT LOG

VERTICAL SCALE —
DATE:
EQUIPMENT TYPE:

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.25		reddish brown sandy GRAVEL. organics, root zone. dry	
2.3		sandy, GRAVEL. dry	
		END OF PIT 2.3m pit dug at toe of old dump site to sample for hydrocarbon at 2.3m.	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: & Site Assessments A.E.S.
Location: Lower Rancheria
Pit No. TP R-3

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 11, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.5		sandy, LOAM · organics. root zone reddish brown.	
1.5		crumbly, sandy, silty, TILL. gray. very dry.	
1.7		blue grey fairly dense, silty, TILL. dry.	
		END OF PIT 1.7m pit located at southern limit of old dump site sampled at 1.0m	

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Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessments, AES.
Location: Burwash Landing
Pit No. TP B-1

TEST PIT LOG

VERTICAL SCALE ~

DATE: Sept. 11, 1996

EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.3		metal waste in silty, organics, SAND, fill.	
1.0		sandy GRAVEL · dry.	
3.5		blue grey, silty, dense, TILL. water table encountered 3.5m	
3.7		saturated blue grey till	
		END OF PIT 3.7m pit located midway along easternmost crest of old dump. Sampled at 3.7 m	

Laberge Environmental Services

Box 5111, Whitehorse, YT Y1A 4S3

Tel: (403) 668-6838

Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments AES.

Location: Burwash Landing

Pit No. TPB-2

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 11, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.1		reddish brown organics, loess.	
.5		very fine, SILT, LOESS.	
2.5		dense, sandy, TILL. Permafrost encountered at 2.0m	
		END OF PIT 2.5 m	
		pit located midway between old dump and meadow.	
		sampled at 1.8m	

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Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessments, AES
Location: Burwash Landing
Pit No. TP B-3

TEST PIT LOG

VERTICAL SCALE —

DATE: Sept. 11, 1996

EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.6		reddish brown, organics, LOESS.	
0.7		very fine SAND. dry	
1.7		sandy, stoney GRAVEL dry	
2.0		stoney, dense, sandy, TILL. wet	
2.7		permafrost, sandy TILL.	
2.8		dense, frozen, gravelly, TILL.	
		END OF PIT 2.8m pit located in northwest corner of site. sampled at 2.7m just above permafrost layer.	

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Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments AES

Location: Burwash Landing

Pit No. TP B-4

TEST PIT LOG

VERTICAL SCALE: —
DATE: Sept. 12, 1996
EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.15		organics, dark grey silty, SAND. backfill.	
1.5		silty, SAND. fill. old metal and wood waste.	
1.7		peat layer	
1.9		white uniform fine SAND.	
3.0		sitly peat layer, saturated sand underneath to 3.0 water table at 2.8m	
		END OF PIT 3.0m pit located at western end of old backfilled dump sampled at 2.3m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11
Project: Site Assessments AES
Location: Old dump near Swede Johnson
Pit No. TPS-1

TEST PIT LOG

VERTICAL SCALE: —

DATE: Sept. 12, 1996

EQUIPMENT TYPE: backhoe

DEPTH (m)	SYMBOL	DESCRIPTION OF MATERIAL	PIEZOMETER
0.5		silty, SAND. fill. organics.	
1.3		old metal waste, glycol cans etc. in sandy fill.	
2.0 2.2		peat layer	
2.8		white fine uniform SAND water table at 2.5m	
		END OF PIT 2.8 m pit located at easternmost end of old backfilled dump. sampled at 2.3 m	

Laberge Environmental Services
Box 5111, Whitehorse, YT Y1A 4S3
Tel: (403) 668-6838
Fax: (403) 667-6956

Job No. 96-11

Project: Site Assessments A.E.S.

Location: old dump near Swede Johnson

Pit No. TP S-2

APPENDIX FIVE

ANALYSIS REPORTS - NORWEST LABS

NORWEST LABS

EDMONTON PH. (403) 438-5522 FAX (403) 438-0396
CALGARY PH. (403) 291-2022 FAX (403) 291-2021
LANGLEY PH. (604) 530-4344 FAX (604) 534-9996
LETHBRIDGE PH. (403) 329-9266 FAX (403) 327-8527
WINNIPEG PH. (204) 982-8630 FAX (204) 275-6019

DATE 20 SEP 96 08:30
P.O. NO. 96-09-2139
W.O. NO. 2 119049
PAGE 1

NORWEST LABS-CALGARY
BAY 6, 2712-37 AVE NE
CALGARY, AB
T1Y 5L3

LABERGE ENVIRON.

WATER ANALYSIS REPORT

SAMPLE		1 W1991 T.P.S-1	2 W1992 T.P.S-2	3 W1993 SWEDE JOHNSON TRIB U/S CREEK	4 W1994 SWEDE JOHNSON TRIB D/S CREEK
ORGANICS					
OIL AND GREASE	mg/L	<0.2	<0.2	<0.2	<0.2
TRACE ICP,DISS					
ALUMINUM	mg/L	0.076	0.019		
ANTIMONY	mg/L	<0.005	<0.005		
ARSENIC	mg/L	<0.01	<0.01		
BARIUM	mg/L	0.106	0.0752		
BERYLLIUM	mg/L	<0.0005	<0.0005		
BISMUTH	mg/L	<0.007	<0.007		
BORON	mg/L	0.005	0.021		
CADMIUM	mg/L	<0.0005	<0.0005		
CALCIUM	mg/L	40.7	62.6		
CHROMIUM	mg/L	0.0014	0.0009		
COBALT	mg/L	0.0029	0.0024		
COPPER	mg/L	0.003	0.006		
IRON	mg/L	2.10	0.082		
LEAD	mg/L	0.003	<0.002		
LITHIUM	mg/L	0.00123	0.00247		
MANGANESE	mg/L	1.63	1.09		
MAGNESIUM	mg/L	7.25	11.6		
MOLYBDENUM	mg/L	0.002	0.002		
NICKEL	mg/L	0.005	0.004		
PHOSPHORUS	mg/L	<0.006	<0.006		
POTASSIUM	mg/L	1.75	4.52		
SELENIUM	mg/L	<0.003	<0.003		
SILICON	mg/L	8.06	8.00		
SILVER	mg/L	<0.001	0.001		
SODIUM	mg/L	3.05	4.13		
STRONTIUM	mg/L	0.113	0.204		
SULPHUR	mg/L	2.46	3.86		
THALLIUM	mg/L	<0.004	<0.004		
TIN	mg/L	0.005	0.009		
TITANIUM	mg/L	0.0010	0.0007		
VANADIUM	mg/L	<0.001	<0.001		
ZINC	mg/L	0.0191	0.0073		

Lab Manager: D. MacMillan

NORWEST LABS

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DATE 20 SEP 96 08:30
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PAGE 2

NORWEST LABS-CALGARY
BAY 6, 2712-37 AVE NE
CALGARY, AB
T1Y 5L3

LABERGE ENVIRON.

WATER ANALYSIS REPORT

SAMPLE		1 W1991 T.P.S-1	2 W1992 T.P.S-2	3 W1993 SWEDE JOHNSON TRIB U/S CREEK	4 W1994 SWEDE JOHNSON TRIB D/S CREEK
TRACE ICP,TOTAL					
ALUMINUM	mg/L			0.033	0.097
ANTIMONY	mg/L			0.007	<0.005
ARSENIC	mg/L			<0.01	0.01
BARIUM	mg/L			0.0225	0.0304
BERYLLIUM	mg/L			<0.0005	<0.0005
BISMUTH	mg/L			<0.007	<0.007
BORON	mg/L			0.005	0.003
CADMIUM	mg/L			<0.0005	<0.0005
CALCIUM	mg/L			27.8	28.7
CHROMIUM	mg/L			<0.0008	<0.0008
COBALT	mg/L			<0.0007	<0.0007
COPPER	mg/L			0.001	0.002
IRON	mg/L			0.390	0.743
LEAD	mg/L			0.003	0.002
LITHIUM	mg/L			0.00064	0.00038
MANGANESE	mg/L			0.221	0.418
MAGNESIUM	mg/L			4.54	4.73
MOLYBDENUM	mg/L			<0.001	<0.001
NICKEL	mg/L			<0.001	0.003
PHOSPHORUS	mg/L			<0.006	<0.006
POTASSIUM	mg/L			3.43	4.35
SELENIUM	mg/L			<0.003	<0.003
SILICON	mg/L			5.73	6.02
SILVER	mg/L			<0.001	<0.001
SODIUM	mg/L			2.18	2.20
STRONTIUM	mg/L			0.0711	0.0753
SULPHUR	mg/L			1.51	1.62
THALLIUM	mg/L			<0.004	<0.004
TIN	mg/L			<0.003	<0.003
TITANIUM	mg/L			0.0005	0.0041
VANADIUM	mg/L			<0.001	<0.001
ZINC	mg/L			<0.0005	<0.0005

Lab Manager: D. MacPhee

Phone:
(604) 530-4344
1-800-889-1433
Fax:
(604) 534-9996

NORWEST LABS

203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 23-Sep-96

Client		Received From	
Name	: Laberge Environmental	Name	:
Address	: Box 5111 Whitehorse, Yukon CANADA Y1A 4S3	Address	:
Phone	: (403) 668-6838	Phone	:
Fax	: (403) 667-6956	Fax	:
Attn.	: Ken Nordin	Attn.	:
Project	:		

Organo-Chloride Pesticides in Tissue

Parameter	20791-33 BC.1 Veg. Silex SP	Detection Limit
Pesticide		
Aldrin	< 0.05	0.05 ppm
BHC (alpha isomer)	< 0.05	0.05 ppm
Chlordane	< 0.05	0.05 ppm
4,4'-DDD	< 0.05	0.05 ppm
4,4'-DDE	< 0.05	0.05 ppm
2,4'-DDT	< 0.05	0.05 ppm
4,4'-DDT	< 0.05	0.05 ppm
Dieldrin	< 0.05	0.05 ppm
Endosulfan I	< 0.05	0.05 ppm
Endosulfan II	< 0.05	0.05 ppm
Endrin	< 0.05	0.05 ppm
Heptachlor	< 0.05	0.05 ppm
Heptachlor epoxide	< 0.05	0.05 ppm
Hexachlorobenzene	< 0.05	0.05 ppm
Lindane	< 0.05	0.05 ppm
Methoxychlor	< 0.05	0.05 ppm
Mirex	< 0.05	0.05 ppm

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.
ND = Not Determined.

Approved:

Randy Neumann, B.Sc.
Laboratory Manager

Phone:
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1-800-889-1433
Fax:
(604) 534-9996

NORWEST LABS

203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Client		Received From	
Name	: Laberge Environmental	Name	:
Address	: Box 5111 Whitehorse, Yukon CANADA Y1A 4S3	Address	:
Phone	: (403) 668-6838	Phone	:
Fax	: (403) 667-6956	Fax	:
Attn.	: Ken Nordin	Attn.	:
Project	:		

Organo-Chloride Pesticides in Soil

Parameter	20791-1 LC Ranchera	20791-2 TP R1, 2.5m	20791-6 TP B2, 3.7m	20791-9 LC Burwash	Detection Limit
Pesticide					
Aldrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
BHC (alpha isomer)	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Chlordane	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDD	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDE	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
2,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Dieldrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan I	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan II	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor epoxide	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Hexachlorobenzene	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Lindane	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Methoxychlor	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Mirex	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Percent Moisture	8.47	2.86	10.42	10.01	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.
ND = Not Determined.

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NORWEST LABS

203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Organo-Chloride Pesticides in Soil (cont.)

Parameter	20791-11 TP S1, 2.5m	20791-12 SJ S1	20791-13 1-1	20791-14 TP1 2.3m	Detection Limit
Pesticide					
Aldrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
BHC (alpha isomer)	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Chlordane	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDD	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDE	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
2,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Dieldrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan I	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan II	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endrin	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor epoxide	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Hexachlorobenzene	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Lindane	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Methoxychlor	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Mirex	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Percent Moisture	32.61	2.59	96.53	5.64	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.
ND = Not Determined.

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NORWEST LABS

203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd.: 17-Sep-96
Date Comp. : 30-Sep-96

Organo-Chloride Pesticides in Soil (cont.)

Parameter	20791-18 TP4 4.2m	20791-22 LC Iron Creek	20791-23 S2 Sediment	20791-25 P-8B	20791-27 R.S 2	Detection Limit
Pesticide						
Aldrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
BHC (alpha isomer)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Chlordane	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDD	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
2,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Dieldrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan I	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan II	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor epoxide	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Hexachlorobenzene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Lindane	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Methoxychlor	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Mirex	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Percent Moisture	4.18	6.93	62.05	ND	23.74	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.
ND = Not Determined.

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NORWEST LABS

203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Organo-Chloride Pesticides in Soil (cont.)

Parameter	20791-28 SJ.S-2	20791-29 LC Swede Johnson	20791-30 S.J. Trib U/S Sed.	20791-31 S.J. Trib D/S Sed.	20791-34 BC.1	Detection Limit
Pesticide						
Aldrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
BHC (alpha isomer)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Chlordane	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDD	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
2,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
4,4'-DDT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Dieldrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan I	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endosulfan II	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Endrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Heptachlor epoxide	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Hexachlorobenzene	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Lindane	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Methoxychlor	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Mirex	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 ppm
Percent Moisture	33.88	26.38	53.67	36.15	8.56	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.
ND = Not Determined.

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Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Organo-Chloride Pesticides in Soil (cont.)

Definitions / Methods

Organo-Chloride Pesticides: This analysis is carried out in accordance with U. S. Environmental Protection Agency Method 8080 (#SW 846, 3rd Edition, Washington DC 20460) which involves extraction of the components with an organic solvent (EPA 3540) followed by analysis by capillary gas chromatography using an electron capture detector.

Percent Moisture: Percentage of the total wet weight of the sample as received. This analysis is carried out gravimetrically by drying the sample to constant weight at 105 C.

Comments

Quality Control Results

QA/QC		Analyst		
Compound	% Recovery	Analysis	Date	Analyst
Lindane	82	O-C Scan	29-Sep-96	Ken M.
DDT	81			
Endosulfan I	86			

R.L. Williamson
Supervisor

Note: All samples will be disposed of after 30 days following analysis unless other arrangements are made.

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203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Client		Received From	
Name	: Laberge Environmental	Name	:
Address	: Box 5111 Whitehorse, Yukon CANADA Y1A 4S3	Address	:
Phone	: (403) 668-6838	Phone	:
Fax	: (403) 667-6956	Fax	:
Attn.	: Ken Nordin	Attn.	:
Project	:		

Polychlorinated Biphenyls (PCBs) in Soil

Parameter	20791-1 LC Ranchera	20791-2 TP R1, 2.5m	20791-4 TP 2, 1.5m	20791-6 TP B2, 3.7m	Detection Limit
Total PCBs	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	0.1 ppm
Percent Moisture	8.47	2.86	8.66	10.42	

Parameter	20791-8 TP B4, 2.7m	20791-9 LC Burwash	20791-11 TP S1, 2.5m	20791-13 1-1	Detection Limit
Total PCBs	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	0.1 ppm
Percent Moisture	5.49	10.01	32.61	96.53	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.

* The chromatogram from this sample was compared to the chromatograms of Aroclors 1248, 1254, 1260 and 1268 at a level comparable to 0.1 ppm, but no match was found.

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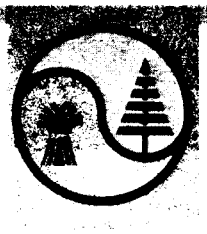

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203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
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Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Polychlorinated Biphenyls (PCBs) in Soil (cont.)

Parameter	20791-14 TP1 2.3m	20791-18 TP4 4.2m	20791-20 TP6 1.7m	20791-22 LC Iron Creek	Detection Limit
Total PCBs	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	0.1 ppm
Percent Moisture	5.64	4.18	2.70	6.93	

Parameter	20791-23 S2 Sediment	20791-29 LC Swede	20791-30 Swede U/S sed	20791-32 Swede D/S sed	Detection Limit
Total PCBs	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	< 0.1 * (Aroclor)	0.1 ppm
Percent Moisture	62.05	26.38	53.67	13.74	

Results are expressed in ppm (mg/kg), dry weight, without correction for recovery data.

* The chromatogram from this sample was compared to the chromatograms of Aroclors 1248, 1254, 1260 and 1268 at a level comparable to 0.1 ppm, but no match was found.

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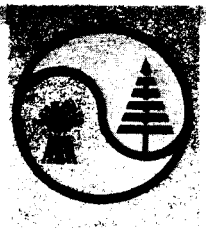

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203-20771 Langley Bypass
Langley, B.C. V3A 5E8

WO (Lang.) : 20791
WO (Other) :
PO # :
Date Samp. :
Date Rec'd. : 17-Sep-96
Date Comp. : 30-Sep-96

Polychlorinated Biphenyls (PCBs) in Soil (cont.)

Definitions / Methods

Total PCBs: This analysis is carried out in accordance with U.S. Environmental Protection Agency Methods 3540/8080 (SW 846, 3rd Edition, Washington DC) which involves extraction of the sample with methylene chloride then cleanup of the sample using a silica gel column followed by analysis by capillary gas chromatography using an electron capture detector.

Percent Moisture: Percentage of the total wet weight of the sample as received. This analysis is carried out gravimetrically by drying the sample to constant weight at 105 C.

Comments

Quality Control Results

Compound	% Recovery	Analysis	Date	Analyst
PCBs	97	PCBs	29-Sep-96	Ken M.

R. Neumann
Supervisor

Note: All samples will be disposed of after 30 days following analysis unless other arrangements are made.

APPENDIX SIX

SITE PHOTOGRAPHS

SITE NO. 1 (WL066) - IRON CREEK: PLATES I1 TO I7

SITE NO. 2 (WL067) - LOWER RANCHERIA: PLATES R1 TO R6

SITE NO. 3 (HJ040) - BURWASH LANDING: PLATES B1 TO B6

SITE NO. 4 (HJ042) - SWEDE JOHNSON CREEK: PLATES S1 TO S6

PLATE I1- WWII garbage dump, over embankment along east side of pond.

PLATE I2 - One of only two remaining collapsed army construction site buildings.

PLATE I3 - Tar tank disposed in clearing south of camp. Typical of junked equipment in the cleared area.

PLATE I4 - Unused sewage disposal pit in clearing south of camp. According to local residents, the pit was never used.

PLATE I5 - Test Pit TPI-7 at north east corner of site between collapsed army buildings.

PLATE I6 - Test Pit TPI-1, edge of back filled dump site in clearing south of the camp.

PLATE I7 - Existing clearing at Iron Creek site, currently used for road maintenance under contract to Public Works Canada. The original army road construction camp was located here.

PLATE R1 - Typical of former camp building restoration work.

PLATE R2 - Power house site. Hydrocarbons detected in backfill material.

PLATE R3 - Looking east at edge of old army dump.

PLATE R4 - End of access to old army dump, edge of dump on right.

PLATE R5 - Toe of old army dump. Test pit R - 2 on crest above.

PLATE R6 - Test Pit R - 2, crest of old army dump.

PLATE B1 - Looking south across buried dump from access road.

PLATE B2 - Looking south along edge of old dump at remaining metal waste.

PLATE B3 - Exposed cut bank at south end of old dump.

PLATE B4 - Test Pit B - 1 at the southern edge of the old dump.

PLATE B5 - Test pit B-5 in cleared area across the access road directly north of the old dump.

PLATE B6 - Casual borrow pit, former location of old Pan American Construction building, across the access road directly north of the old dump.

PLATE S1 - Looking down on casual garbage dating to road construction.

PLATE S2 - Typical of old construction era dumps along road embankment.

PLATE S3 - Looking south across clearing, old buried dump is at edge of clearing, creek just beyond.

PLATE S4 - Test pit S-2 at southeast extent of buried dump.

PLATE S5- Garbage dump currently in use.

PLATE S6 - U.S. Military container dated 1957, near surface in TPS-2.