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DEW LINE CLEAN UP PROJECT
FOX-C (EKALUGAD FJORD)
DEW LINE SITE
2004 GEOTECHNICAL INVESTIGATION

Project No. 1100065.001

NOVEMBER 2004

eba

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

DEW LINE CLEAN UP PROJECT
FOX-C (EKALUGAD FJORD)
DEW LINE SITE
2004 GEOTECHNICAL INVESTIGATION

Submitted To:

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EDMONTON, ALBERTA

Prepared by:

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Project No. 1100065.001

NOVEMBER 2004

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PHOTOGRAPHS

FIGURES

APPENDICES

Appendix A: Geophysical Survey Procedures
Appendix B: Testpit Logs
Appendix C: Geotechnical Laboratory Analysis Results
Appendix D: Geotechnical Report General Conditions

- Identify, characterize and quantify gravel borrow sources for use as road repair material and landfill cover and/or construction material.

- Perform a geophysical survey (electromagnetic or ground penetrating radar) of known and suspected landfill locations to establish the areal limits of the landfills.

- Conduct a testpit program to confirm the geophysical survey defined boundaries established and presence of buried materials identified by the geophysical survey.

- Conduct a geotechnical assessment to determine suitable sites for new landfill construction at FOX-C.

- Complete a topographical survey of the site that identifies all key existing features, current and proposed landfill areas, testpit locations, and other sampling locations as identified by the other consultants on site.

EBA's scope of work does not include landfill design or remediation design; however, some preliminary concepts and recommendations are discussed in this report.

1.3 Site Visit

The geotechnical investigation was carried out between August 20 and September 1, 2004. EBA's representative for the geophysical work was Mr. Brad Anshelm. Mr. Jason Berkers of EBA conducted the geotechnical investigation. Topographic surveys were carried out by Rick Wagar of UMA Engineering Ltd.

Geophysical surveys were carried out over areas known or suspected to contain buried debris. The geophysical survey involved using Geometrics G856 and G858 magnetometers to map the total magnetic field and vertical magnetic field gradients to delineate areas of ferrous debris. The Geometrics G858 cesium magnetometer has two vertically oriented sensors and a GPS positioning system and is used as the roving field unit. The Geometrics G856 proton precession magnetometer was used as a total magnetic field base station. Positioning for all surveys was accomplished using an integrated, real-time, sub-metre accuracy, differentially-corrected GPS system consisting of a base station unit with a UHF radio transmitter and a low magnetic signature roving

unit with a UHF radio receiver. An overview of the operational theory behind these units and a description of the survey technique used at FOX-C are presented in Appendix A.

Shallow testpits were excavated at proposed new landfill locations and in potential granular borrow areas. A total of 48 testpits were excavated either by hand or using a John Deere 4600 tractor with a backhoe attachment. Soil samples were collected during the testpit program for laboratory index testing. The testpit logs are presented in Appendix B. Laboratory test results are presented in Appendix C.

The following sections provide observations of the local terrain, existing dumps and debris areas; collection of detailed geotechnical information at proposed new landfill locations and prospective borrow areas, and assessment of the condition of the existing access roads are provided in the following sections. Select photographs taken during the site visit are presented at the end of this report (see "Photographs" tab).

1.4 Previous Work

Since 1985, numerous environmental and risk assessments have been completed at the site, however, the existing landfills, locations of new engineered landfills and borrow sources have not been assessed. To EBA's knowledge, no geotechnical testpits or geotechnical testing soil samples have been undertaken prior to 2004.

2.0 SITE CONDITIONS

2.1 Site Description

The terrain at FOX-C consists of high rugged hills with exposed rock outcrops. Figure 1 shows the overall plan view of the layout of FOX C. Figures 2 through 13 provide larger scale plans of various areas of interest. The three primary areas of past activity at FOX-C include the Beach Area (Figure 13), the Lake Area (Figure 9), and the Upper Station (Figure 2). Beach Road, Lake Road and Station Road access the Beach Area, Lake Area and Upper Station, respectively. All three roads meet at the junction shown in Figure 1. The Beach Area is located on Qarmaralik Cove. Upper Station overlooks Ekalugad Fjord and is 770 m above sea level and about 3 flight kilometres southeast of the cove. The distance from the junction to Upper Station on the Station Road is about 5.9 kilometres

and the distance from the junction and the Beach Area is about 2.2 km. Several road sections have become impassable since the site was abandoned in the 1960's.

The terrain and respective soil conditions at Fox-C are varied. Soil observed includes a clayey silt in the outwash valley located in the Beach Area, sand and gravel on parts of Lake Road, and boulders and weathered bedrock outcrop are dominant at the upper site.

The site is accessible by barge and by helicopter. An airstrip was never constructed at FOX-C due to the difficult terrain. The freshwater lake at the west end of Lake Road has been used as a landing strip in the winter.

2.2 Terrain

Baffin Island is part of the northeastern Canadian Shield and is underlain by granitic rock assemblages. The bedrock geology of this site is primarily granite and quartz monsonite. Permafrost is continuous and widespread in the Quaternary deposits which mantle Baffin Island.

Surficial geology units at higher site elevations, in the areas at referenced as Upper Station, Midstation and upper reaches of the Upper Station South comprise primarily bedrock and colluvium. At lower elevations surficial geology units include bedrock, moraines, alluvium, and beach sediments.

The Fox Charlie Glacier is situated some 1.5 km south of the upper site. One branch of the alpine glacier flows down to about 1 km south of the lower site. The whole icefield spreads from Ekalugad Fjord in the north to Kangok Fjord in the south.

2.3 Hydrology

Drainage systems associated with the fjords on the north coast of Baffin Island are generally short and steep.

High elevation development at FOX-C is located on a narrow summit and drainage divide.

Most of the development in the lower elevations is located between the ocean and a fresh water lake. The lake is mainly fed by melt water from the glacier, by snow melt, and by a larger lake situated approximately 2 km to the west. The lake itself is approximately 3 km long and 1 km wide and discharges into the ocean through a river approximately 1.5 km long.

2.4 Topography

The topography of Ekalugad Fjord is characterized by high rugged hills with numerous rock outcrops. The upper site is located on the summit of one of these hills which drops steeply on all its faces. The upper site is situated about 3 km from and 770 m above the beach area. The beach area is located on the south shore of the fjord in the lower reaches of an outwash valley.

3.0 OBSERVATIONS AND PRELIMINARY RECOMMENDATIONS OF EXISTING DUMPS

Five existing dumps were investigated during the 2004 site investigation program. Four dumps were reported in previous literature (Sinanni 2001) and are referenced as the Main Dump, the Garage Dump, the House Dump, and the Original Dump. The first three of these existing dump sites are located at the Upper Station. The Original Dump site is located at Upper Station South (approximately 750 m southeast of the Upper Station). The Midstation Dump was evaluated for the first time in 2004.

The five dumps and results of the respective geophysical surveys are described in Sections 3.1 through 3.5. Smaller debris areas assessed using geophysical survey are described in Section 4.0. EBA's investigation focused predominantly on areas of potential buried debris. A complete inventory of surface debris was completed by others.

3.1 Main Dump (Upper Station)

The Main Dump (Photos 1 and 2) is located 20 m northeast of a module train shown in Figures 2A and 2B. The dump contains barrels, domestic waste, miscellaneous metal and wood debris etc. scattered throughout the area. It appears that the material was disposed

downslope from the edge of the summit. With the exception of two barrel cache locations, there is no specific dump area of concentrated debris.

Typically, the dump site terrain consists of bedrock controlled ridges, small plateaus and steep slopes throughout the area. Surface materials include boulders, rock outcrop and discontinuous areas of colluvial soils.

Drainage flows directly down the steep slope and eventually into the Ekalugad Fjord.

Results of the gradiometer survey at the Main Dump are presented on Figures 2B, 2C and 2D. Two distinct debris lobes were identified and named on the figures as Main Dump Lobes A and B. Both Lobe A and B are locations of surface debris barrel caches.

All other anomalies present on Figure 2B indicate areas of surface debris detected in the path of the geophysical survey. Not all of the surface debris present at the main dump is presented in the geophysical anomalies. Additional debris scattered throughout the area is shown in Figure 2A.

The collection of the debris at the Main Dump will be difficult due to the steep rocky terrain.

3.2 Garage Dump (Upper Station)

The Garage Dump is located south to southwest of the garage as shown in Figure 2A. The dump primarily contains barrels and miscellaneous metal and wooden debris, etc. that is scattered throughout the area. With the exception of one barrel cache, there is no specific area of concentrated debris. The debris is located on small pads and pathways between bedrock outcrops as shown in Photo 3 and 4.

Drainage from Garage Dump flows south approximately 1 km over relatively steep slope gradients to a glacier fed river. This river flows into the freshwater lake, which, in turn, discharges into the Ekalugad Fjord.

Results of the gradiometer survey at the Garage Dump are presented on Figures 2B, 2C and 2D. Two distinct debris lobes were identified and named on the figures as Garage Dump Lobes A and B. Both Lobe A and B are locations of surface debris. Lobe A

contains heavy equipment tracks and other miscellaneous metal debris, while Lobe B is a barrel cache. All debris appears to be surface debris.

Not all of the surface debris present at the garage dump is presented in the geophysical survey figures. Additional surface debris is present throughout the area.

3.3 House Dump (Upper Station)

The House Dump (Photos 5 and 6) is located northeast of the remnants of the Inuit House shown in Figure 2A. The dump was hard to identify as it contains only a small amount of domestic waste, miscellaneous metal and wood debris and a couple of barrels that are scattered throughout the area. There is no specific dump area of concentrated debris.

The dump site terrain is comprised of a small pad area and bedrock outcrops. Drainage flows southwest down the steep slope and eventually into a glacier fed river approximately 1 km away. This river flows into the freshwater lake which, in turn, drains into the Ekalugad Fjord.

The results of the gradiometer survey are at the House Dump are presented on Figures 2B, 2C and 2D. One distinct debris lobe was identified and named House Dump Lobe A. Lobe A indicates an area of surface debris comprised of barrels. Lobe A along with all other surface debris in the area should be collected during clean up. No regrading will be required in the area.

The remnants of the Inuit House constitutes the majority of surface debris in the area which is located directly south of the House Dump.

3.4 Midstation Dump (Midstation)

The Midstation Dump (Photos 9 through 12) is located 350 m northeast of the Original Dump area along Station Road as shown in Figure 3A. Development at the site comprises a large laydown pad, an access road and Midstation Dump. The dump contains barrels, domestic waste, miscellaneous metal and wood debris, etc.

The local terrain comprises bedrock controlled ridges, small plateaus and steep slopes. A discontinuous veneer of soil exists with numerous boulders and rock outcrops. The

laydown pad is in the saddle between two rock outcrops. The Midstation Dump is on a steep slope downgradient of the laydown pad. Drainage from the dump flows in the east direction into Ekalugad Fjord.

Drainage from the dump flows east down slopes that dip in the east direction and eventually into Ekalugad Fjord.

Results of the gradiometer survey at the Midstation Dump are presented on Figures 3A, 3C and 3D. Two distinct debris lobes were identified and named on the figures as Midstation Dump Lobes A and B, as shown. Lobe A contains surface debris consisting of barrel caches on the laydown pad area.

Lobe B is the location of the main dump area and contains barrels, domestic waste, miscellaneous metal and wood debris etc. There appears to be little soil mixed with the debris. Additional debris is scattered down the slope from Lobe B. The slope is very steep with numerous boulders and bedrock outcrops.

The geophysics survey indicates an anomaly in the south portion of Lobe B. This anomaly could be a result of surface debris; however, some buried debris may be present in the southern portion of Lobe B.

Consolidating and covering Lobe B in its present condition would be very difficult due to the steep slopes of the area. Construction safety would be a concern. It is recommended the debris be removed and placed in an engineered landfill. Collection of the debris will be difficult due to the steep rocky terrain.

Additional surface debris is present in the area between the pad area of Lobe A and Lobe B which was not surveyed with geophysics. This material should also be collected during clean up. Collection of the debris from this area is expected to be difficult due to the rocky terrain.

3.5 Original Dump (Upper Station South)

The Original Dump (Photos 7 and 8) is located along the Station Road as shown in Figure 4A. There is no specific area of concentrated debris. The dump contains barrels,

domestic waste, miscellaneous metal and wood debris etc. that is scattered throughout the area.

Typically, the natural terrain is comprised of bedrock controlled ridges, small plateaus and steep slopes. Surface material comprised a discontinuous veneer of soils with widespread rock outcrop and boulders.

Drainage flows south down the slope into the glacier fed river to the freshwater lake which, in turn, discharges into a river that drains into the Ekalugad Fjord.

The results of the gradiometer survey at the Original Dump are presented on Figures 4A, 4B and 4C. One distinct debris lobe was identified and named on the figures as Original Dump Lobe A. Lobe A is a location of a barrel cache. Lobe A should be collected during clean up. No regrading will be required in the area.

Lobe A only presents a small fraction of the total amount of surface debris in the area. There is a large amount of scattered surface debris, and remnants of two Quonset huts and one storage shed in the area. All additional surface debris should also be collected during clean up. It is expected that collection of the debris at the Original Dump will be difficult due to the steep rocky terrain in which the material is scattered.

4.0 EXISTING DEBRIS AREAS

Debris areas investigated that are located separate from the dump areas were as follows:

- West Laydown Debris Area (Upper Station);
- Southwest Laydown Debris Area (Upper Station);
- Garage Debris Area (Upper Station);
- Main Tower Debris Area (Upper Station);
- East Laydown Debris Area (Upper Station);
- West Midstation Debris Area;
- East Midstation Debris Area;
- River Crossing Debris Area;
- Lake Debris Area;

landfill. Lobe C is partially buried debris in the sideslope of the pad area southwest of the garage. A pallet of four barrels had been strapped together and used as fill during the construction of the pad area. Since these barrels will eventually fail, regrading the area is not recommended. This debris should be excavated during clean up.

4.4 Main Tower Debris Area

The Main Tower Debris Area is located at the Upper Station, approximately 70 m southeast of the module train as shown in Figure 2A. The area was geophysically surveyed in 2004. The debris area includes surface debris that consists of a large communication tower and miscellaneous metal debris.

4.5 East Laydown Debris Area

The East Laydown Debris Area (Figure 2A and Photo 14) is located at the Upper Station east of the Inuit House. The area is comprised of several pads and access roads. The area was geophysically surveyed as shown in Figures 2B, 2C and 2D. The debris area includes two lobes, East Laydown Debris Area Lobes A and B. Lobe A is a surface debris barrel cache, while Lobe B is primarily buried debris.

Lobe B is located on the north side of a pad area. The ground surface of the area is relatively flat and level with the pad. There are no visible signs of surface debris. It is recommended that Lobe B be regraded with fill 0.7 m thick, provided that environmental assessments by others indicate there are no environmental concerns in the area. A recommended area to be regraded is shown on Figure 2A.

4.6 West Midstation Debris Area

The West Midstation Debris Area is located on the north side of Station Road approximately 180 m southwest of the Midstation Dump area as shown in Figure 3A. The area consists of a laydown pad. The area was geophysically surveyed, as shown in Figures 3B, 3C and 3D. The debris area includes two lobes, West Midstation Debris Area Lobes A and B. Lobe A is located on the west side of the debris area. Lobe B is located on the east side of the debris area. Both Lobe A and Lobe B consist of barrel caches. All debris appears to be surface debris.

4.7 East Midstation Debris Area

The East Midstation Debris Area is located off the south side of Station Road approximately 70 m southwest of the Midstation Dump area as shown in Figure 3A. The area consists of a helipad location and pad area. The area was geophysically surveyed and the results are presented in Figures 3B, 3C and 3D. The debris area consists of a barrel cache. Several anomalies also are shown on the geophysical results. These anomalies are the result of individual surface barrels in the area.

Not all of the surface debris present in the area is presented in the geophysical survey figures. Additional surface debris is present throughout the area.

4.8 River Crossing Debris Area

The River Crossing Debris Area is located on Station Road approximately 500 m west of Borrow Area 1 as shown in Figure 6A. The area was geophysically surveyed and the results presented in Figures 6A, 6B, 6D. The debris is in four lobes, Lobe A through Lobe D. All four lobes consist of surface debris consisting of crushed barrels and miscellaneous metal debris.

4.9 Borrow Debris Area

The Borrow Debris Area (Figure 8A) is located on a ridge in a glacier river outwash. The area was geophysically surveyed and the results are presented in Figures 8A, 8B and 8C. The disturbed area was surveyed to determine if it contained buried debris. No anomalies or indication of buried debris were found in the area.

4.10 Lake Debris Area

The Lake Debris Area is located approximately 150 m east of the Lake as shown in Figure 9A. The area is a natural terrace and was used as a laydown area. The area was geophysically surveyed and the results are presented in Figures 9A, 9B, 9C. The debris is in four lobes, Lobe A through Lobe D. Lobe A and Lobe B are located on the north portion while Lobe C and Lobe D are located on the south. Lobe A consists of buried debris while the remaining three lobes consist of surface debris made up of construction

equipment and miscellaneous metal debris. This surface debris should be collected during clean up.

The ground surface at Lobe A is relatively flat and is level with the surrounding area. There are no visible signs of surface debris in the immediate area. Provided that environmental assessments by others indicate there are no environmental concerns in the area, it is recommended that Lobe A be regraded with fill 0.7 m thick. The recommended area to be regraded is shown on Figure 9A.

4.11 Beach POL Debris Area

The Beach Debris Area (Figure 13A and Photos 15) is located at the POL tanks on the beach site of Ekalugad Fjord. The area was geophysically surveyed and includes two Lobes; Lobe A and Lobe B. Lobe A consists of buried debris while Lobe B consists of an area of miscellaneous surface metal debris.

Lobe A is located in the west sideslope of the POL pad. It is recommended that Lobe A be regraded with fill 0.7 m thick, provided that environmental assessments by others indicate there are no environmental concerns in the area. A regrade perimeter is shown in Figure 13A.

5.0 PROPOSED NEW LANDFILL LOCATIONS

At least one new landfill will be required for disposal of demolition debris, surface debris and excavated debris. A second landfill may be required to minimize haul distances. A soil disposal facility for contaminated soil or a landfarm for treatment of hydrocarbon contaminated soil may also be required at the site. Potential locations for these facilities were examined.

The location of these facilities is based on a variety of factors, including:

- size of the area available;
- acceptable soil and foundation conditions;
- surface drainage;
- topography;

- distance from natural water bodies or water courses; and
- ground conditions that could allow permafrost to function as a containment system.

The volume of contaminated soil and debris that have to be landfilled will dictate the size of the facilities and to a certain degree influence the areas chosen for construction of these new facilities. The volumes were unknown at the time of the report.

Four potential debris landfill locations, one soil disposal facility location were evaluated in 2004. Some of the areas are also suitable for landfarm locations as noted. The proposed locations are shown on Figures 1, 3, 9 and 11. Design considerations and parameters for the new landfills along with the proposed landfill locations are described in the following sections.

5.1 Debris Landfills

5.1.1 Design Considerations

Design considerations for Debris Landfills include the following.

Waste characterization - The waste material placed in new debris landfills should consist only of non-hazardous debris which includes treated and untreated wood, metal wastes from demolition and equipment disposal, empty crushed barrels, and concrete. Asbestos, when packaged according to regulations, is also considered non-hazardous.

Surface water run-on and run-off control - The final landfill surface must be graded to positively shed water so as to prevent ponding and infiltration. The landfill surface must not be so steep that it promotes erosion of the cover materials.

Leachate Control – It is understood that the proposed landfill material is inert waste; therefore, leachate needs to be controlled rather than eliminated completely. The following design factors will control the amount of leachate within the landfills:

- Only "Dry Waste" will be placed in the landfills;
- The short arctic summer limits the amount of time that water infiltration can occur;
- The compacted and graded cap material will promote surface run-off; and

- The proposed landfill sites have been located where natural overland runoff is minimal.

Frost Jacking - Frost jacking of debris occurs when; (1) fills contain debris subjected to seasonal freezing and thawing; (2) the mineral soils used for fill are frost susceptible (fine grained; and (3) there is access to free water. In order to prevent frost jacking, the landfill backfill material should be frost stable, and both groundwater and surface water must be controlled. Backfill material specifications that address these considerations are presented in Section 6.0.

Biological Odour and Methane Gas Control - Odour and gas generation are typical of most domestic landfills in the south and are the result of decomposition due to biological activity, fungi and bacteria. These are not considered to be significant factors in the design of demolition debris landfills at FOX-C for two reasons; firstly (1) the proportion of domestic waste to be landfilled will be insignificant in relation to the total volume of debris; and (2) the temperature of the waste and surrounding permafrost will limit decomposition and therefore the rate at which gas is generated.

Settlement of Landfill Surface - To reduce settlement and ground subsidence, the debris should be placed in 0.5 m thick lifts with a prescribed earth fill graded over each lift of debris to fill the voids. The earth fill should be a minimum of 0.15 m thick and worked into the underlying debris. Quality assurance testing should be carried out to determine the optimum debris lift thickness and to confirm that there are no large voids in the landfill.

5.1.2 Debris Landfill Design Parameters

The cover and berms may be constructed with appropriate granular borrow materials available at FOX-C. The intermediate fill should be a frost stable material. Recommended material specifications for the berm and cover and intermediate fill materials are presented in Section 6.0.

The landfills are generally constructed on grade to reduce constructability issues, and permafrost disturbance. The landfills should be constructed by first building containment berms around the perimeter of the landfill area. It is recommended that the containment berms have a maximum outside slope of 3H:1V and an inside slope of 1.5H:1V. The top