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1.0 INTRODUCTION

EBA Engineering Consultants Ltd. (EBA) was retained by UMA Engineering Ltd. (UMA) to participate with UMA in a site visit to the PIN-3 Lady Franklin Point DEW Line station. The site visit was carried out with a team leader and survey crew from UMA, a construction and demolition specialist from Sheppard Green Engineering (SGE). Environmental sampling for the project was the Environmental Sciences Group from the Royal Military College (ESG).

EBA's scope of work included the following:

- evaluate existing landfills to determine the design for landfill remediation. The intent of the landfill remediation was to be specified by ESG following their environmental assessment.
- identify sites for new proposed sites for a new landfill.
- carryout a geophysical survey of existing landfill sites.
- characterize available borrow material on site.

The site visit was carried out from July 9 to July 16 and July 29 to August 4, 2000. One of the purposes of the site visit was to determine if any modifications are required to the 1994 95% design submission drawings prepared by UMA. This report is intended to supplement EBA's site visit report prepared in 1992. Any recommendations made in this letter supercede previous recommendations.

Additional environmental sampling was carried out by ESG in a 2001 site re-visit. EBA assisted with environmental sampling in 2001. The report for the 2001 environmental sampling is being prepared by ESG. UMA was on site during the 2001 site re-visit. Additional samples of borrow materials were collected by UMA. Logs of the UMA testpits are appended to this report.

This report is submitted as a draft. The environmental sampling report was not available at the time of preparing report. The recommendations have been based on preliminary sample results and a draft report from ESG. The recommendations made in this report need to be re-visited once the ESG final report is received.

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2.0 METHODOLOGY

The site was accessed using a twin otter from Cambridge Bay. The existing airstrip was in good condition. Equipment for the site visit was mobilized to the site using a C46 out of Yellowknife. A camp was established on a gravel pad between the airstrip and the station .

Shallow testpits were excavated around existing landfills, in proposed landfill sites and borrow areas. It was intended to excavate testpits with North Warning Systems Case 621 loader with backhoe attachment; however the backhoe attachment was in poor condition and required numerous repairs during the site visit. Many of the testpits were excavated by hand.

Geophysical techniques were used to assess the extent of buried debris at four landfill locations. The technique involved mapping the total magnetic field and vertical magnetic field gradients. The instruments used were a Geometrics G858 cesium gradiometer with an integrated real time GPS positioning system as the roving field unit and a Geometrics G856 proton precession magnetometer as a total magnetic field base station. The positioning for all surveys was accomplished using a real time GPS system consisting of two components, 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 involving these units and a description of the survey technique used on site is included in Appendix A.

Two additional debris areas were surveyed with geophysics in 2001. A Geometrics G856 was used for these surveys. The surveys were carried out using a 5 m grid. A total station was used to measure the coordinates of the geophysical grid.

3.0 GEOMORPHOLOGY AND SURFICIAL GEOLOGY

The site is located at Lady Franklin Point, Nunavut, on the Coronation Gulf. The topography is relatively flat, with the main station area on a local topographic high and remainder of the site sloping down gradually to the north, west, and south beaches.

Bedrock at the site comprises Paleozoic carbonate rock that is flat-lying and jointed. Surficial deposits are of marine origin and comprise poorly graded, stratified to massive gravel, sand, silt and clay. These deposits occur as ridges and blankets on large coastal platforms with terraces marking sea-level events. A 0.1 to 3 m thick veneer commonly

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overlies bedrock. Figures 1 through 4 illustrate the geomorphology and surficial geology of the site.

4.0 EXISTING LANDFILLS

4.1 North Landfill

The North Landfill is located about 650 m north of the main station area. Debris has been buried in an area of gravel beach ridges. The gravel in the beach ridges is very angular. Low areas surrounding the perimeter of the landfill are mostly vegetated with low plants and grasses. Bedrock is shallow in the area and exposed in some areas by site activities. Drainage is towards the north. The debris includes crushed barrels among other debris. The landfill surface is illustrated in Photos 3 and 4.

The results of the geophysical survey are presented in Figures 5, 6 and 7. The buried debris falls within the boundaries defined in 1992; however it appears that the debris is concentrated in smaller areas within the perimeter. The perimeter requiring remediation is smaller than the area defined in 1992. The anomalies have only a small difference in the magnetic field strength than the background readings indicating there are only small amounts of metal debris in the landfill.

Geophysical surveys were carried out on two additional buried debris areas in the vicinity of the North Landfill. The south area contains crushed barrels and domestic debris. The pile is approximately 15 m diameter and 1.0 m high. Domestic debris is scattered around the area. The east area appears to contain a piece of heavy equipment covered with coarse gravel. A corner of the equipment protrudes from the pile. The pile is several meters high and 10 to 15 m in diameter.

ESG sampled the landfill area. They conclude that contaminants are not migrating from the landfill. ESG recommends that the north landfill be covered with fill to ensure its contents do not become exposed and also to minimize infiltration of surface and precipitation (ESG 2001). EBA recommends that the landfill be covered with a minimum of 0.75 m of well graded fill. It is recommended that the fill extend a minimum of 3 m beyond the geophysical perimeters shown on Figure 5. The litter and partially buried debris beyond the specified fill limits should be removed.

EBA has not received information regarding sampling at the two small additional buried debris piles on either side of the landfill – pending review of this data it is recommended to

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remove the small pile south of the main landfill to avoid long term monitoring of the area. The other pile appears to be limited to buried equipment. It is suggested that this pile be buried in place with a minimum cover 0.75 m thick; alternatively the pile could be removed.

4.2 South Landfill

The South Landfill is located adjacent to the beach POL area approximately 1450 m south of the station. The results of the geophysical investigation are shown in Figures 8, 9 and 10.

Partially exposed barrels are present in areas of the landfill and ground subsidence over some of the barrel barrels is evident as illustrated in Photo 8. The area is covered with little vegetation. Several ponds and low-lying wet areas surround the perimeter of the area as illustrated in Photo 7. Eight testpits were excavated around the perimeter of the landfill. Testpit locations are shown on Figure 8 and logs are presented in Appendix C. The soils generally consist of sand with varying amounts of gravel and a trace of silt. Groundwater was shallow with seepage noted at 0.3 m to 0.5 m. Frozen ground was encountered in Testpit TP-00-27 at a depth of 1.7 m. The area is close to the ocean, with southern most area approximately 10 m from the high water line of the shoreline. The coastline adjacent to the landfill appears to be a depositional environment.

The debris areas detected by the geophysical survey roughly agrees with perimeters surveyed in 1992; however, the east and west areas do not extend as far north. The northern portion of the east and west areas appears to have been used for cover material for the southern areas. A third area was detected during the 2000 geophysical investigation south of the west area. Several small anomalies were also detected by the geophysics. The anomaly at the southwest corner is a partially buried cable. A small area of buried barrels is located at the southeast corner of the area. Several other small anomalies were detected which could be buried ferrous debris.

ESG sampled the area and concluded that the south landfill is not leaching contaminants. ESG recommended that some remedial action is required at the landfill due to the fact that it is close to the ocean and is subject to ice push up (ESG 2001).

Coarse gravel due to ice push up is present between the road and the shoreline. It is recommended that all buried debris in south of the road be removed. The approximate perimeter of the buried debris is shown on Figure 8. There are several geophysical

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anomalies west of the large anomaly. It is recommended that the source of the anomalies be investigated and debris removed if encountered. It is recommended that buried debris north of the road be covered with a minimum of 1 m of well graded sand and gravel. The fill should extend a minimum of 3 m beyond the perimeters shown on Figure 8.

4.3 Main Landfill

The Main Landfill is located on the western side of the site on a gradual west-facing slope as shown in Photo 9. The landfill drains west towards the coast, which is approximately 150 m west of the landfill.

The landfill debris is covered with sand and gravel with little vegetation as shown in Photo 10. Debris occasionally protrudes through the fill. The results of the geophysical survey are presented in Figures 11, 12 and 13. The limits of the landfill indicated by the geophysical anomalies are somewhat smaller than the landfill perimeter shown on the 1994 design drawings. There appears to be little buried debris in the southeast corner as shown on the 1994 design drawings; although there is a small amount of litter in the area.

Eleven testpits were excavated around the outside perimeter of the landfill. The soils at the toe of the landfill consist of sand and gravel overlying shallow bedrock. Bedrock is exposed at the toe of the landfill north of Testpit TP-00-2 and several other locations. The depth to bedrock increases towards the north, with bedrock encountered at a depth 1.2 m in Testpit TP-00-7, and greater than 1.5 m in Testpit TP-00-6. Sand and gravel overlying bedrock was encountered at the upslope side the landfill adjacent to the road; bedrock was encountered at depth of 1.2 m at the north end at TP-00-8 and 0.4 m in the central area at TP-00-10.

Samples from the landfill surface and the landfill toe had elevated concentrations of inorganics, PCBs and hydrocarbons (ESG 2001). Additional sampling was carried out in 2001. Preliminary results confirm the presence of contaminants. The remediation plan for the landfill should be reviewed upon receipt of the 2001 sampling results and ESG report.

4.4 NWS Landfill

The NWS Landfill is located just north of the Main Landfill. It was the active landfill NWS landfill in 1992 but has since been graded over. The landfill consists of several distinct areas. The east portion of the area was recently the active landfill, while there is some

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equipment buried in the central portion. There may be barrels and domestic debris buried towards the western edge of the area.

The landfill is covered relatively well with sand and gravel with little vegetation. Some heavy equipment is protruding out of the landfill surface and there are localized areas with small amounts of debris visible at the ground surface as shown in Photos 11 and 12. The landfill is relatively level with a steep slope several metres high on the southwest side.

The results of the geophysical survey are presented in Figures 11, 12 and 13. In general the limits are similar to those shown on the 1994 design drawings; with the exception of the western area. The geophysics indicate that there is little buried debris on the northwest area, but there is buried debris within the southwest slope.

Ten testpits were excavated around the perimeter of the landfill. The soils at the toe of the landfill consisted of sand and gravel overlying shallow bedrock. The depth to bedrock in Testpits TP-00-13 through TP-00-18 varied from 0.5 to 1.2 m. The soils encountered at the top of the landfill (TP-00-19 through TP-00-21) consisted of sand and gravel overlying bedrock. The depth to bedrock varied from 0.4 to greater than 1.1 m. Frozen ground was encountered at the base of testpit TP-00-21 at depth of 1.1 m.

Additional environmental samples were collected at the NWS Landfill in 2001. Recommendations for the area should be reviewed following the receipt of this information.

4.5 Asbestos Landfill

The Asbestos Landfill is adjacent to road west of the station as shown on Figure 2. It is a small landfill measuring about 20 m by 10 m. It is marked by corner posts and clearly identified by a sign. The top of the landfill is 0.6 m higher than the surrounding ground as shown in Figure 13. A small amount of vegetation is starting to grow on the surface.

The landfill has been built in a relict beach ridge composed of coarse gravel with some sand. There is no visible debris protruding from the surface.

There are no drainage courses through the area and there are no erosion channels nearby the area. There is small pond 60 m south of the area.

The landfill appears to be performing well from physical standpoint. No environmental samples have been collected from the landfill area.

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5.0 PROPOSED LANDFILL AND LANDFARM AREAS

Several areas were evaluated for possible new landfill construction. New landfills will be required for demolition debris, module train fire debris and Tier II soils. The location of the potential landfills is shown on Figure 1 along with geomorphology and surficial geology of the area. The following presents a description of the areas.

5.1 Proposed Pallet Line Landfill

The Proposed Pallet Line Landfill is located between the pallet line and the existing North Landfill as shown on Figure 2. Coarse gravel beach ridges overlying bedrock characterize the area. The area is relatively level with the beach ridges providing 0.5 m to 1.0 of relief. The area is shown in Photo 14 and 15.

The overall drainage flows towards the northwest to Austin Bay located greater than 1 km north of the site. There are no drainage paths through the area. There are several shallow ponds in low-lying areas between the proposed landfill site and Austin Bay.

Testpits TP-00-56 through TP-00-62 were excavated in the area. The testpits encountered coarse angular gravel in the beach ridges. Bedrock was near or at surface between the beach ridges.

5.2 Proposed Airstrip Landfill

The Proposed Airstrip Landfill is located on the south side of the airstrip as shown in Figures 1 and 4 and Photos 16 and 17. The entire area adjacent to the south side of the airstrip has been used as a borrow area. The western half of the south airstrip area has been excavated down to bedrock, but there is some sand and gravel overburden remaining in the eastern portion of the area. The proposed landfill location is located in the eastern portion of the area.

Testpits TP-00-36, 37, 50, 52, and 53 were excavated in the area. All testpits encountered sand and gravel at the surface with a trace of cobbles and boulders. Bedrock was encountered at a depth of 0.6 m in TP-00-37, and a large boulder or bedrock was encountered at a depth of 1.2 m in TP-00-36. Seepage was encountered at a depth of 0.75 m in Testpit TP-00-36. Testpits TP-00-50, 52 and 53 were shallow hand excavated pits ranging in depth from 0.3 to 0.5 m.

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A low-lying marine terrace is located below the airstrip area. This area is well vegetated with numerous small shallow ponds. Testpit TP-00-51, excavated in this area, encountered 100 mm of sandy peat overlying sand and gravel.

The area drains towards the south. There is little run on into the area as the adjacent airstrip is local topographic high. There are several shallow ponds located 100 m south of the area as shown in Figure 4.

The area is somewhat lower than the airstrip. The height of the landfill should be kept to a minimum as to not create an obstruction along side of the airstrip. The area could be excavated approximately 0.5 m to obtain borrow material and lower the grades of the area.

5.3 Proposed Station Landfill

The Proposed Station Landfill is located between the station and the north side of the airstrip as shown on Figures 1 and 2. The area is slightly depressed from the surrounding area and airstrip. Bedrock is exposed at several locations throughout the area and occasional large boulders are present on the ground surface along with a thin layer of vegetation. The area is shown in Photos 18 and 19.

There are no drainage courses across the area. The area is a local topographic high with the only run-on coming onto the area from the airstrip adjacent to the area. The direction of flow from the area is towards the west.

Six shallow testpits were excavated in the area. Refusal on boulders or bedrock was encountered in most of the testpits at depths ranging from 0.1 to 0.5 m. Bedrock was exposed at surface in several locations in the area. The overburden soils consisted of sand and gravel. Grass cover and organics is present in the majority of the area. Numerous boulders are scattered throughout the area.

5.4 Proposed Landfarm

The proposed landfarm is located between the station POL tanks and the NWS landfill as shown on Figures 1 and 2. The area is bounded by a road on the south side. The ground is partially disturbed with gravel beach ridges excavated from the south and west portions of the area.

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No defined drainage courses are present in the area; however it appears that some run-on may cross the northeast corner of the area.

Twelve shallow testpits were excavated in the area. Bedrock was encountered in many of the testpits at depths ranging from 0.1 m to greater than 0.5 m. Overburden varied from coarse angular gravel in relict beach ridges to silty sand in lower lying areas.

6.0 DEBRIS AREAS

The following describes several debris areas that contained partially buried debris. Additional debris areas were catalogued by UMA and are not discussed here.

North Debris

The north debris area consists of several piles of buried debris at the north edge of the site. The first area is approximately 1200 m north of the pallet line open storage area on the west side of the road to Austin Bay. The pile is up to 1.5 m high and is approximately 30 m by 20 m. It has debris visible on the surface including wood, metal strapping and barrels as shown in Photo 22. Most of the debris is buried with sand and gravel. Shallow bedrock is present around the perimeter of the pile. A geophysical survey was carried out over the pile in 2001. The results of the survey are presented in Figures 14, 15 and 16. ESG collect soil samples of the debris pile. They conclude that the pile contains Tier II contaminated soil and speculate that contamination may be coming from the pile. They recommend that the entire pile be excavated.

A second debris area is located 50 m west of this area. Samples were collected from this area in 2001 but the results were not available at the time of preparing this report.

A pile is located near the Austin Bay coast (approximately 400 m north of the area described above). The pile is approximately 2 m high and is approximately 30 by 20 m. Little surface debris was noted on the pile. No visible debris was encountered in a shallow testpit (TP-00-22 - 0.4 m deep) excavated in the top of the pile. The pile consists of coarse gravel. ESG sampled around the pile. Test results were near background levels and they concluded that the pile is not producing leachate.

Another pile is located north 80 north of this area near Austin Bay coast. This pile is approximately 20 m long by 5 m wide and 1 to 1.5 m high. The pile contains barrels

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covered with sand and gravel as shown in Photo 24. It is recommended that this pile be excavated and the debris placed in an onsite landfill.

Northeast Debris Areas

Two mounds of debris are located approximately 150 m east of the pallet line open storage and 250 m north of the station garage. The southern area is approximately 60 m by 35 m, and the northern area is approximately 70 m by 25 m. Both debris areas are less 1 m high. Bedrock is exposed at the ground surface around the mounds. Debris includes scrap metal and wood planks. Some debris is on surface and some is partially buried. Debris is more prevalent in the north mound as shown in Photo 23.

ESG has sampled around the mounds. They found one area of soil contaminated with copper and recommend that it be excavated. They conclude that the mounds are not producing leachate and recommend that they be covered with fill to cover the partially exposed debris.

EBA recommends all surface debris should be removed from the area. A 0.5 m minimum cover should be placed on the south pad and 0.75 m minimum cover should be placed on the north pad.

Open Storage Building Pad

The open storage building pad is located east of the mogas area on the south side of the road that leads west from the station area to the main landfill. The pad is approximately 20 m by 25 m and is approximately 1.0 m to 1.5 m high. The pad is constructed of sand and gravel. Shallow bedrock is present at the toe of pad. Debris is visible along the south edge of the pad as shown in Photo 25.

A geophysical survey was carried out over the area using a Geomtrics G856 Magnetometer. The results are presented in Figures 17, 18 and 19. The survey agrees with field observations that debris is concentrated along the south edge of the pad. Debris may be buried a few metres back into the pad.

ESG's environmental sampling around the toe of the pad encountered PCB contaminated soil. EBA recommends that the debris within the pad be excavated. The soil and debris and debris should be tested to determine if it is a contaminant source such that its disposal location can be determined.

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7.0 BORROW SOURCES

Borrow material sources are limited on the site due to shallow bedrock in some areas and high ground water in other areas. The most abundant supply of borrow material is from beach ridges. Borrow material must be excavated from some wet lower lying areas and some areas off of DND reserve to obtain sufficient quantities for the project. A brief description of the borrow areas is presented in the following sections and summarized in Table 1. The borrow area locations are shown on Figure 1.

7.1 Borrow Area #1 (East Airstrip)

Borrow Area #1 is an existing borrow area located east of the station between the airstrip and the water lake. The material at this site is gravel and sand, with a trace of silt. The material is well graded and generally 100 mm maximum size with the occasional particle up to 300 mm size. There is some ponded water in parts of the pit. Ground water is shallow in the area with water observed at 0.8 m and 1.1 m in the two testpits excavated in the area. The material in the pit is soft and shifts under vehicle traffic. It is estimated that approximately a 0.5 m depth of material could be excavated from the area resulting in volume of 15,000 m³.

The percentage of fines in the material is variable. Two grain size analysis of the material contained approximately 60% gravel (Testpit TP-00-48, and 1992 Borrow #1 sample). One sample had 39% sand and 1% silt, and the other sample at 25% sand and 17% fines. The variability in fines would make it difficult to extract Type 4 material from the area; however the area could be used for Type 2 fill.

7.2 Borrow Area #2 (Crusher Feed Stockpiles)

Stockpiles were identified west of the hanger in 1992. The majority of this material has been used. The remaining stockpile is estimated to be less than 100 m³. The area has been used for borrow material previously; however it is expected that a small amount of material can be scraped from the surface. It is estimated that 4,000 m³ of sand and gravel can be excavated from the area. A small amount of debris and litter is present in the area. This material should be removed from any fill taken from the area.

*DRAFT***7.3 Borrow Area #3 (Beach Cargo)**

Borrow Area #3 is located about 250 m west of the Beach Cargo Area. The area is outside of the DND reserve. The site is not developed. Portions of the area are covered with coarse sand and gravel beach ridges overlying sand with some gravel, while other areas contain sand with some gravel. Groundwater is shallow in the area. Saturated ground was encountered at depths ranging from 0.3 to 0.4 m in August 2001. The shallow ground water will make it difficult to excavate sand from the area.

Sand is available from the area beach area west of the south beach landfill. Testpit TP-00-79 and UMA-0105 were excavated in the area. The testpits encountered sand with some gravel. Saturated ground was encountered at a depth of 0.3 m. Much of the area is disturbed and has little vegetation.

A small thickness of sand could be excavated from the areas. Assuming 0.3 m of material is excavated 5,000 m³ could be excavated from the area east of the south beach landfill and 7,000 m³ further to the east.

Coarser and drier sand and gravel exists in beach ridges south of these areas; however the deposits are outside of the DND reserve by the beach cargo area. Approximately 4,000 m³ of material can be excavated from this area.

7.4 Borrow Area#4 (NWS Landfill Beach Ridges)

Borrow Area #4 is a series of angular gravel beach ridges to the north and west of the NWS landfill. The material is coarse angular gravel with some cobbles. The coarse nature of the material makes it pervious; however the material is erosion resistant. It would be suitable erosion protection on landfill covers or gentle slopes. The depth of material is variable. Some beach ridges are as shallow as 0.3 m, while others are 0.6 m high. The material between the beach ridges is sand or bedrock. It is estimated that 8,000 m³ of material can be excavated from the area.

Archeological heritage sites have been noted within the area (UMA, 1989). The location of the heritage sites should be field confirmed and marked. No borrow material should be excavated within an appropriate distance from the sites.

DRAFT**7.5 Borrow Area #5 (South East Airstrip)**

Borrow Area #5 is located south of the east end of the airstrip. The area is a ridge above the marine terrace. An area west of the proposed airstrip landfill is also included in Borrow Area 5. Testpits TP-00-38 through TP-00-45 were excavated throughout the east area, and Testpits TP-00-33, TP-00-34, UMA0116, UMA117 and UMA118 were excavated in the west area. The material ranged from a sandy gravel to sand and gravel in the ridge, and sand with a trace of gravel to sand and gravel in the lower area adjacent to the ridge. The fines content in the samples tested varied from 2 to 20%.

It is estimated that 0.5 to 1.5 m of material can be excavated from the east area. Shallow ground water will be encountered adjacent to ponds north of the ridge and the low lying area below the ridge; however the area can be graded to south to provide positive drainage. It is estimated that 25,000 m³ of material can be excavated from the east area. The material would be suitable for landfill cover.

It is estimated that 0.5 to 1.0 m of material can be excavated from the west area. Shallow ground water will be encountered however the area can be drained toward the south. Bedrock will be encountered within the area. It is estimated that 17,000 m³ of material can be excavated from the area. The material would be suitable for landfill cover.

7.6 Borrow Area #6 (North East Airstrip)

Borrow Area # 6 is located north of the east end of the airstrip. The area is covered with shallow sand and gravel beach ridges overlying more sand and gravel. A small amount of material has been excavated in the area. The ridges themselves have little vegetation, but the adjacent natural ground has a thin vegetation cover. Testpits TP-00-46, 47 and 49 were excavated in the southern portion of the area. The material consisted of sand and gravel with a trace of fines. Typically the material was 100 mm maximum particle size. Seepage was encountered 0.7 m below the surface in the area previously excavated; the previously excavated area is 0.6 m below original ground. It is estimated that approximately 10,000 m³ of material can be excavated from the area assuming 0.7 m of material can be excavated. The area is expected to soft and wet at depth.

The area can be expanded to the north; however the terrain is relatively flat and high ground water was observed in 2001. Testpits UMA0106, UMA0107, UMA0108 and UMA0122 were excavated in the area. The testpits encountered sand with a trace of gravel overlying sandy gravel or uniform sand. Bedrock was encountered in Testpit UMA0106 at 0.6 m

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depth. Saturated ground was encountered at 0.6 m in testpits UMA0107 and UMA0108 and 0.8 m in UMA0122. Excavation in the area will be difficult due to the high water table; however material could be excavated during a dry period or when the active layer is thin by using a thaw and strip operation over frozen ground. It is estimated that approximately 10,000 m³ of material can be excavated from the area.

Three sieves analysis were carried out on samples from the area. The percentage of fines in all three samples was 2%, the percentage of sand varied from 51 to 75%, and the percentage of gravel varied from 23 to 47%.

7.7 Borrow Area #7 (East Ridge)

Borrow Area #7 is a large beach ridge east of the DND Reserve. No testpits were excavated in the area. It is recommended that the site be further characterized at the prior to construction.

The area is accessed by a trail through Borrow Area #6. The trail would have to be upgraded to sustain haul truck traffic. The area is approximately 800 m northeast of east end of the airstrip. The beach ridge is approximately 1 km long. The width and elevation relief varies. The top surface of the ridge is covered with coarse gravel. No testpits were excavated in the beach ridge; however it is expected that the gravel is underlain by sand and gravel at depth. The area is a ridge with a sharp elevation drop to the south and a gradual elevation drop to the north.

It is estimated that a thickness of fill between 0.5 and 1.5 m could be excavated from the area. Deeper excavation could be possible in portions of the area. Approximately 50,000 m³ of material could be extracted from the area. Bedrock could be encountered in portions of the area. Ponds are present in portions of the area. The ponds can be drained to the low lying ground to the south of the ridge.

An archeological heritage site has been noted within the area (UMA, 1989). The location of the heritage site (or sites) should be field confirmed and marked. No borrow material should be excavated within an appropriate distance from the sites.

DRAFT**7.8 Borrow Area #8 (North East Ridge)**

Borrow Area #8 is a beach ridge north of the water lake. An access road approximately 250 m long would be required into the area from the area north of the garage to ridge. The material is expected to consist of coarse gravel over sand and gravel.

It is estimated that a thickness of fill between 0.3 to 1.0 m could be excavated from the area. It is estimated that 9,000 m³ of material can be excavated from the area. No testpits have been excavated in the area. It is recommended that the site be further characterized at the prior to construction.

7.9 Borrow Area #9 (Marine Terrace)

Borrow Area #9 is a marine terrace south of the hangar. The material in the area consists of sand and sand and gravel. The area is covered with little vegetation and the groundwater is near the surface. Excavation procedures to deal with high ground water are required. A thaw and strip operation may be required working off of frozen ground early in the season. Ponded water may develop following borrow extraction. Provisions to drain the drain the area towards the south or east may be required.

7.10 Borrow Area #10 (South West Airstrip)

Borrow Area #10 is south of the west half of the airstrip. Much of this area has been used as a borrow area in the past. Allot of the area has been excavated down to bedrock; however there are pockets of material remaining. Undisturbed ground adjacent to the south edge is available for borrow. Testpits UMA0102, UMA0103, UMA104 and UMA0115 were excavated in this area. Shallow ground water is present; however it can be drained towards the south. Shallow bedrock is also present. Wet material may have to be drained and stockpiled prior to use.

7.11 Borrow Area #11

Borrow Area #11 is north of the pallet line in an undisturbed area. The area consists of beach ridges and a thin layer of sand and gravel overlying bedrock. The area was investigated as the proposed pallet line landfill as described in Section 5.1 of this report; however it is understood that there are no current plans to construct a landfill at this location. Testpits TP-00-56 through TP-00-62 were excavated in the area. The testpits

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encountered coarse angular gravel in the beach ridges. Bedrock was near or at surface between the beach ridges.

7.12 Summary of Granular Resources

The borrow materials at the site are generally coarse grained and free draining with the exception of limited amounts of fine grained material at depth. The project has requirements for different fill types.

Type 1 Granular Fill is rip rap or coarse gravel and cobbles. At this time there is no large rip rap specified for the project. Coarse cobbly gravel is available from the beach ridges on site, particularly in Borrow Areas #4 and #8. This material can be placed over top of Type 2 fill to create an erosion resistant landfill cover.

Type 2 Granular Fill is generally used for landfill cover material. The sands available in many of the borrow areas are acceptable as Type 2 cover; although it will relatively free draining. Most of the sand on site contains limited fines and a small percentage of gravel; therefore it is susceptible to erosion. Erosion can be minimized by covering these materials with coarse gravels.

Type 3 Granular Fill is used for general fill for contaminated soil excavations among other things. Most of the material on site is acceptable for this use.

Type 4 Granular Fill is used for a frozen containment barrier for landfill remediation and some new landfill construction. It is placed in a nearly saturated condition such it has a low permeability when it freezes. The material must be well graded and contain enough fines such that it can be placed in a near saturated condition and remain in the condition until it freezes back. Several soil samples from Borrow Area #5 contained sufficient fines to make them acceptable for Type 4 material; however other samples from the borrow area were not acceptable. The deposit is variable. A fined grained silt and clay deposit was encountered in several testpits at the southwest side of the site. This material was found at depth and was always below the water table. The material was very wet. This material would be very difficult to use as a construction material. It is recommended that the silty sand from Borrow Area #5 be used for Type 4 material. Coarser grained areas of the borrow area could be avoided. Type 4 material is also required to have a salinity of less than 5 parts per thousand (ppt). Marine deposited soils contain some salinity; however soils within the active layer generally are non saline or have a low salinity due to the salts being leached out over time. Salinity content was measured in five samples from Borrow Area #5. Four of

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the samples had salinity less than 4 ppt as would be expected. One sample had a salinity of 25 ppt. The higher salinity in this sample may be a result of this area being previously excavated, such that sample was from below the original active layer. It is recommended that salinity testing be carried out during construction to identify any particular areas within the deposit that have a high salinity.

Type 5 Granular Fill is sand used to protect geosynthetic liners. Sand deposits have been identified in Borrow areas #3 and #9. The sand generally contains some gravel. The gravel is generally 25 to 50 mm minus; however some rounded cobbles are present and the occasional angular cobble is present. The sands will have require stockpiling and draining such that it can be placed and compacted. Screening the sands would be difficult due to it's high moisture content. It is recommended to use the sand without processing but to protect the geosynthetic liners with thick geosynthetics. Any angular cobbles should be removed from the sand.

Type 6 Granular Fill is non-frost susceptible sand and gravel it is used as intermediate fill within landfill construction. The material must have a fines content of less than 8%. There are many sources of material on site that were suitable for this.

**TABLE 1
BORROW MATERIAL SUMMARY**

| Borrow Source | Estimated Volume (m³) | Depth of Excavation |
|--|--|--|
| Borrow Area #1 (East Airstrip) | 15,000 | 0.5 m deep |
| Borrow Area #2 (West Hangar) | 4,000 | 0.3 m deep |
| Borrow Area #3 (Beach Cargo) | 12,000 in DND Reserve 7,000 off DND Reserve | 0.3 m deep on DND Reserve, 0.5 m deep off DND Reserve |
| Borrow Area #4 (NWS Landfill Beach Ridges) | 8,000 m ³ | 0.3 to 0.6 m deep |
| Borrow Area #5 (South East Airstrip) | 42,000 m ³ | 0.5 to 1.5 m deep |

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TABLE 1 CONT.
Borrow Material Summary

| Borrow Source | Estimated Volume (m³) | Depth of Excavation |
|--|--|----------------------------|
| Borrow Area #6 (North East Airstrip) | 10,000 m ³ | 0.7 m deep |
| Borrow Area #7 (East Ridge) | 70,000 m ³ (off DND reserve) | 0.5 to 1.5 m |
| Borrow Area #8 (North East Ridge) | 9,000 m ³ | 0.3 to 1.0 m |
| Borrow Area #9 (Marine Terrace) | 5,000 m ³ | 0 to 0.4 |
| Borrow Area #10 (Southwest Airstrip) | 14,000 m ³ | 0.0 to 1.0 |
| Borrow Area #11 (Pallet Beach Ridges) | 6,000 m ³ | 0.2 to 1.0 |

8.0 LIMITATIONS

This report pertains to the specific site and development described in Section 1.0. Isolated information should not be reproduced, transferred, or used outside the context of this report unless clearly referenced to the source. EBA Engineering Consultants Ltd. will not be responsible for unauthorized reuse or interpretation of information presented herein.

The report presents a concept design level. Design details and specifications have to be developed. It is recommended that EBA be given the opportunity to review or develop the details of the final design. It is also recommended that geotechnical/materials and environmental engineering field services, such as backfill and drainage measures and testing of soil density and gradation be preformed as construction proceeds to ensure that the requirements outlined in the construction specifications are followed and the design intent is met.

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It should be noted that geological conditions are innately variable and are seldom spatially uniform. At the time of preparation of this report stratigraphic information was based on shallow testpits and surface exposures. In order to develop recommendations from this information, it is necessary to make assumptions concerning the stratigraphy. Adequate monitoring should be provided during construction to check that these assumptions are reasonable.

This report has been prepared in accordance with generally accepted engineering practices and judgement has been used in developing recommendations. No other warrant is made, either expressed or implied.

Respectfully submitted
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FIGURES