PART 1 GENERAL

1.1 Related Sections

.1 Section 02315 Excavating, Trenching and Backfilling

.2 Section 02721 Granular Base

.3 Section 02723 Granular Sub-Base

.4 Section 03300 Cast-in-Place Concrete

1.2 References

.1 ASTMD4791-89, Test Method for Flat or Elongated Particles in Coarse Aggregate.

1.3 Samples

.1 Submit samples in accordance with Section 01330 - Submittal Procedures.

.2 Allow continual sampling by Engineer during production.

.3 Provide Engineer with access to source and processed material for sampling.

.4 Install sampling facilities at discharge end of production conveyor to allow Engineer to obtain representative samples of items being produced. Stop conveyor belt when requested by Engineer to permit full cross section sampling.

.5 Pay cost of sampling and testing of aggregates that fail to meet specified requirements.

.6 Provide water, electric power and propane to Engineer laboratory trailer at production site.

PART 2 PRODUCTS

2.1 Materials

.1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.

.2 Flat and elongated particles of coarse aggregate: to ASTMD4791.

  .1 Greatest dimension to exceed five times least dimension.

.3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:

  .1 Natural sand.

  .2 Manufactured sand.

  .3 Screenings produced in crushing of quarried rock, boulders, gravel or slag.

.4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:

  .1 Crushed rock.

  .2 Gravel and crushed gravel composed of naturally formed particles of stone.

  .3 Light weight aggregate, including slag and expanded shale.

2.2 Source Quality Control

.1 Inform Engineer of proposed source of aggregates and provide access for sampling at least 4 weeks prior to commencing production.

.2 If, in opinion of Engineer, materials from proposed source do not meet, or cannot reasonably be processed to meet specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.

.3 Advise Engineer 4 weeks in advance of proposed change of material source.

.4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

PART 3 EXECUTION

3.1 Preparation

.1 Aggregate source preparation

  .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as directed by Engineer.

  .2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.

  .3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.

  .4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.

  .5 Trim off and dress slopes of waste material piles and leave site in neat condition.

.2 Processing

  .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.

  .2 Blend aggregates, if required, to obtain gradation requirements, percentage of crushed particles, or particle shapes, as specified. Use methods and equipment approved by Engineer.

  .3 Wash aggregates, if required to meet specifications. Use only equipment approved by Engineer.

.4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate.

.3 Handling

.1 Handle and transport aggregates to avoid segregation, contamination and degradation.

.4 Stockpiling

.1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Engineer. Do not stockpile on completed pavement surfaces.

.2 Stockpile aggregates in sufficient quantities to meet project schedules.

.3 Stockpiling sites to be level, well drained, and have adequate bearing capacity and stability to support stockpiled materials and handling equipment.

.4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into work.

.5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.

.6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Engineer within 48 h of rejection.

.7 Stockpile materials in uniform layers of thickness as follows:

.1 Max 1.5 m for coarse aggregate and base course materials.

.2 Max 1.5 m for fine aggregate and sub-base materials.

.3 Max 1.5 m for other materials.

.8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.

.9 Do not cone piles or spill material over edges of piles.

.10 Do not use conveying stackers.

.11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.2 Cleaning

.1 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.

.2 Leave any unused aggregates in neat compact stockpiles as directed by Engineer.

.3 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of authority having jurisdiction.

END OF SECTION

PART 1 GENERAL

1.1 References

.1 ASTMC117-90, Test Method for Material Finer Than 0.075mm Sieve in Mineral Aggregates by Washing.

.2 ASTMC131-89, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTMC136-92, Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTMD698-91, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft3) (600kN-m/m3).

.5 ASTMD1557-91, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft3) (2,700kN-m/m3).

.6 ASTMD1883-92, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

.7 ASTMD4318-84, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.8 CAN/CGSB-8.1-88, Sieves Testing, Woven Wire, Inch Series.

.9 CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.

1.2 Delivery, Storage, and Handling

.1 Deliver and stockpile aggregates in accordance with Section 02701- Aggregates General..

.2 Store cement in weathertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.

PART 2 PRODUCTS

2.1 Materials

.1 Granular base: material to Section 02701- Aggregates: General and following requirements:

.1 Crushed stone or gravel.

.2 Gradations to be within limits specified when tested to ASTMC136. Sieve sizes to CAN/CGSB-8.1.

.1 Gradation to:

Sieve Designation	% Passing		
	(1)	(2)	(3)
100 mm	-	-	-
75 mm	-	-	-
50 mm	100	-	-
37.5 mm	70-100	-	-
25 mm	-	100	-
19 mm	50-75	-	100
12.5 mm	-	65-100	70-100
9.5 mm	40-65	-	-
4.75 mm	30-50	35-60	40-70
2.00 mm	-	22-45	23-50
0.425 mm	10-30	10-25	7-25
0.180 mm	-	-	-
0.075 mm	3-8	3-8	3-8

.2 Material to level surface depressions to meet gradation (2)limits in accordance with 2.1.1.2.1.

.3 Liquid limit: to ASTMD4318, maximum25

.4 Plasticity index: to ASTMD4318, maximum6

.5 Los Angeles degradation: to ASTMC131. Max. % loss by weight: 45

.6 Crushed particles: at least [60]% of particles by mass within each of following sieve designation ranges to have at least [1]freshly fractured face. Material to be divided into ranges using methods of ASTMC136.

Passing		Retained on
[50] mm	to	25 mm
[25] mm	to	19.0 mm
[19.0] mm	to	4.75 mm

.7 Soaked CBR: to ASTMD1883, min 80, when compacted to 100% of ASTMD1557.

PART 3 EXECUTION

3.1 Sequence of Operation

.1 Place granular base after sub-base surface is inspected and approved by Engineer .

.2 Placing

.1 Construct granular base to depth and grade in areas indicated.

.2 Ensure no frozen material is placed.

.3 Place material only on clean unfrozen surface, free from snow and ice.

.4 Begin spreading base material on crown line or on high side of one-way slope.

.5 Place material using methods which do not lead to segregation or degradation of aggregate.

.6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.

.7 Place material to full width in uniform layers not exceeding 150mm compacted thickness. Engineer may authorize thicker lifts (layers) if specified compaction can be achieved.

.8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.9 Remove and replace that portion of layer in which material becomes segregated during spreading.

.3 Compaction Equipment

.1 Compaction equipment to be capable of obtaining required material densities.

.2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Engineer before use.

.3 Equipped with device that records hours of actual work, not motor running hours.

.4 Compacting

.1 Compact to density not less than 100% maximum dry density in accordance with ASTMD1557.

.2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.

.3 Apply water as necessary during compacting to obtain specified density.

.4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Engineer .

.5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

.5 Proof rolling

.1 For proof rolling use standard roller of 45400kg gross mass with four pneumatic tires each carrying 11350kg and inflated to 620kPa. Four tires arranged abreast with centre to centre spacing of 730mm.

.2 Obtain approval from Engineer to use non standard proof rolling equipment.

.3 Proof roll at level in granular base as indicated. If use of non standard proof rolling equipment is approved, Engineer to determine level of proof rolling.

.4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

.5 Where proof rolling reveals areas of defective subgrade:

.1 Remove base, sub-base and subgrade material to depth and extent as directed by Engineer .

.2 Backfill excavated subgrade with common material and compact in accordance with Section sub-base material and compact in accordance with Section 02722- Granular Sub-Base.

.3 Replace sub-base material and compact in accordance with Section 02722- Granular Sub-base.

.4 Replace base material and compact in accordance with this section.

.6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Engineer and replace with new materials in accordance with Section 02722- Granular Sub-base and this section at no extra cost.

3.2 Site Tolerances

.1 Finished base surface to be within plus or minus 10mm of established grade and cross section but not uniformly high or low.

3.3 Protection

.1 Maintain finished base in condition conforming to this section until succeeding material is applied or until acceptance by Engineer .

END OF SECTION

PART 1 GENERAL

1.1 References

.1 ASTM C 117-90, Test Method for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.

.2 ASTM C 131-89, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTM C 136-92, Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTM D 422-63(1990), Method for Particle-Size Analysis of Soils.

.5 ASTM D 698-91, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3) (600 kN-m/m3).

.6 ASTM D 1557-91, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2,700 kN-m/m3).

.7 ASTM D 1883-92, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

.8 ASTM D 4318-84, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.9 CAN/CGSB-8.1-88, Sieves Testing, Woven Wire, Inch Series.

.10 CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.

PART 2 PRODUCTS

2.1 Materials

.1 Granular sub-base material to Section 02701- Aggregates: General and following requirements:

.1 Crushed, pit run or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1.

.3 Table

Sieve Designation	% Passing			
100 mm	-	-	-	-
75 mm	100	100	100	-
50 mm	-	-	-	100
37.5 mm	-	-	-	-
25 mm	55-100	-	-	60-100
19 mm	-	-	-	-
12.5 mm	-	-	-	38-70
9.5 mm	-	-	-	-
4.75 mm	25-100	25-85	-	22-55

Sieve Designation	% Passing			
2.00 mm	15-80	-	-	13-42
0.425 mm	4-50	5-30	0-30	5-28
0.180 mm	-	-	-	-
0.075 mm	0-8	0-10	0-8	2-10

.4 Other Properties as follows:

.1 Liquid Limit: to ASTM D 4318, Maximum 25.

.2 Plasticity Index: to ASTM D 4318, Maximum 6.

.3 Los Angeles degradation: to ASTM C 131. Max % Loss by mass: [40] [50].

.4 Particles smaller than 0.02 mm: to ASTM D 422, Maximum 3%.

.5 Soaked CBR: to ASTM D 1883, Min 40 when compacted to 100% of ASTM D 1557.

PART 3 EXECUTION

3.1 Placing

.1 Place granular sub-base after subgrade is inspected and approved by Engineer.

.2 Construct granular sub-base to depth and grade in areas indicated.

.3 Ensure no frozen material is placed.

.4 Place material only on clean unfrozen surface, free from snow or ice.

.5 Begin spreading sub-base material on crown line or high side of one-way slope.

.6 Place granular sub-base materials using methods which do not lead to segregation or degradation.

.7 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.

.8 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. Engineer may authorize thicker lifts (layers) if specified compaction can be achieved.

.9 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.10 Remove and replace portion of layer in which material has become segregated during spreading.

3.2 Compaction

.1 Compaction equipment to be capable of obtaining required material densities.

.2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Engineer before use.

.3 Equipped with device that records hours of actual work, not motor running hours.

.4 Compact to density of not less than 98% maximum dry density in accordance with ASTM D 1557.

.5 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.

.6 Apply water as necessary during compaction to obtain specified density.

.7 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Engineer.

.8 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.3 **Proof Rolling**

.1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm maximum.

.2 Obtain approval from Engineer to use non standard proof rolling equipment.

.3 Proof roll at level in sub-base as indicated. If non standard proof rolling equipment is approved, Engineer to determine level of proof rolling.

.4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

.5 Where proof rolling reveals areas of defective subgrade:

.1 Remove sub-base and subgrade material to depth and extent as directed by Engineer.

.2 Backfill excavated subgrade with common material and compact.

.3 Replace sub-base material and compact.

.6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

3.4 **Site Tolerances**

.1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.5 **Protection**

.1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Engineer.

END OF SECTION

07-0002-2000

7 March 2003
AMEC Project No.: YX00677

Dillon Consulting Limited
Suite 303, 4920 47 Street
PO Box 1409,
Yellowknife, NT X1A 2P1

Attention: **Mr. Gary Strong**

Dear Mr. Strong:

RE: Geotechnical Desk Study
Proposed Water Treatment Plant, Gjoa Haven, NU.

At the request of Dillon Consulting Ltd (Dillon), AMEC Earth & Environmental Limited (AMEC) has conducted a geotechnical desk study for the proposed Water Treatment Plant (WTP) in Gjoa Haven, NU. The lot for the proposed WTP is situated between the lot legally described as LTO 2742, Lot 386 to the south and the airport runway to the north. Authorization to proceed with this study was received by yourself on February 6, 2003. This work was performed under Dillon's Consultant / Sub-Consultant agreement dated February 6, 2003.

1.0 SCOPE OF WORK

It is understood that the Dillon is currently in the planning and design stages of a new Water Treatment Plant in Gjoa Haven, NU. The proposed facility will be a single storey structure with a building footprint approximately of 15 m x 20 m.

AMEC was requested to conduct a desk study of readily available geotechnical information, including geotechnical reports, air photos, community maps, climate and permafrost historical data to determine the likely subsurface conditions at the subject site and provide recommendations for possible foundation options for the project.

It is understood that the preferred foundation design is an at-grade, raft or mat foundation, with control joints between building and exterior piping. It is further understood that the building is to be divided in half, with interior temperatures being 5°C and 15°C in either half.

2.0 REVIEW OF EXISTING INFORMATION

Previous investigations and other available information with respect to geotechnical and climate information of the community of Gjoa Haven were reviewed by AMEC. The information is presented below.

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2.1 PREVIOUS SUBSURFACE INVESTIGATIONS

Subsurface Soils Investigation, Kerkertak Ilihakvik School, Gjoa Haven, NWT, August, 1975, Prepared by Bernard & Hoggan Engineering and Testing

A field drilling program consisting of drilling ten boreholes in the area of the proposed Kerkertak Ilinakvik School, was conducted between July 12 to 17, 1975. The school is located about 800 m south of the proposed Water Treatment Plant. The boreholes were drilled to depths varying between 1.1 m and 9 m below grade. Subsurface conditions were reported to consist of medium grained sand near the surface, decreasing in grain size with increasing depth. The sand was reported to be in a dense state. Thin silt and clay layers were reported in three of the ten boreholes at depths varying between 2 m and 6 m. Ice crystals, lenses and layers were reported in various boreholes. Rock, possibly bedrock, is implied at depths of about 5 m in boreholes numbered 6 and 7.

In general, moisture contents reported in the borehole logs varied between about 10 and 20 percent, with some values reported in near surface sand and ice rich zones as 1 percent and 100 percent.

The depth of seasonal thaw at the time of this investigation, varied between 0.9 m and 1.2 m. Ground temperature measurements were taken three days after drilling and reported to be about -13°C at a depth of 7.3 m below grade.

A layer of water, up to 75 mm deep, was reported to be perched above the permafrost table in the boreholes.

Geotechnical Investigation, Residential Housing and Warehouse, Gjoa Haven, NWT, May 1984, Submitted to Northwest Territories Housing Corporation, Submitted by Thurber Consultants Ltd.

Ten boreholes were drilled at various locations within the community as shown in Figure 1. The nearest test hole is located about 1,000 m south of the proposed WTP. Boreholes were drilled to a depth of 6.1 m. One borehole was terminated at 0.9 m due to sloughing conditions. Moisture contents are reported to generally vary from about 5 to 25 percent.

Generally, the subsurface conditions was reported to be fine to medium sand at the surface to a depth varying between 1 m and 6 m. The sand was underlain by silty sand, silt, and silty clay to the termination of the boreholes. Bedrock was not reported in this investigation.

Generally, ice in the soils was reported as Nbn - well bonded frozen soil with no excess ice. Some random ice crystals were reported in isolated locations. Soils salinity was reported at less than one part per thousand (ppt) indicating a low salinity content.

Insulated Spread Footing Installation Monitoring, Proposed Additions to Quqshuun Ilihakvik Centre, Gjoa Haven, NU, October 1997, Submitted to Ferguson Simek Clark, Submitted by AGRA Earth & Environmental Ltd.

The insulated spread footing installation monitoring at the site of the Proposed Additions to Quqshuun Ilinakvik Centre was conducted between September 24, 1997 and October 2, 1997.

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Quqshuun Ilihakvik Centre is located approximately 800 m south of the site of the Proposed Water Treatment Plant. Forty-eight spread footings were placed on the project site with excavations up to the depth of 2.0 m below existing grade.

The soil profiles at the footing locations were reported to generally consist of uniform, fine to medium grained sands with some gravel and trace cobble sizes. Bedrock was not encountered in any of the boreholes. Permafrost with small amounts of excess ice was encountered throughout, with the thaw zone varying from 0.9 m to 1.0 m below grade.

There was groundwater seepage within the active layer report resulting in a layer of water 25 to 75 mm deep at the base of the excavations.

Adfreeze Pile Installation Monitoring, New Community Health Centre, Gjoa Haven, NU, August 1997, Submitted to Ferguson Simek Clark, Submitted by AGRA Earth & Environmental Ltd.

The New Community Health Centre is located approximately 1400 m south of the site of the Proposed Water Treatment Plant. The adfreeze piling installation monitoring at the site of the New Community Health Centre was conducted in June/July 1997. The installation of 53 piles commenced on June 21, 1997 and was completed on July 2, 1997. It is understood that the foundation design was based on AGRA Earth & Environmental Limited's geotechnical desk study for the noted project.

Boreholes ranging in depth from 7.0 m to 11.0 m below existing grade were drilled for the pile installation. The soil profiles at the borehole locations were reported to generally consist of sand and silty sand.

The thawed active layer zone varied from 0.7 m to 1.0 m below grade at the time of pile installation. Tests conducted on select samples obtained during borehole drilling indicated the salinity content ranged between 1 and 2 ppt at a depth between 2.8 m and 9 m. A salinity content less than 5 ppt is considered to be low.

2.2 GENERAL GEOLOGY, CLIMATE, and PERMAFROST

The community of Gjoa Haven is situated on the shores of Petersen Bay on the southwest of King William Island at about 68°30′ N latitude and 95°53′ W longitude. The general terrain of the area consists of limestone bedrock, covered with a thin layer of frost weathered in situ sand and boulders. Bedrock predominates in the higher hills, which rise up to 45 m. The surface in lower areas is covered by a thick layer of fine sand and coarse rock.
The average thawing and freezing data for Gjoa Haven between 1984 and 1999 was based on climate normals and calculated to be about 450°C-days and 5750°C-days, respectively. The mean annual air temperature for the equivalent time period was estimated to be −14.6°C.

The community lies within the zone of continuous permafrost. The depth of seasonal thaw has been reported to vary from about 0.9 to 1.5 m below grade but may me greater in dry, granular fill.

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3.0 SITE CONDITIONS

3.1 INFERRED SUBSURFACE CONDITIONS

Figure 1 shows the location for the proposed Water Treatment Plant. Based on the review of geotechnical information, the following stratigraphy may be inferred to be present at the subject site.

There may be local fill material in some areas of the site. Native soils underlying any granular fill is likely to consist of sand and silt sand. Bedrock is not likely encountered within the near surface subsoils. Ice crystals and lenses have been reported at select sites in the area and may be present in the subsoils at the proposed WTP site.

Ground temperatures at the site may be expected to be in the order of -10°C at a depth of about 10 m. Porewater salinity at the site can be expected to be low.

One grain size analysis and standard Proctor test was conducted on a surface sample obtained by the client from the site. Results of the grain size analysis and standard Proctor test are presented in Appendix A.

4.0 FOUNDATION RECOMMENDATIONS

4.1 GENERAL

Based on the results of the geotechnical review, a grade-supported foundation with a heat interceptor system is considered to be the technically preferred alternative for the proposed structure. The typical design comprises of an insulated slab-on-grade with structural loads supported on a mat foundation, edge-thickened slab, or perimeter grade beams. In order to reduce the thermal impact of the structure on the underlying permafrost, a heat interceptor system should be installed. The heat interception system could comprise of thermosyphons, heat pumps or an active refrigeration system. An adfreeze pile or shallow footing foundation with an air space are also a technically feasible foundation designs.

It is understood that the client prefers a foundation design consisting of a raft or mat foundation at grade with insulation alone. Insulation alone does not act as a "heat-interceptor" but rather a "heat-retarder". Provisions should be considered by which a heat interception system is constructed in the gravel pad but not operated. Should insulation alone prove inadequate for heat transfer reduction, the heat interception system could then be operated. Insulation alone has been used in various building across the north and has varying degrees of success. Recommendations with respect to insulation alone are presented in the following sections.

4.2 SITE PREPARATION

It has been assumed that construction of the foundation for the WTP will take place in late summer to early fall. Grading may be required to level the site and provide surface drainage. Prior to pad construction, the subgrade should be checked to detect any soft or loose areas. Any such areas detected should be over-excavated and replaced with gravel fill material.

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The contractor should be notified that pumps may be required to control water within any excavation. If extensive water accumulates in the fill, frost heave may occur.

Snow and ice must be removed from the prepared subgrade prior to the placement of any fill material. Engineered fill material should be placed immediately after subgrade preparation. If grading has occurred while the soil is frozen, fill placement would commence as soon as the granular material is unfrozen and the soil can be compacted in an unfrozen state. If significant thaw of the base of the excavation occurs prior to fill placement, initial settlement of the pad may occur.

Based on the entire building temperature being maintained +15°C, calculations indicate that the depth of thaw over a 25 year building life can be expected to be about 3 m. Therefore, a clean gravel pad a minimum 2 m thick should be placed directly over the prepared subgrade. Settlement associated with this thickness of gravel pad and depth of thaw, should be limited to 25 mm over 25 years.

If it can be ensured that the building temperature will not exceed +5°C and +15°C in each designated half over the structure's life, the gravel pad thickness can be reduced to 1 m. If the above temperatures are maintained over the life of the building, thaw settlement should be limited to 25 mm over 25 years.

The gravel pad should consist of granular material no greater than 75 mm and containing less than 5 percent fines. The upper 0.2 m of pad should consist of 50 mm minus clean gravel. Two recommended gradations are presented in Appendix A. Other gradations may be acceptable but should be reviewed by a geotechnical engineer.

All fill should be placed in lifts not exceeding 200 mm compacted thickness and compacted to a minimum of 95 percent of SPMDD at a water content ± 3 percent of optimum. No gravel should be placed that is in a frozen state. The crest of the granular pad should extend at least 3 metres beyond the exterior perimeter of the building, and beyond that have side slopes that are at least 3H:1V.

4.3 MAT FOUNDATIONS RECOMMENDATIONS

Structural loads may be supported on a reinforced mat foundation, an edge-thickened reinforced concrete slab, or on a perimeter grade beam. A mat foundation or floating slab-on-grade should be placed on a gravel pad at least 2000 mm thick.

A mat foundation may be designed based on an allowable contact pressure between the mat and the underlying engineered gravel pad of 150 kPa. The gravel pad should be constructed as described in Section 4.2. It is understood that control joints will be used to compensate for differential settlement between the structure and piping system.

The modulus of subgrade reaction for the mat foundation may be taken as 50 MPa/m.

The foundation factor for seismic design may be taken as 1.0 in accordance with the National Building Code criteria.

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4.4 INSULATION REQUIREMENTS

The mat foundation should be placed directly on 200 mm of extruded polystyrene insulation. Prior to placing the insulation, a layer of levelling sand, approximately 150 mm thick should be compacted over the granular pad for protection.

A 50 mm thick layer of insulation should extend laterally outwards 1.8 m from the perimeter of the building. The exterior insulation should be covered by a minimum of 0.2 m of granular fill in areas not subjected to vehicular traffic. An increased depth of cover and higher strength insulation should be considered in areas underlying vehicular traffic.

Figure 2 shows a general cross section of insulation requirements.

4.5 CONCRETE TYPE

All concrete should be surrounded by relatively clean sand or gravel fill. If this is implemented, Type 10 Portland cement may be used. Air entrainment is recommended for all concrete to improve freeze-thaw characteristics of the concrete. All concrete should be designed in accordance with CSA Standards.

If chemicals detrimental to the integrity of the concrete are to be used within the building, AMEC should be advised and concrete recommendations should be revised, if necessary.

5.0 ADDITIONAL RECOMMENDATIONS

5.1 SITE GRADING AND DRAINAGE

Adequate drainage is required near the building to reduce the potential thermal and physical erosion. A drainage plan should be implemented to drain surface water from the areas adjacent to the proposed building.

For those areas immediately adjacent to the building, design grades should promote rapid drainage and should be sloped a minimum of three (3) percent over a distance of two (2) metres in order to shed water away from the structure.

Downspouts for eaves troughs should be directed away from the building with the discharge point at least 1.5 metres from the exterior of the building. This will reduce the potential for erosion of the subgrade adjacent to the structure. Other areas in the vicinity should be graded to drain at slopes of at least two (2) percent away from the building.

5.2 DESIGN REVIEW AND FOUNDATION MONITORING

It is recommended that a geotechnical review be conducted prior to finalization of design details and contract specifications. This review is considered to be an important part of the design process, as it enables AMEC to be assured that the recommendations contained herein have been understood and interpreted correctly.

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Monitoring of the installation of foundation is an integral part of the design process. Compaction testing should be carried out on all engineered fill placement. Proper compaction is important to help minimize the potential for differential settlement.

6.0 CLOSURE

It is recommended that a field investigation be conducted to confirm actual site conditions. Following the confirmation of the site-specific conditions, the foundation design option can be confirmed, including raft foundation capacity.

The findings and recommendations presented herein are based on published reports and air photographs of the Gjoa Haven area. It should be noted that no drilling was conducted on this site, nor has an AMEC representative inspected the project site. It has been assumed that qualified personnel will obtain site-specific soil conditions for foundation design confirmation. Should the conditions encountered during construction appear to be different than those assumed in this report, AMEC Earth & Environmental Limited should be advised immediately and the recommendations contained herein will be revised, if necessary.

This preliminary report has been prepared for the exclusive use Dillon Consulting Limited and its agents, for the specific application described herein. It has been prepared in accordance with generally accepted permafrost and foundation engineering practices. No other warranty, expressed or implied, is made.

Respectfully submitted,

AMEC Earth & Environmental Limited

REGISTERED PROFESSIONAL ENGINEER
K.G. BARNES
LICENSEE
NWT/NU

PERMIT TO PRACTICE
AMEC Earth & Environmental Limited
Signature ____________
Date ____________
PERMIT NUMBER: P 047
The Association of Professional Engineers, Geologists and Geophysicists of the NWT / NU

Keith Barnes, P. Eng.
Permafrost Engineer

Reviewed by: Alexandre Tchekhovski, Ph.D., P.Eng.
Senior Permafrost Engineer

APPENDIX A

Figure 1: General Location Plan
Figure 2: Insulation Configuration
Recommended Gradations for Gravel
Grain Size Analysis
Standard Proctor Test Results

RECOMMENDED GRADATION FOR GRAVEL

Sieve Size	Percent Passing by Weight
25 mm Minus Crushed Gravel	
25 mm	100
20 mm	95 - 100
10 mm	60 - 80
4.75 mm	40 - 60
2.36 mm	28 - 48
600 µm	13 - 29
300 µm	9 - 21
150 µm	6 - 15
75 µm	4 - 10
75 mm Minus Screened Gravel	
75 mm	100
40 mm	60 - 80
20 mm	40 - 66
10 mm	25 - 54
4.75 mm	15 - 43
2.36 mm	10 - 35
600 µm	5 - 23
150 µm	3 - 12
75 µm	2 – 10

SIEVE ANALYSIS REPORT

AMEC Earth & Environmental Limited

To: Dillon Consulting Ltd
Suite 303, 4920 47 Street
P.O. Box 1409
Yellowknife NT X1A 2P1

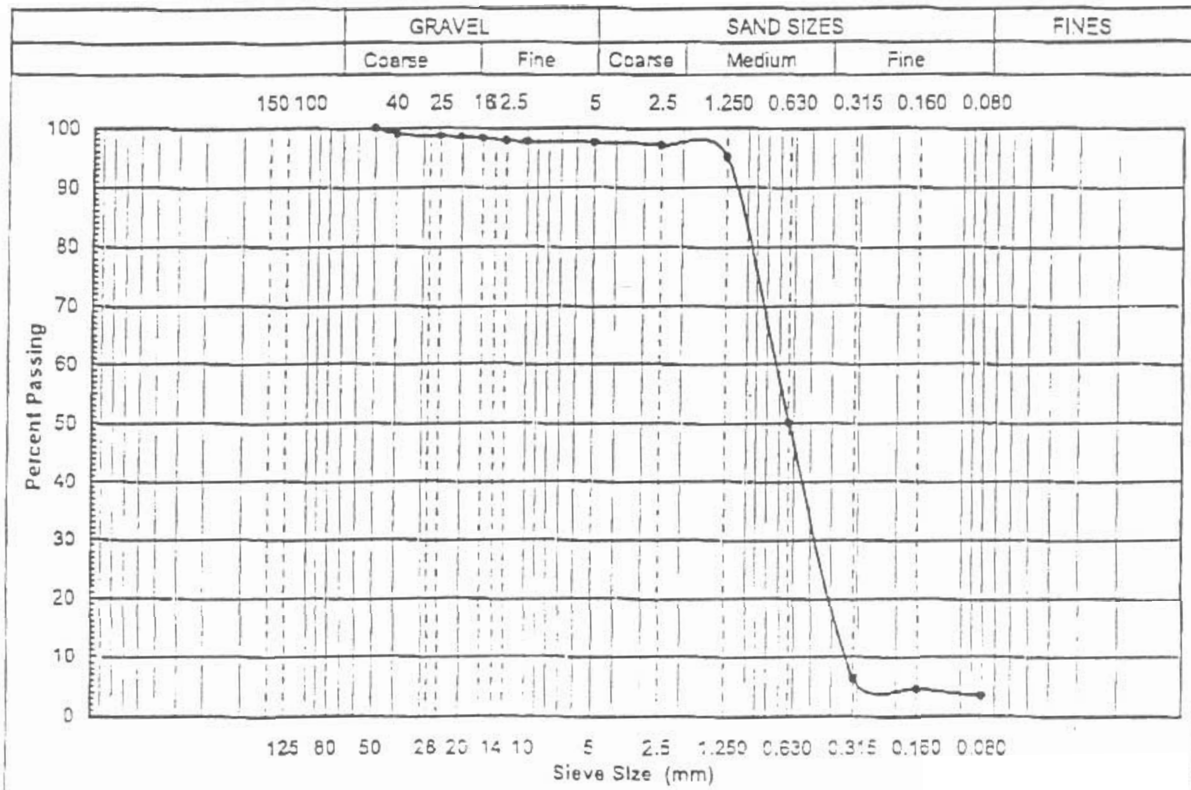
Office : Calgary
Project No: YX00681
Client : Dillon
Copies to :

Attn: Mr. Gary Strong, P.Eng.

Project: Water Treatment Plant, Gjoa Haven, NU

Sample ID: | **Sample Type:** Grab Sample | **Sampled By:** AMEC

Date Sampled: | **Date Received:** | **Date Tested:** 14-Feb-03



Sieve Size	% Passing
150.0	
125.0	
100.0	
80.0	
50.0	100
40.0	99
28.0	
25.0	99
20.0	98
16.0	98
14.0	
12.5	98
10.0	98
5.0	98
2.5	97
1.250	95
0.630	50
0.315	7
0.160	5
0.080	3.5

Source: Bulk

Sample Description: SAND, medium grained, trace gravel, trace fines

Comments : Initial moisture content = 6.1%

AMEC Earth & Environmental Limited

Per: ____________