# APPENDIX 8

GEOTECHNICAL AND
HYDROGEOLOGICAL
INVESTIGATIONS
TAILINGS POND AREA

PITEAU ENGINEERING LTD. 1996



# PITEAU ENGINEERING LTD. HYDROGEOLOGICAL AND GEOTECHNICAL CONSULTANTS

SUITE 100, 4500 - 16th AVENUE N.W. CALGARY, ALBERTA CANADA T3B 0M6 TELEPHONE (403) 286-2522 TELEX 03-821172 FAX (403) 247-4811

# GEOTECHNICAL AND HYDROGEOLOGICAL ASSESSMENT PROPOSED TAILINGS POND AREA TELKWA COAL PROJECT

PREPARED FOR:

MANALTA COAL LTD.

K197-3773-12 JANUARY, 1997

# TABLE OF CONTENTS

<u>Page No.</u>
EXECUTIVE SUMMARYi
1. INTRODUCTION1
2. TAILINGS POND AREA
2.1 PROGRAM OVERVIEW2
2.2 SURFICIAL GEOLOGY3
2.3 BEDROCK GEOLOGY4
2.4 HYDROGEOLOGICAL CONDITIONS5
2.4.1 GROUNDWATER FLOW
2.4.2 GROUNDWATER QUALITY6
2.5 PRELIMINARY SEEPAGE ANALYSIS8
2.6 GEOTECHNICAL CONSIDERATIONS
2.6.1 SOIL PROPERTIES11
2.6.2 PERIMETER DYKE
2.6.3 CONSTRUCTION MATERIALS
2.6.4 SAND AND GRAVEL ZONE CUTOFF
3. CONCLUSIONS15
4. RECOMMENDATIONS
5. ACKNOWLEDGMENTS18
6. REFERENCES

# LIST OF TABLES

TABLE 1	PIEZOMETER INSTALLATION DETAILS, DATUM/GROUNDWATER
	ELEVATIONS AND HYDRAULIC CONDUCTIVITIES
TABLE 2	BOREHOLE SUMMARY INFORMATION
TABLE 3	SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA
TABLE 4	FIELD MEASURED PARAMETERS
TABLE 5	GROUNDWATER QUALITY INDICATOR PARAMETERS
TABLE 6	LABORATORY ANALYSIS RESULTS FOR METALS

# LIST OF FIGURES

FIGURE 1	LOCATION PLAN
FIGURE 2	SITE PLAN
FIGURE 3	BOREHOLE AND PIEZOMETER LOCATIONS
FIGURE 4	TAILINGS POND CROSS SECTION A - A'
FIGURE 5	TAILINGS POND CROSS SECTION B - B'
FIGURE 6	TAILINGS POND CROSS SECTION C - C'
FIGURE 7	MAIN ION CHEMISTRY(SURFICIAL DEPOSITS): EXPANDED
	DUROV DIAGRAM
FIGURE 8	PLASTICITY INDEX VS LIQUID LIMIT
FIGURE 9	MOISTURE CONTENT VS DEPTH (TILL)
FIGURE 10	SPT VS DEPTH
FIGURE 11	PENETROMETER VS DEPTH

# LIST OF APPENDICES

APPENDIX	FIELD PROGRAM PROTOCOLS
APPENDIX II	BOREHOLE LOGS AND PIEZOMETER COMPLETION DETAILS
APPENDIX III	HYDRAULIC CONDUCTIVITY TEST DATA AND ANALYSES
APPENDIX IV	LABORATORY REPORTS

APPENDIX V B.C. MINISTRY OF ENVIRONMENT LAND AND PARKS WATER
NUMERICAL CRITERIA

#### EXECUTIVE SUMMARY

#### Introduction

Piteau Engineering Ltd. (PEL) was retained by Manalta Coal Ltd. (Manalta) to conduct a series of geotechnical and hydrogeological investigations in support of the proposed Telkwa Coal Project near Telkwa, B.C. The work program for this investigation was designed to address a number of engineering and environmental considerations required to evaluate the suitability of the proposed site for tailings pond construction.

#### Program Overview

Nine sites were drilled under the supervision of PEL personnel within the tailings pond area while another eleven sites were drilled under the supervision of Manalta personnel. Boreholes were typically advanced to 20 m depth or the bedrock surface. At key locations where the depth to bedrock exceeded 20 m, boreholes were continued to bedrock to improve understanding of subsurface conditions. These sites were well distributed throughout the tailings pond area and provide good lateral site coverage.

Soil samples for geotechnical tests were obtained from testholes at selected intervals using both split spoon and Shelby tube samplers. Where split spoon samples were obtained, a standard penetration test (recording of blow counts per unit length) was also conducted. The unconfined compressive strength of split spoon samples was measured in the field using a pocket penetrometer. Shelby tube samples were sealed with tape and were used for laboratory tests as required.

Double piezometer nests were installed at three locations. The upper piezometer was completed (screened) across the water table or inferred water table, while the lower piezometer was completed in the next potential groundwater bearing zone. The installation of double piezometer nests allows for the determination of vertical hydraulic gradients. After installation, all piezometers containing groundwater were developed using an air-lift technique. Where possible, single well response or "bail" tests were subsequently performed to determine hydraulic conductivity and samples were then collected for groundwater chemical analyses.

#### Surficial Geology

Surficial geological conditions were evaluated based on airphoto interpretations and borehole drilling. Within the tailings pond area, distinct upper and lower stratigraphic units were identified. The lower unit exhibits a high degree of lateral variability, ranging from coarse grained outwash sands and gravels to fine grained glacio-lacustrine silts and clays. Distribution of the lower unit is interpreted to be controlled by bedrock topography. The lower unit is encountered within the northern portion of the tailings pond area where the depth to bedrock exceeds approximately 20 m.

The upper unit is a lower permeability sand and silt till which is continuous beneath most of the tailings pond area. The upper surficial unit consists of 12 - 20 m of sand and silt till, overlain by up to 2.5 m of fine grained clayey silt deposits. The till is medium to dark brown and contains

some to little clay ( $\sim 20\%$ ) and gravel. The overlying glacio-lacustrine sediments grade from pure silt in the south to clayey silt in the north.

A localized sand and gravel deposit, extending from surface to 9.5 m below ground surface was encountered within the west-central portion of the proposed tailings pond area. The sand and gravel unit occurs within a topographic low and is incised into the till and clay deposits which otherwise blanket the proposed tailings pond area. The deposit appears to follow the course of a northwest trending intermittent stream which drains into the local resident's dugout pond. Because of the inferred localized nature of the sand and gravel deposit, potential seepage through this unit can be easily mitigated as discussed below.

#### **Bedrock Geology**

The upper 10 m of bedrock comprises an interbedded sequence of dark gray mudstone, siltstone and sandstone. The bedrock surface dips to the north, at an estimated angle of approximately six degrees. At the south end of the tailings pond area, the depth to bedrock ranges from 12 m - 17.6 m below ground; near the north end of the tailings pond area, depth to bedrock is greater than 42.5 m below ground.

#### **Hydrogeology**

#### Groundwater Flow

Depth to groundwater in the surficial groundwater bearing zone ranges from 0.4 m to > 42.5 m below ground surface. Variations in groundwater surface elevations are interpreted to be controlled by the elevation of the bedrock surface, the occurrence of sand and gravel deposits in the lower surficial unit, and the elevation of adjacent valleys (which act as local drainage areas).

Groundwater flow within the surficial deposits is generally expected to follow topography in a north/northwest direction at a rate estimated to be less than 10 m/year. Groundwater flow patterns within bedrock are also expected to be in the same direction towards the Telkwa River. An upward vertical hydraulic gradient was measured at one of the piezometer nests. At this location, flowing artesian conditions occur; based on visual observations, the flow rate is estimated to be less than approximately 4 L/min. It was not possible to establish vertical hydraulic gradients at the other two piezometer nests as they were dry at the time of measurement.

Based on one single well response test, the in-situ hydraulic conductivity of the till was estimated to be approximately  $6.5 \times 10^{-9}$  m/s. The hydraulic conductivity of the underlying gravel/mudstone was estimated from one single well response test to be  $8.2 \times 10^{-7}$  m/s. Results of laboratory permeameter tests on till samples yielded a hydraulic conductivity of approximately  $7.0 \times 10^{-10}$  m/s (depth interval 0.50 - 0.95 m) and  $4.0 \times 10^{-11}$  m/s (depth interval 6.20 - 6.65 m).

#### Groundwater Quality

Groundwater temperatures were in the range of 6.5 to 7.3°C. Groundwater pH was in the range of 7.44 - 7.50, with electrical conductivities in the range of 734 to 1,090 µS/cm. Groundwater analyses from the two piezometers may be characterized as a sodium-bicarbonate hydrochemical type. The dominance of the sodium cation suggests groundwater with a relatively long subsurface residence time and/or natural softening by cation exchange. Concentrations of total dissolved solids (TDS) were in the range of 460 - 688 mg/L.

The B.C. Ministry of Environment Land and Parks water quality criteria for freshwater aquatic life were used to appraise results for select indicator parameters and metals. Concentrations of the indicator parameters sulphate, chloride, TDS, and nitrogen species in groundwater were below the freshwater aquatic life criteria.

Total metals measured at concentrations above the recommended criteria were cadmium (total and dissolved), chromium, copper, lead, zinc, aluminum, iron, and manganese. Chemical results from the first sampling event may not be representative of actual groundwater conditions due to the likelihood of high levels of suspended solids occurring within the sand pack following piezometer installation. Laboratory results from a second sampling event are expected to provide a better indication of metal concentrations in groundwater.

#### Preliminary Seepage Analysis

Neglecting the northwest portion of the proposed tailings pond area underlain by sand and gravel, the seepage rate through the remaining tailings pond area (~ 1.20 km²) is estimated to be in the order of 6 L/sec. Using assumed distributions for the factors that control seepage (i.e., hydraulic conductivity of the till and vertical hydraulic gradient between the tailings pond and underlying till), a statistical technique was also employed to estimate what the possible range of seepage values may be. From this analysis, seepage through the tailings pond is estimated to be in the range of approximately 0.1 - 22.5 L/sec.

Results from the preliminary seepage analysis suggest that the majority of the proposed tailings pond area, which is largely underlain by more than 10 m of low permeability till, would be suitable for tailings deposition. Potential high seepage rates through a limited sand and gravel deposit can be readily mitigated by constructing a low permeability subsurface cutoff wall.

# **Geotechnical Considerations**

#### Soil Properties

The clayer silt layer, which was noted in most boreholes varies in thickness from 0.8 to 3.1 m and extends to a maximum depth of 3.5 m below grade. The clayer silt is medium brown coloured, low plastic, firm to stiff in consistency and contains a trace of sand. Moisture content values are in the range of 25 to 26 percent. Corresponding average SPT blow count and undrained shear strength values are 10 blows/0.3 m and 0.75 kg/cm<sup>2</sup> respectively.

The till deposit consists predominantly of silt and sand. The till is medium brown coloured, low plastic, stiff to hard in consistency, and contains a little to some clay and gravel. Moisture content values are in the range of 8 to 11 percent and laboratory measured coefficient of permeability for the clayey silt is  $4 \times 10^{-7}$  m/s. The tills are generally classified as CL-ML, CL or ML-OL. SPT blow counts throughout the deposit ranged from 16 to 44, which is indicative of a stiff to hard deposit. Similarly, compressive strength values varied between 1.25 and 4.5 kg/cm² (125-450 kPa). Corresponding undrained shear strength values are 63 to 225 kPa (i.e., half the compressive strength values).

## Perimeter Dyke

The proposed 2.6 km of perimeter dykes are feasible from a geotechnical design stand point. The till and sand and gravel foundations will provide adequate support for the structure. However, it will be necessary to provide a seepage cut off or impervious blanket across the sand and gravel zone as discussed below.

The dykes would be constructed from earth materials, the bulk of which would be excavated from within the reservoir area. The most economic and effective design would probably entail a homogeneous till section, with upstream rock riprap as erosion protection, placed on sand and gravel transition zone material. An internal drainage layer of sand or sand and gravel would also be required. The till can be readily placed and compacted to a dense condition with a minimal amount of moisture conditioning required. Riprap would be obtained from a suitable rock quarry, or from mine rock waste, depending on its properties, particularly the resistance to breakdown from physico-chemical weathering processes. Some or all of the granular transition and filter materials may be obtained from the dam and reservoir area, depending on the material specifications and design requirements.

## Sand and Gravel Zone Cutoff

Although the sand and gravel deposit underlying a 200 m long section of the perimeter dyke will provide adequate foundation support, it will need to be sealed off to separate the reservoir water from groundwater. Based on the available drilling information, it should be feasible to excavate at relatively steep slopes (1.5 horizontal to vertical) down to the water table at a depth of approximately 4 m. For the remaining 5-6 m below the water table to the bottom of the deposit, a slurry cutoff wall is recommended.

An alternative to an excavated cutoff is to place a blanket of low permeability soil over the area of sand and gravel deposit which is exposed in the reservoir. The blanket would be constructed from till in compacted layers to a minimum thickness of 1 m. It would be covered with a 1 m thick layer of free dumped till to protect the blanket from desiccation and weathering effects.

# 1. INTRODUCTION

Piteau Engineering Ltd. (PEL) was retained by Manalta Coal Ltd. (Manalta) to conduct a series of geotechnical and hydrogeological investigations in support of the proposed Telkwa Coal Project near Telkwa, B.C. (Figure 1). This report presents results from the geotechnical and hydrogeological investigations within the proposed tailings pond area (Figure 2). It parallels additional studies by PEL involving: 1) an assessment of the engineering geology and geotechnical considerations at the Tenas Pit and waste dumps (PEL, 1997a), and 2) an investigation of baseline hydrogeological conditions at Tenas Pit, the waste dumps, and Pit 3 (PEL, 1997b).

The work program for this investigation was designed to address a number of engineering and environmental considerations required to evaluate the suitability of the proposed site for tailings pond construction. Field work was completed between July and September, 1996.

# 2. TAILINGS POND AREA

#### 2.1 PROGRAM OVERVIEW

Geotechnical and hydrogeological investigations were conducted within the proposed tailings pond area (Figure 3). Nine sites (denoted TOB96 series) were drilled by Cora Lynn Drilling Ltd. under the supervision of PEL personnel within the tailings pond area. Boreholes were typically advanced to 20 m depth or the bedrock surface. At key locations where the depth to bedrock exceeded 20 m, boreholes were continued to bedrock to improve understanding of subsurface conditions. Eleven sites (one denoted T79R and ten denoted T96R series) were drilled as coal exploration holes in the vicinity of the pond under the supervision of PEL personnel. Overall, borehole locations were well distributed throughout the tailings pond area and provide good lateral site coverage.

Soil samples for geotechnical tests were obtained from testholes at selected intervals using both split spoon and Shelby tube samplers. Where split spoon samples were obtained, a standard penetration test (recording of blow counts per unit length) was also conducted. The unconfined compressive strength of split spoon samples was measured in the field using a pocket penetrometer. Shelby tube samples were sealed with tape and were used for laboratory tests as required.

Double piezometer nests were installed at the following three locations within the proposed tailings pond area: at TOB96-07 (upgradient position), TOB96-10 and TOB96-14 (downgradient positions). The upper piezometer was completed (screened) across the water table or inferred water table, while the lower piezometer was completed in the next potential groundwater bearing zone. The installation of double piezometer nests allows for the determination of vertical hydraulic gradients.

After installation, all piezometers containing groundwater were developed using an air-lift technique. Where possible, single well response or "bail" tests were subsequently performed to determine hydraulic conductivity and samples were then collected for groundwater chemical analysis. Field protocols for these activities are discussed in Appendix I. Piezometer completion details are summarized in Table 1 and are illustrated on the logs in Appendix II. Summary information on the T79R and T96R series boreholes are presented in Table 2. Hydraulic conductivity test data and analyses are provided in Appendix III, while the laboratory reports are given in Appendix IV.

#### 2.2 SURFICIAL GEOLOGY

The surficial geology is discussed below based on airphoto interpretations (PEL, 1996) and borehole drilling. The geotechnical properties of the surficial deposits are discussed separately in Section 2.6.1.

Within the tailings pond area, the surficial geology comprises distinct upper and lower stratigraphic units. The lower unit exhibits a high degree of lateral variability, ranging from coarse-grained outwash sands and gravels to fine grained glacio-lacustrine silts and clays. Distribution of the lower unit is interpreted to be controlled by bedrock topography. The upper unit is a lower permeability sand and silt till which is continuous beneath most of the tailings pond area. The surficial geology of the tailings pond area is illustrated in cross-sections A-A', B-B', and C-C' on Figures 4 - 6, respectively.

#### Lower Surficial Unit

The lower unit is encountered within the northern portion of the tailings pond area where the depth to bedrock exceeds approximately 20 m. It consists of predominantly fine grained silts and clays likely deposited in a glacio-lacustrine environment. Basal clays (TOB96-10, Figure 5) are overlain by silty clay, with thin sand and gravel layers. North of TOB96-10 at T96R-151 (Figure 5), and within the northeastern portion of the tailings pond area at TOB96-14 (Figure 6), the lower surficial unit predominately consists of sand and gravel outwash or valley fill deposits.

Within the central portion of the tailings pond area (i.e., T96R-I12, TOB96-10, and TOB96-14), a gravel deposit marks the contact between the lower and upper surficial units. The gravel

deposit is absent in the southern end of the tailings pond area, but increases gradually to the north where it attains a thickness of approximately 10 m at TOB96-10 (Figure 5).

## Upper Surficial Unit

The upper surficial unit consists of 12 - 20 m of sand and silt till, overlain by up to 2.5 m of fine grained clayey silt deposits. The till is medium to dark brown and contains some to little clay (~20%) and gravel. The colour of the till becomes darker and clay percentage appears to increase with depth. The overlying glacio-lacustrine sediments grade from pure silt in the south to clayey silt in the north. The silt is medium brown, soft and varved (as observed in shelby tube samples).

A localized sand and gravel deposit, extending from surface to 9.5 m below ground surface was encountered at TOB96-06 (Figures 4 and 5). The sand and gravel unit occurs within a topographic low and is incised into the till and clay deposits which otherwise blanket the proposed tailings pond area. The deposit appears to follow the course of a northwest trending intermittent stream which drains into the local resident's dugout pond. Because of the inferred localized nature of the sand and gravel deposit, potential seepage through this unit can be easily mitigated. This is discussed further in Section 2.6.4.

#### 2.3 BEDROCK GEOLOGY

The upper 10 m of bedrock comprises an interbedded sequence of dark gray mudstone, siltstone and sandstone. The bedrock surface dips to the north, at an estimated angle of approximately six degrees (Figure 5). At the south end of the tailings pond area, the depth to bedrock ranges from 12 m (TOB96-16) - 17.6 m (TOB96-07). Near the north end of the tailings pond area, depth to bedrock exceeds 81 m at TOB96-10.

#### 2.4 HYDROGEOLOGICAL CONDITIONS

#### 2.4.1 GROUNDWATER FLOW

Key features of the hydrogeology beneath the proposed tailings pond area are summarized below based on Figures 4-6.

- the bedrock surface is interpreted to dip steeply to the north/northwest and consequently the thickness of surficial sediments overlying bedrock increases significantly in this direction;
- with the exception of the localized sand and gravel deposit in the northwest area (see below)
   the majority of the proposed tailings pond area is interpreted to be underlain by a low
   permeability till deposit which has a minimum thickness of 12 m;
- depth to groundwater in the surficial groundwater bearing zone ranges from 0.4 m (TOB96-07-10) to > 42.5 m below ground surface (TOB96-14-43). Variations in groundwater surface elevations are interpreted to be controlled by the elevation of the bedrock surface, the occurrence of sand and gravel deposits in the lower surficial unit, and the elevation of adjacent valleys which act as local drainage areas; and,
- at TOB96-07-20 (completed across the till/mudstone bedrock contact) flowing artesian conditions occur; based on visual observations, the flow rate is estimated to be less than approximately 4 L/min.

Although there is insufficient information to contour groundwater surface elevations (four of the six piezometers completed in the surficial sediments were dry at the time of measurement) and thus to determine horizontal hydraulic gradients and groundwater flow velocities, groundwater flow within the upper surficial deposits is generally expected to follow topography in a north/northwest direction at a rate estimated to be less than 10 m/year. Groundwater flow patterns within bedrock are also expected to be in the same direction towards the Telkwa River.

Upward vertical hydraulic gradients were measured at piezometer nest TOB96-07-10/20. It was not possible to establish vertical hydraulic gradients at the other piezometer nest sites (*i.e.*, TOB96-10-11/28 and TOB96-14-10/43) as they were dry at the time of measurement.

Based on one single well response test (TOB96-07-10), the in-situ hydraulic conductivity of the till was estimated to be approximately  $6.5 \times 10^{-9}$  m/s (Table 1). The hydraulic conductivity of the underlying gravel/mudstone was estimated from one single well response test (TOB96-07-20) to be  $8.2 \times 10^{-7}$  m/s.

Results of laboratory permeameter tests on till samples from TOB96-09 (Table 3) yielded a hydraulic conductivity of 7 x  $10^{-10}$  m/s (depth interval 0.5 - 0.95 m) and 4 x  $10^{-11}$  m/s (depth interval 6.2 - 6.65 m.

#### 2.4.2 GROUNDWATER QUALITY

#### Field Measured Parameters

Measurements of sensitive water quality parameters (i.e., temperature, pH, and electrical conductivity) were conducted during the field sampling program and are summarized on Table 4. Groundwater temperatures were in the range of 6.5 to 7.3°C. Groundwater pH was in the range of 7.44 - 7.50, with electrical conductivities in the range of 734 to 1,090 μS/cm.

#### Laboratory Analysis

Key results from the analyses are presented on Tables 5 and 6. The original laboratory and quality assurance/quality control (QA/QC) data sheets are provided in Appendix IV.

The hydrochemical nature of the groundwater samples was characterized on an expanded Durov diagram (Figure 7). This diagram allows a simple, concise graphical representation of the water analyses. Analytical data are plotted according to the relative proportions of the major cations (i.e., calcium, magnesium, and sodium + potassium) and major anions (i.e., bicarbonate, sulphate, and chloride), expressed as milliequivalents per litre (meq/L). Depending on the dominant cation(s) and anion(s), various hydrochemical water types can be identified.

Recently recharged groundwater is usually a calcium-bicarbonate type, plotting in the upper left-hand square of the Durov diagram. Natural softening by cation exchange (i.e., sodium for calcium) can occur with increased residence time. This type of groundwater plots in the upper right-hand square of the diagram. Groundwater characterized by relatively long residence time is commonly of a sodium-chloride type, which plots in the lower right-hand square.

As shown on Figure 7, groundwater analyses from the two piezometers completed in the upper surficial units can be characterized as a sodium-bicarbonate hydrochemical type. The dominance of the sodium cation suggests groundwater with a relatively long subsurface residence time and/or natural softening by cation exchange. Concentrations of total dissolved solids (TDS) were in the range of 460 - 688 mg/L.

## **Indicator Parameters**

Water quality standards as specified by the B.C. Ministry of Environment Land and Parks for freshwater aquatic life (Appendix V) were used to assess results for select indicator parameters and metals.

Concentrations of indicator parameters sulphate, chloride, TDS and nitrogen species, together with the applicable water quality criteria are presented in Table 5. Concentrations of the indicator parameters in groundwater were all below the freshwater aquatic life criteria.

#### **Metals**

Concentrations of metals, together with the B.C. freshwater aquatic life criteria are presented in Table 6. Metals measured at concentrations (total) above the recommended criteria were as follows:

Piezometer	Metals Above Freshwater Aquatic Life Criteria (1)
TOB96-07-10	cadmium (total and dissolved), copper, lead, zinc, aluminum, iron, and
:	manganese
TOB96-07-20	cadmium, chromium, copper, zinc, aluminum, iron, and manganese
(includes dup.)	

#### NOTES:

Chemical results from the first sampling event may not be representative of actual groundwater conditions due to the likelihood of high levels of suspended solids occurring within the sand pack following piezometer installation. Laboratory results from a second sampling event are expected to provide a better indication of metal concentrations in groundwater.

In addition to the standard laboratory QA/QC procedures (see Appendix IV), a field blank and a duplicate sample from TOB96-07-20 were submitted for analysis. Concentrations of all indicator parameters and metals were below the laboratory detection limits for the field blank. With the exception of certain total metal concentrations, analytical results from TOB96-07-20 were within 20% of the duplicate sample. Overall, the QA/QC results are considered satisfactory.

#### 2.5 PRELIMINARY SEEPAGE ANALYSIS

One of the key considerations in the assessment of the proposed tailings pond area is the amount of seepage (i.e., volume per unit time) that may occur through the native soils. The seepage analysis was carried out using Darcy's Law as given by:

<sup>(1)</sup> Based on B.C. Ministry of Environment Land and Parks Water Numerical Criteria (see Appendix V).

## Q = K i A

where "Q" is the seepage rate [L³/T], "i" is the vertical hydraulic gradient between the tailings pond and the underlying native soil [L/L], "K" is the hydraulic conductivity of the underlying native soil [L/T] and "A" is the surface area of the proposed tailings pond [L²]. Results from the preliminary seepage analysis are summarized below based on an assumed vertical hydraulic gradient of 0.5. It is noted that no allowance is made for the potential sealing effect of the deposited tailings.

POND SECTOR	APPROXIMATE  AREA  (km²)	HYDRAULIC CONDUCTIVITY (m/s)	ESTIMATED SEEPAGE RATE (L/sec)
Northwest portion	0.05	1 x 10 <sup>-5</sup>	250
(underlain by sand and gravel)			
Western, Eastern, and Northern	1.20	1 x 10 <sup>-8</sup>	6
portions (i.e., remaining area)			

#### Notes:

- 1. Pond sector areas are approximate.
- Hydraulic conductivity of the northwest portion (sand and gravel) assumed based on literature values (Freeze and Cherry, 1979).
- Hydraulic conductivity of the till in the western, eastern, and northern portions of the tailings pond assumed to be ~ 0.5 order of magnitude greater than the value determined from the single well response test at TOB96-07-10.

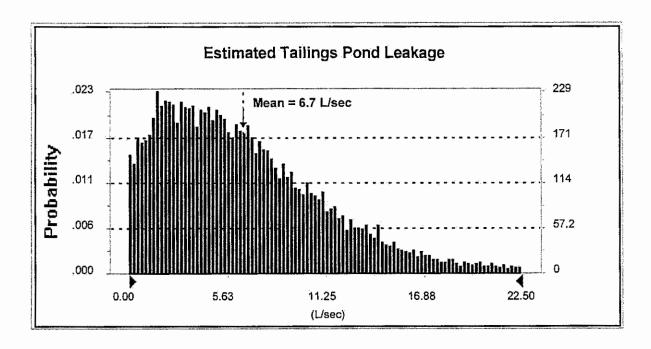
A very high seepage rate is estimated in the northwest portion of the tailings pond. The rate reflects the assumed high hydraulic conductivity of the sand and gravel sediments encountered at TOB96-06. Although the area extent of the sand and gravel deposits have not been determined, they are interpreted to be associated with the intermittent stream that traverses through the

northwest portion of the proposed tailings pond. Therefore, for calculation purposes, the deposits were assumed to occur within the area outlined by the 600 metres above sea level (masl) contour (~0.05 km² - see Figure 3).

Neglecting the northwest portion of the proposed tailings pond area, the estimated seepage rate over the remaining area of the tailings pond (~ 1.20 km²) is in the order of 6 L/sec. (This value is less than the total maximum tailings pond seepage of 13.5 L/s estimated for the Telkwa north pond site, located north of the Telkwa River (PEL, 1994). Expressed another way, the leakage rate is equivalent to a water level decline of 0.16 m/year in the tailings pond.

It should be noted that the above analysis is based on a small number of hydraulic conductivity values determined either in the field (i.e., single well response tests) or in the laboratory (i.e., permeameter tests). While these values are considered to be realistic based on lithology, local variations in hydraulic conductivities may occur. Thus, to provide an estimate of what the potential range of seepage rates may be within the tailings pond (excluding the northwest sector underlain by sand and gravel), a risk analysis program (CRYSTAL BALL, V4.0a, Decisioneering Inc., 1996) was used.

Using assumed distributions for the factors that control seepage (i.e., hydraulic conductivity of the till and vertical hydraulic gradient between the tailings pond and underlying till), a statistical technique was employed to estimate what the possible range of tailings pond seepage may be. Output from this analysis is presented below.



Given an assumed distribution for the hydraulic conductivity of the till (i.e., log normal distribution with a mean of  $1.0 \times 10^{-8}$  m/s and a standard deviation of  $1.0 \times 10^{-8}$  m/s) and vertical hydraulic gradient (i.e., varying between 0.3 and 0.8), seepage through the tailings pond is estimated to be in the range of approximately 0.1 - 22.5 L/sec. The maximum seepage rate is considered conservative as it is expected that, over time, the effect of fine tailings deposition in the pond would be to reduce seepage rates.

Results from the preliminary seepage analysis suggest that the majority of the proposed tailings pond area, which is largely underlain by more than 10 m of low permeability till, would be suitable for tailings deposition. Potential high seepage rates through a limited sand and gravel deposit can be readily mitigated by constructing a low permeability subsurface cutoff wall (see Section 2.6.4).

#### 2.6 GEOTECHNICAL CONSIDERATIONS

#### 2.6.1 SOIL PROPERTIES

Foundation conditions in the area of the proposed tailings pond are presented on borehole logs provided in Appendix II. These logs were prepared based on soil samples visually classified

according to the Unified Soil Classification (USC) system. Moisture content, Atterberg limits, grain size distribution, and permeability were determined in the laboratory on selected soil samples. These results are summarized in Table 3. Shear strength values were obtained from pocket penetrometer measurements to assess the stiffness of the deposit.

As noted in Section 2.2, the soil profile consists of a clayey silt layer underlain by a till, gravel or sand and gravel and mudstone/siltstone bedrock. The geotechnical characteristics of each unit are described below.

The clayey silt layer, which was noted in all boreholes with the exception of TOB96-05 and TOB96-16, varies in thickness from 0.8 to 3.1 m and extends to a maximum depth of 3.5 m below grade. The clayey silt is medium brown coloured, low plastic, firm to stiff in consistency and contains a trace to little sand. Coefficient of permeability of the clayey silt is in the order of  $7x10^{-10}$  m/s. Encountered in the clayey silt deposit are areas of iron oxide straining, carbonaceous material in the form of coal fragments, calcareous deposits and occasional rootlets. Moisture contents values are in the range of 25 to 26 percent. Corresponding average SPT blow count and undrained shear strength values are 10 blows/0.3 m and 0.75 kg/cm² respectively.

The till deposit consists predominantly of silt and sand. The till is medium brown coloured, low plastic, stiff to hard in consistency, and contains a little to some clay and gravel. Noted in the till deposit are areas of iron oxide staining, calcareous deposits, carbonaceous materials in the form of coal fragments, siltstone fragments, and occasional sand stringers. Moisture content values are in the range of 8 to 11 percent and laboratory measured coefficient of permeability for the clayey silt is  $4 \times 10^{-7}$  m/s. The tills are generally classified as CL-ML, CL or ML-OL (i.e., low plastic inorganic silts or clays), as shown in Figure 8.

Profiles of moisture content, SPT blow count and compressive strength (pocket penetrometer) against depth are provided in Figures 9 to 11 respectively. As indicated on Figure 10, SPT blow counts throughout the deposit ranged from 16 to 44, which is indicative of a stiff to hard deposit. Similarly, compressive strength values (Figure 11) varied between 1.25 and 4.5 kg/cm<sup>2</sup> (125-450)

kPa). Corresponding undrained shear strength values are 63 to 225 kPa (i.e., half the compressive strength values).

The geologic units encountered beneath the glacial till deposit varied between boreholes. Geotechnical information on these deposits is limited to visual description and overall thickness as detailed in the borehole logs (Appendix II).

#### 2.6.2 PERIMETER DYKE

The proposed 2.6 km of perimeter dykes are feasible from a geotechnical design stand point. The till and sand and gravel foundations will provide adequate support for the structure. However, it will be necessary to provide a seepage cut off or impervious blanket across the sand and gravel zone as discussed below.

#### 2.6.3 Construction Materials

The dykes would be constructed from earth materials, the bulk of which would be excavated from within the reservoir area. The most economic and effective design would probably entail a homogeneous till section, with upstream rock riprap as erosion protection, placed on sand and gravel transition material. An internal drainage layer of sand or sand and gravel would also be required. The till could be readily placed and compacted to a dense condition with a minimal amount of moisture conditioning required.

Riprap would be obtained from a suitable rock quarry, or from mine rock waste, depending on its properties, particularly the resistance to breakdown from physico-chemical weathering processes. Some or all of the granular transition and filter materials may be obtained from the dyke and reservoir area, depending on the material specifications and design requirements.

#### 2.6.4 SAND AND GRAVEL ZONE CUTOFF

Although the sand and gravel deposit underlying a 200 m long section of the perimeter dyke will provide adequate foundation support, it will need to be sealed off to separate the reservoir water from groundwater. Based on the available drilling information, it should be feasible to excavate

at relatively steep slopes (1.5 horizontal to vertical) down to the water table at a depth of approximately 4 m. For the remaining 5-6 m below the water table to the bottom of the deposit, a slurry cutoff wall is recommended.

The trench may be excavated through the sand and gravel with a backhoe. A soil-bentonite slurry would retain the trench walls at a near vertical angle. Following excavation, the slurry would be displaced by a well graded, low permeability soil, most likely till material from the adjacent area. Above the cutoff trench, the cutoff would be completed by placing layers of low permeability compacted till. The cutoff would be integral with the core of the overlying dyke, which would also be constructed in the same manner from till borrow material, as described above.

An alternative to an excavated cutoff is to place a blanket of low permeability soil over the area of sand and gravel deposit which is exposed in the reservoir. The blanket would be constructed from till in compacted layers to a minimum thickness of 1 m. It would be covered with a 1 m thick layer of free dumped till to protect the blanket from desiccation and weathering effects.

# 3. CONCLUSIONS

- The site proposed for disposal of mine tailings appears to be satisfactory from both hydrogeological and geotechnical stability perspectives. The till deposit underlying the majority of the site offers a natural low permeability containment medium. The geotechnical properties of the till are also suitable both for foundation support and for use in dam construction.
- 2. The surficial geology of the tailings pond area comprises distinct upper and lower units. The upper surficial unit underlies the majority of the tailings pond area and consists of 12 m to 20 m of sand and silt till, overlain by up to 2.5 m of fine grained clayey silt deposits. The in-situ hydraulic conductivity of the till was estimated to be approximately 6.5 x 10<sup>-9</sup> m/s. (TOB96-07-10). Results of permeameter tests yielded hydraulic conductivity values of approximately two orders of magnitude lower than determined from the in-situ test.
- 3. The depth to groundwater in the surficial groundwater bearing zone ranges from 0.4 m (TOB96-07-10) to > 42.5 m (TOB96-14-43). Variations in groundwater surface elevations are interpreted to be controlled by the elevation of the bedrock surface, the occurrence of sand and gravel deposits in the lower surficial unit, and the elevation of adjacent valleys (which act as local drainage areas). Groundwater flow within the upper surficial deposits is generally expected to follow topography in a north/northwest direction at a rate estimated to be less than 10 m/year. Groundwater flow patterns within bedrock are also expected to be in the same direction towards the Telkwa River.
- 4. An upward vertical hydraulic gradient was measured at piezometer nest TOB96-7-10/20. At this location, flowing artesian conditions occur; based on visual observations, the flow rate is estimated to be less than approximately 4l/min. It was not possible to establish vertical hydraulic gradients at the other piezometer nest sites (i.e., TOB96-10-11/28 and TOB96-14-10/43) as they were dry at the time of measurement

- 5. Given an assumed distribution for the hydraulic conductivity of the till and vertical hydraulic gradient, the initial rate of seepage through the tailings pond is estimated to be in the range of approximately 0.1 22.5 L/sec. The maximum seepage rate is considered conservative as it is expected that, over time, the effect of fine tailings deposition in the pond would be to reduce seepage rates.
- 6. The localized sand and gravel deposit at TOB96-06, extending from surface to 9.5 m below ground surface could be hydraulically isolated from the tailings pond utilizing either a cutoff trench or a low permeability soil blanket.
- 7. Groundwater analyses from the two piezometers completed in the upper surficial units can be characterized as a sodium-bicarbonate hydrochemical type. Dominance of the sodium cation suggests groundwater with a relatively long residence time and/or natural softening by cation exchange. Concentrations of all indicator parameters were below the B.C. Ministry of Environment Land and Parks freshwater aquatic life criteria.
- 8. Total concentrations of cadmium (total and dissolved), chromium, copper, lead, zinc, aluminum, iron, and manganese were above the freshwater aquatic life criteria at TOB96-07-10 and TOB96-07-20. As results are based on the first sampling event, they may not be representative of actual groundwater conditions due to the high levels of total suspended solids occurring within the sand pack. Subsequent sampling programs will provide a better indication of groundwater chemistry.

# 4. RECOMMENDATIONS

- The lateral extent and thickness of the sand and gravel deposit at TOB96-06 should be confirmed using a combination of geophysics surveys and borehole drilling. Based on these findings, the most cost effective approach to hydraulically isolate the deposits from the tailings pond should be identified.
- Although the investigation program covered the general area of the proposed reservoir, additional delineation soil probing and/or geophysical investigation is warranted in the detailed engineering phase to confirm the continuity and thickness of the till and the limits of the sand and gravel deposit (s).

# 5. ACKNOWLEDGMENTS

The cooperation and assistance of project personnel from Manalta Coal Ltd. throughout the study is acknowledged and appreciated. Particular thanks are extended to Mr. A. Vanderputten and to Mr. A. Ledda.

Respectfully Submitted,

PITEAU ENGINEERING LTD.

Tadeusz L. Dabrowski, P.Eng. (Alta.)

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Frederic B. Claridge, P.Eng.

Robert S. Clarkson, P.Geol. (Alta.)

Michael L. Brewster, P.Geol. (Alta.)

PEL Engineering Ltd. (3773-12)

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PIEZOMETER INSTALLATION DETAILS, DATUM/
GROUNDWATER SURFACE ELEVATIONS AND HYDRAULIC CONDUCTIVITIES

PIEZO. NO.	NORTHING	EASTING	GROUND ELEVATION	STICK-UP PVC PIPE (above ground - approx.)	DATUM ELEVATION (top of PVC casing)	TOTAL DEPTH OF PIEZO. (below ground)	SCREEN INTERVAL (below ground)	DATE	DEPTH TO WATER BELOW DATUM	GROUNDWATER SURFACE ELEVATION	HYDRAULIC CONDUCTIVITY	LITHOLOGY
			(masl)	(m)	(masl)	(m)	(m)	(y/m/d)	(m)	(masl)	(m/s)	
Tailings Pond												
TOB96-07-10	6057178	622256	613.28	0.65	613.93	10.4	7.4 - 10.4	96-Sep-18	1.08	612.85	6.5 x 10 <sup>-9</sup>	Silty clay till
TOB96-07-20	6057178	622256	613.28	0.65	613.93	19.7	16.6 - 19.6	96-Sep-18	flowing	>613.93	8.2 x 10 <sup>-7</sup>	Gravel / mudstor
TOB96-10-11	6057833	621877	605.02	0.65	605.67	10.5	7.5 - 10.5	96-Sep-18	dry	<605.67	N/A	Silty clay till
TOB96-10-28	6057833	621877	605.02	0.65	605.67	27.5	24.5 - 27.5	96-Sep-18	drý	<605.67	N/A	Sand & gravel
TOB96-14-10	6057804	622501	604.39	0.38	604.77	10.2	7.2 - 1.0.2	96-Sep-18	dry	<604:77	N/A	Silty clay till
TOB96-14-43	6057804	622501	604.39	0.38	604.77	42.5	41.0 - 42.5	96-Sep-18	dry	<604.77	N/A	Sand & gravel

#### NOTES:

- 1. masi metres above sea level.
- 2. NA not analyzed.
- 3. Borehole logs and piezometer completion details provided in Appendix II.

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	EASTING TOTAL DEPTH OF BOREHOLE	TOTAL DEPTH OF BOREHOLE	INTER	RVAL	LITHOLOGY
			(below ground, m)	From (m)	To (m)	
ailings Pond						
TOB96-05	6057406	621498	20.0	0.0	13.0	sand,silt,till
				13.0	20.0	silt (gravel)
TOB96-06	6057562	621644	10.0	0.0	9.5	sand,gravel
			•	9.5	10.0	till
TOB96-08	6057435	622515	19.0	0.0	1.0	silty clay
				1.0	8.0	sand,silt,till
				8.0	17.0	silt,gravel seams
				17.0	19.0	siltstone
TOB96-09	6057636	622296	20.0	0.0	1.9	clayey silt
				1.9	20.0	sand,silt,till
TOB96-15	6057406	622236	17.5	0.0	3.2	silty clay
				3.2	5.0	sand,gravel
				5.0	16.0	sand,silt,till
				16.0	16.5	gravel
				16.5	17.5	siltstone
TOB96-16	6057145	617700	13.5	0.0	2.0	silt
				2.0	2.5	sand
				2.5	10.0	sand,silt,till
				10.0	12.0	clay,silt,tiil
				12.0	13.5	siltstone
T79R-04	6057509	621492	71.3	N/A	N/A	N/A

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	EASTING	TOTAL DEPTH OF BOREHOLE	INTEF	RVAL	LITHOLOGY
5,1122.1022			(below ground, m)	From (m)	To (m)	
ailings Pond	111317					
T96R-104	6056245	622320	76.0	0.0	5.0	overburden
10011 107			•	5.0	19.8	mudstone
				19.8	27.0	siltstone
				27.0	28.5	sandstone
				28.5	31.0	mudstone
				31,0	38.0	siltstone
				38.0	44.0	mudstone
				44.0	47.8	siltstone
				47.8	61 <i>.</i> 7	mudstone
				61.7	61.8	coal
				61.8	62.1	mudstone
				62.1	62.3	coal
				62.3	62.6	mudstone
				62.6	64.2	coal
				64.2	64.4	mudstone
				64.4	65.6	coal
				65.6	69.0	conglomerate
				69.0	70.4	mudstone
				70.4	70.8	coal
				70.8	71.0	mudstone
				71.0	71.3	coal
				71.3	78.9	siltstone
				78.9	84.6	sandstone
				84.6	91.3	mudstone
				91.3	97.0	sandstone
				97.0	101,1	siltstone

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	<b>EASTING</b>	TOTAL DEPTH OF BOREHOLE	INTER	RVAL	LITHOLOGY
			(below ground, m)	From (m)	To (m)	
ailings Pond				-		
T96R-104 (CON'T)				101.1	102.5	mudstone
1001, 101 (0011 1)				102.5	102.9	coal
				102.9	104.0	mudstone
				104.0	116.0	conglomerate
		·		116.0	122.0	sandstone
T96R-106	6056577	622290	135.1	0.0	5.0	overburden
13011-100	0000011	OZZZOO	100.1	5.0	9.2	mudstone
				9.2	22.3	siltstone
				22.3	34.1	sandstone
				34.1	41.5	siltstone
				41.5	48.6	mudstone
				48.6	63.2	sandstone
				63.2	67.4	siltstone
				67.4	67.8	coal
				67.8	68.8	mudstone
				68.8	69. <b>1</b>	coal
				69.1	70.5	mudstone
				70.5	75.9	siltstone
				75.9	79.1	conglomerate
				79.1	86.2	mudstone
				86.2	86.8	coal
				86.8	87.0	mudstone
				87.0	87.2	coal
				87.2	88.2	mudstone
				88.2	88.7	coal
				88.7	91.0	mudstone
				91.0	91.3	coal

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	EASTING	TOTAL DEPTH OF BOREHOLE	INTER	RVAL	LITHOLOGY
			(below ground, m)	From (m)	To (m)	
Tailings Pond						
T96R-106 (CON'T)				91.3	91.7	mudstone
				91.7	91.9	coal
				91.9	92.4	mudstone
				92.4	92.7	coal
			•	92.7	92.9	mudstone
				92.9	94.0	coal
				94.0	94.3	mudstone
				94.3	95.4	coal
				95.4	98.0	sandstone
				98.0	99.6	mudstone
				99.6	99.8	coal
				99.8	100.1	mudstone
				100.1	101.1	coal
				101.1	101.3	mudstone
				101.3	101.6	coal
				101.6	105.0	mudstone
				105.0	105.3	coal
				105.3	105.7	mudstone
				105.7	107.1	coal
				107.1	107.4	mudstone
				107.4	107.7	coal
				107.7	108.6	mudstone
				108.6	109.2	coal
				109.2	116.9	siltstone
				116.9	123.0	conglomerate
				123.0	130.5	sandstone
				130.5	133.0	conglomerate
				133.0	140.0	mudstone

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	<b>EASTING</b>	TOTAL DEPTH OF BOREHOLE	INTER	RVAL	LITHOLOGY
			(below ground, m)	From (m)	To (m)	
ilings Pond						
T96R-107	6056619	622141	86.0	0.0	4.0	overburden
				4.0	6.7	sandstone
				6.7	7.0	coal
			•	7.0	7.9	mudstone
				7.9	8.3	coal
				8.3	9.3	mudstone
				9.3	9.6	coal
				9.6	11.0	mudstone
				11.0	18.0	sandstone
				18,0	21.2	mudstone
				21.2	34.2	sandstone
				34.2	39.0	siltstone
				39.0	39.3	coal
				39.3	45.0	mudstone
				45.0	50.2	sandstone
				50.2	60.4	mudstone
				60.4	61.0	coal
				61.0	61.1	mudstone
				61.1	61.3	coal
				61.3	61.7	mudstone
				61.7	61.8	coal
				61.8	64.5	mudstone
				64.5	64.7	coal
				64,7	65.0	mudstone
				65.0	65.2	coal
				65.2	65.5	mudstone
				65.5	65.9	coal
				65.9	66.7	mudstone

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	EASTING	TOTAL DEPTH OF BOREHOLE (below ground, m)	INTERVAL		LITHOLOGY
				From (m)	To (m)	
Tailings Pond						
T96R-107 (CON'T)				66.7	66.9	coal
				66.9	67.2	mudstone
				67.2	67.5	coal
				67.5	67.7	mudstone
				67.7	68.1	coal
				68.1	<b>6</b> 8.2	mudston <b>e</b>
				68:2	69.4	coal
				69.4	69.7	mudstone
				69.7	70.3	coal
				70.3	72.3	sandstone
				72.3	72.7	coal
				72.7	72.8	mudstone
				72.8	73.1	coal
				73.1	73.6	mudstone
				73.6	73.8	coal
				73.8	76.2	mudstone
				76.2	81,2	siltstone
				81.2	81.6	coal
				81.6	81.7	mudstone
				81.7	82.1	coal
				82.1	85.6	mudstone
				85.6	89.3	siltstone
				89.3	100.4	sandstone
				100.4	100.8	coal
				100.8	116.1	siltstone

TABLE 2
BOREHOLE SUMMARY INFORMATION

DRILLHOLE	NORTHING	EASTING	TOTAL DEPTH OF BOREHOLE (below ground, m)	INTERVAL		LITHOLOGY
				From (m)	To (m)	
ailings Pond						
T96R-108	6056569	621978	120.2	N/A	N/A	N/A
T96R-109	6056588	621653	65 <b>.0</b>	N/A	N/A	N/A
T96R-112	6057637	621875	64.0	N/A	N/A	N/A
T96R-116	6057088	621362	25.0	N/A	N/A	N/A
T96R-145	6057117	622529	91.1	N/A	N/A	N/A
T96R-146	6056893	621621	94.0	N/A	N/A	N/A
T96R-151	6058251	621876	39.0	N/A	N/A	N/A

#### **NOTES:**

- 1. TOB96 series boreholes drilled under the supervision of Piteau Engineering Ltd.
- 2. T96R series boreholes drilled under the supervision of Manalta coal Ltd.
- 3. Borehole logs for TOB96 series boreholes provided in Appendix II.
- 4. N/A Borehole log information not available.

TABLE 3
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

Borehole	Depth	Moisture	Liquid Limit	Plastic Limit	Plasticity Index	Grai	n Size D	istribut	ion	Activity	*K value
	(m)	Content (%)				Gravel	Sand	Silt	Clay	P.I./% Clay	(m/sec)
Tailings Pond TOB96-09	0.5-0.95	25.5	28,5	23.5	5	0	0.9	83.4	15.7	0.32	7 x 10 <sup>-10</sup>
TOB96-09	0.9-1.3	25	30	24.9	5.1	0.4	3.5	73.4	22.7	0.23	N/A
TOB96-09	2.0-2.45	8.8	22	15.2	6.8	N/A	N/A	N/A	N/A	Ņ/A	N/A
TOB96-09	4.0-4.45	12.6	28	15	13	16.4	34.7	30.7	18.2	0.71	N/A
TOB96-09	6.2-6.65	11	27	13.7	13.3	N/A	N/A	N/A	N/A	N/A	4 x 10 <sup>-11</sup>
TOB96-09	10.5-10.95	. <del>1</del> 1	27.7	15.6	12.1	14.7	35	29.3	.21	0.58	N/A

#### Notes:

<sup>1. \*</sup> Permeability tests conducted on remoulded samples consolidated to present overburden stress.

<sup>2.</sup> N/A not analyzed.

TABLE 4
FIELD MEASURED PARAMETERS

WELL NUMBER	DATE	TEMPERATURE	ELECTRICAL CONDUCTIVITY	рН	REMARKS
	( y-m-d )	(°C)	(µS/cm)		
Tailings Pond					
TOB96-07-10	96-Sep-18	6.5	734	7.44	
TOB96-07-20	96-Sep-18	7.3	1,090	7.50	
TOB96-10-11	96-Sep-18	N/A	N/A	N/A	Dry <sup>-</sup>
TOB96-10-28	96-Sep-18	N/A	N/A	N/A	Dry
TOB96-14-10	96-Sep-18	Ń/A	N/A	N/A	Dry
TOB96-14-43	96-Sep-18	N/A	N/A	N/A	Dry

NOTES:

<sup>1.</sup> N/A - not analyzed.

3773-12

# TABLE 5 GROUNDWATER QUALITY INDICATOR PARAMETERS

Location	Sample Date	Sulphate (mg/L)	Chloride (mg/L)	TDS (mg/L)	TDS-calculated (mg/L)	Tot. Amm. (as N) (mg/L)	NO <sub>2</sub> +NO <sub>3</sub> (as N) (mg/L)
Tailings Pond							
TOB96-07-10	96-Sep-18	52.1	13.1	460	427	0.17	0.902
TOB96-07-20	96-Sep-18	16.3	29.2	688	676	0.5	0.037
TOB96-07-20 (duplicate)	96-Sep-20	16,3	30.7	688	664	0.51	0.058
Distilled Water Blank #1	96-Sep-20	<0.1	<0.5	6.0	2.0	<0.01	0.035
.C. freshwater aqual	tic life criteria:	100	NC	NC	NC	1.84 *	40

#### NOTES:

<sup>1.)</sup> NC - No Criteria.

# TABLE 6 LABORATORY ANALYSIS RESULTS FOR METALS

												\$. \$.											
Location	Sample Date	Arsenic:T	Arsenic	Barium:T	Barium	Cadmium:T	Cadmium	Chromium:T	Chromium	Cobalt:T	Cobalt	Copper:T	Copper	Lead:T	Lead	Mercury:T	Mercury	Molybdenum:T	Molybdenum	Nickel:T	Nickel	Selenium:T	Selenium
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Tailings Pond																		ANTONIO TO THE PERSON OF THE P					
TOB96-07-10	96-Sep-18	.0015	.0012	.115 <sup>-</sup>	.077	.0021	.0005	<001	< .001	.0011	.0003	.0044	.004	.0042	< .0003	< .00005	< .00005	.0058	.0035	< .0005	< .0005	< .0002	< .0002
TOB96-07-20	96-Sep-18	.0007	.0002	.14	.032	.0007	< .0002	.039	< .001	.029	< .000:	.0040	< .0002	.0021	< .0003	< .00005	< .00005	< .0002	< .0002	< .0005	< .0005	<0002	< .0002
TOB96-07-20 (Dup)	96-Sep-18	.0007	< .0002	.164	.146	.0032	< .0002	< .001	< .001	.0008	.0004	< .0002	< .0002	.0023	< .0003	< .00005	< .00005	.0023	.002	< .0005	< .0005	.0007	< .0002
<u>Water Blanks</u>																		-CETTALCETTAL THE STATE OF T					
Distilled Water Blank #1	96-Sep-18	<0.0002	<0.0002	0.006	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.0003	<0.000	<0.0002	<0.0002	<0.0003	<0.0003	<0.00005	<0.00005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002
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Location	Sample Date	Silver:T	Silver	Zinc:T	Zinc	Aluminum:T	Aluminum	Beryllium:T	Beryllium	[Boron:T	Boron	lron:T	lron	Manganese:T	Manganasa	PhocoborusiT	Dheenheris	Ortho B	Tetal Dies D	l Diametria	Dessions	VanadiT	Visnadium
Essatisti	Cample Date	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	l	(mg/L)			_	~	1 '	Phosphorus (mall)	Ortho P	Total Diss. P	l			
•		(119/2)	(1115/1-)	(1119/2)	(1119/11)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(nig/L)	(IIIg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
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<u>Tailings Pond</u>											# *									}			
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TOB96-07-20	96-Sep-18	<0.0001	<0.0001	0.0556	<0.0006	0.713	<0.001	<0.0002	< 0.0002	0.24	0.1	1.26	0.03	0.752	0.019	<0.1	<0.1	<0.003	0.004	0.0074	0.0074	< 0.001	<0.001
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TOB96-07-20 (Dup)	96-Sep-18	<0.0001	<0.0001	0.0053	0.005	0.379	<0.001	0.0004	<0.0002	0.16	0.07	0.94	<0.01	0.04	0.025	<0.1	<0.1	0.011	0.015	0.0073	<0.0004	<0.001	<0.001
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Distilled Water Blank #1	<u> </u>	<0.0001	<0.0001	<0.0006	<0.0006	<0.001	<0.001	<0.0002	<0.0002	<0.01	<0.01	<0,01	<0.01	<0,001	<0.001	<0.1	<0.1	<0.003	<0.003	<0.0004	<0.0004	<0.001	<0.001
B.C. freshwater aquatic life c	riteria:	0.0	001	0.0	3	0.05	**	0.00	053	Λ	IC	0.	3	0.1	1	NO			NC	O.	3	No	C

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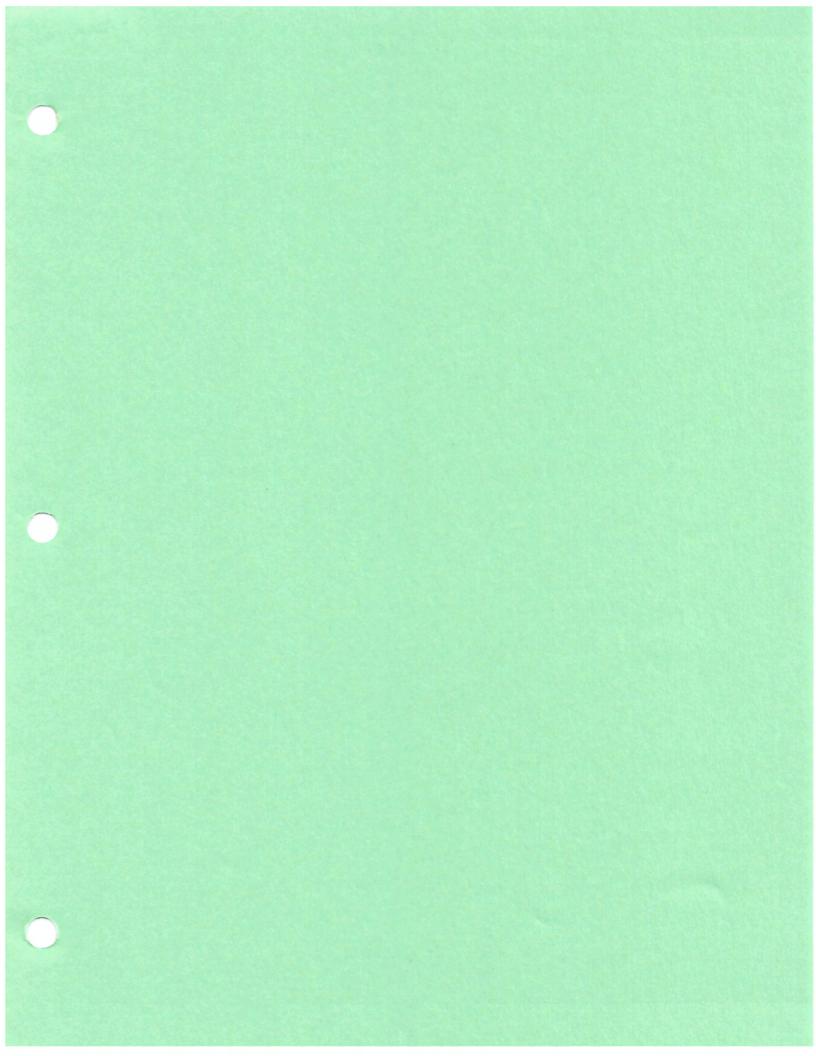
<sup>1.)</sup> Shaded area indicates concentrations which exceed B.C. Ministry of Environment Land and Parks freshwater aquatic life criteria (See Appendix V).

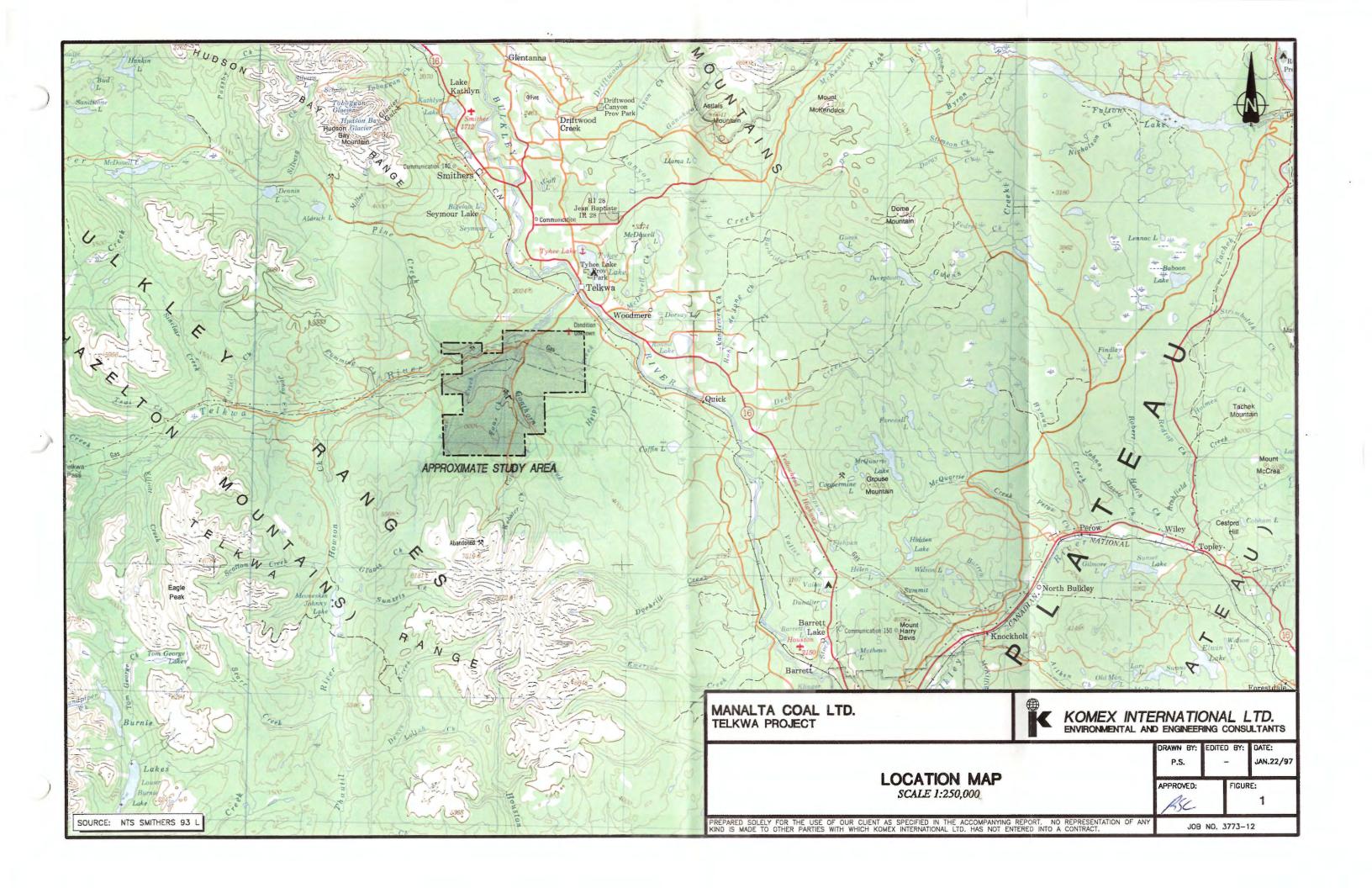
<sup>2.) \* -</sup> Criteria increases with water hardness (see Appendix V).

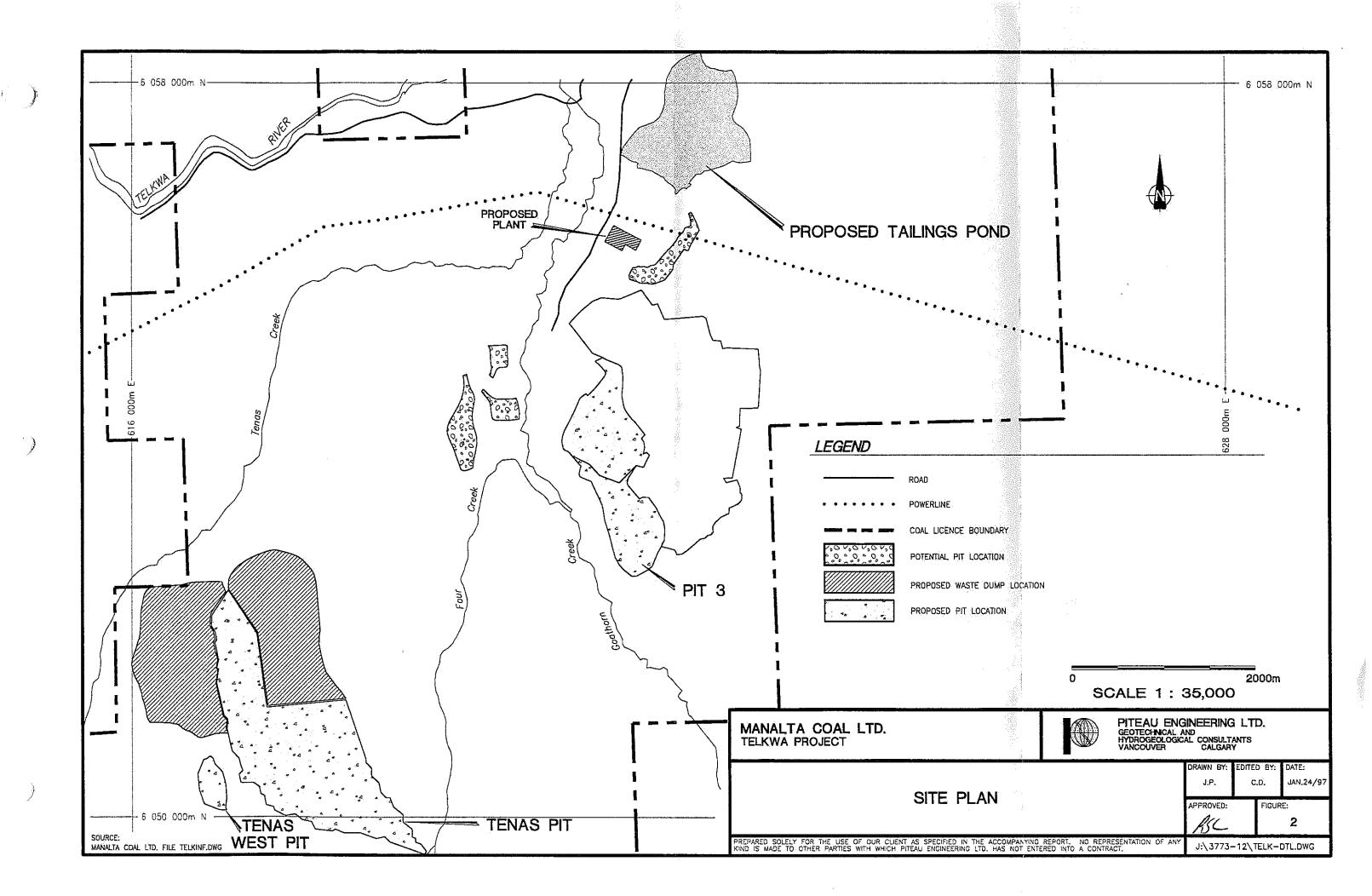
<sup>3.) \*\* -</sup> Criteria increases with pH (see Appendix V).

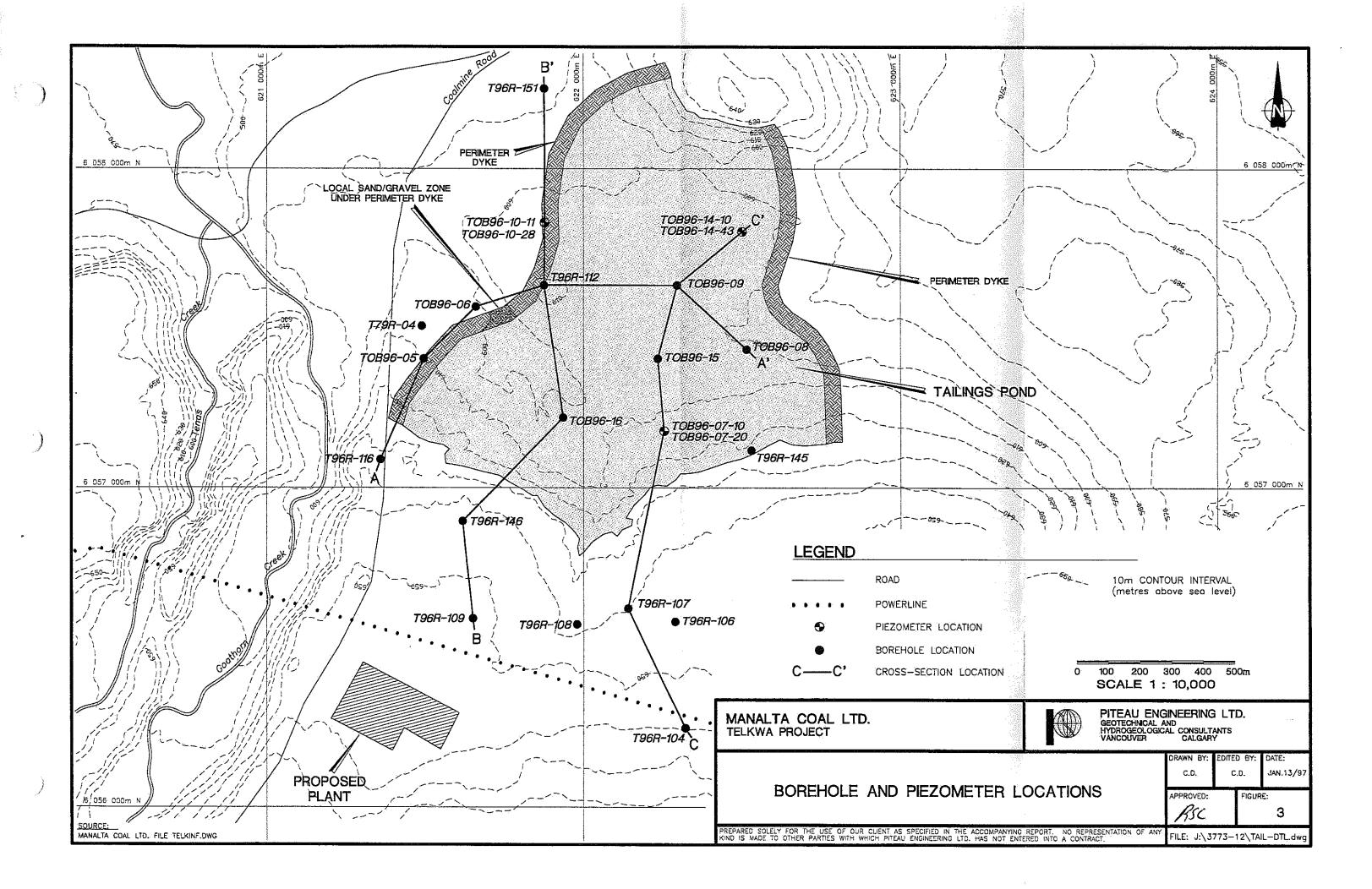
<sup>4.)</sup> T indicates total metals analysis, otherwise analysis indicates dissolved concentration.

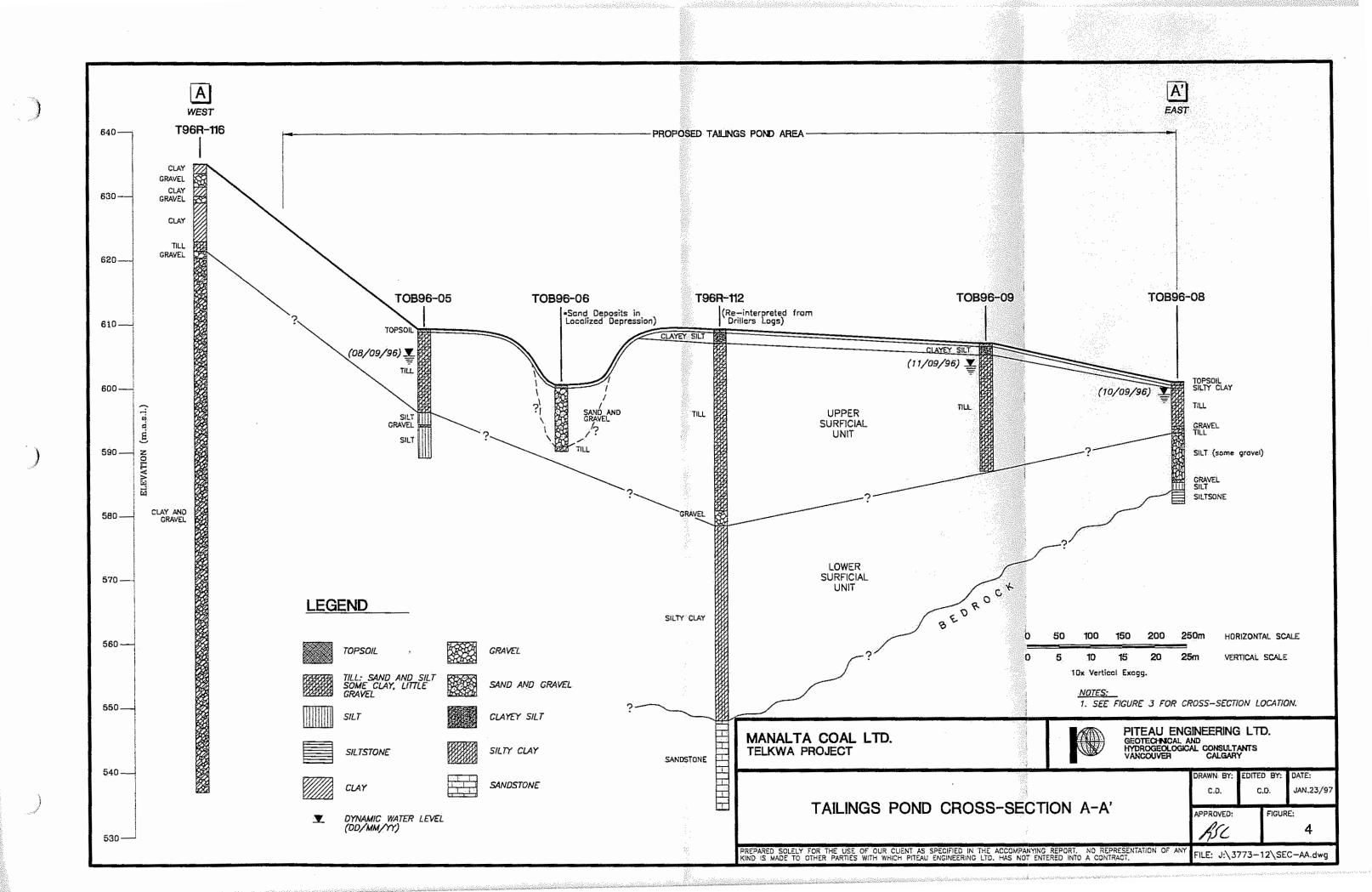
<sup>5)</sup> NC - no criteria.

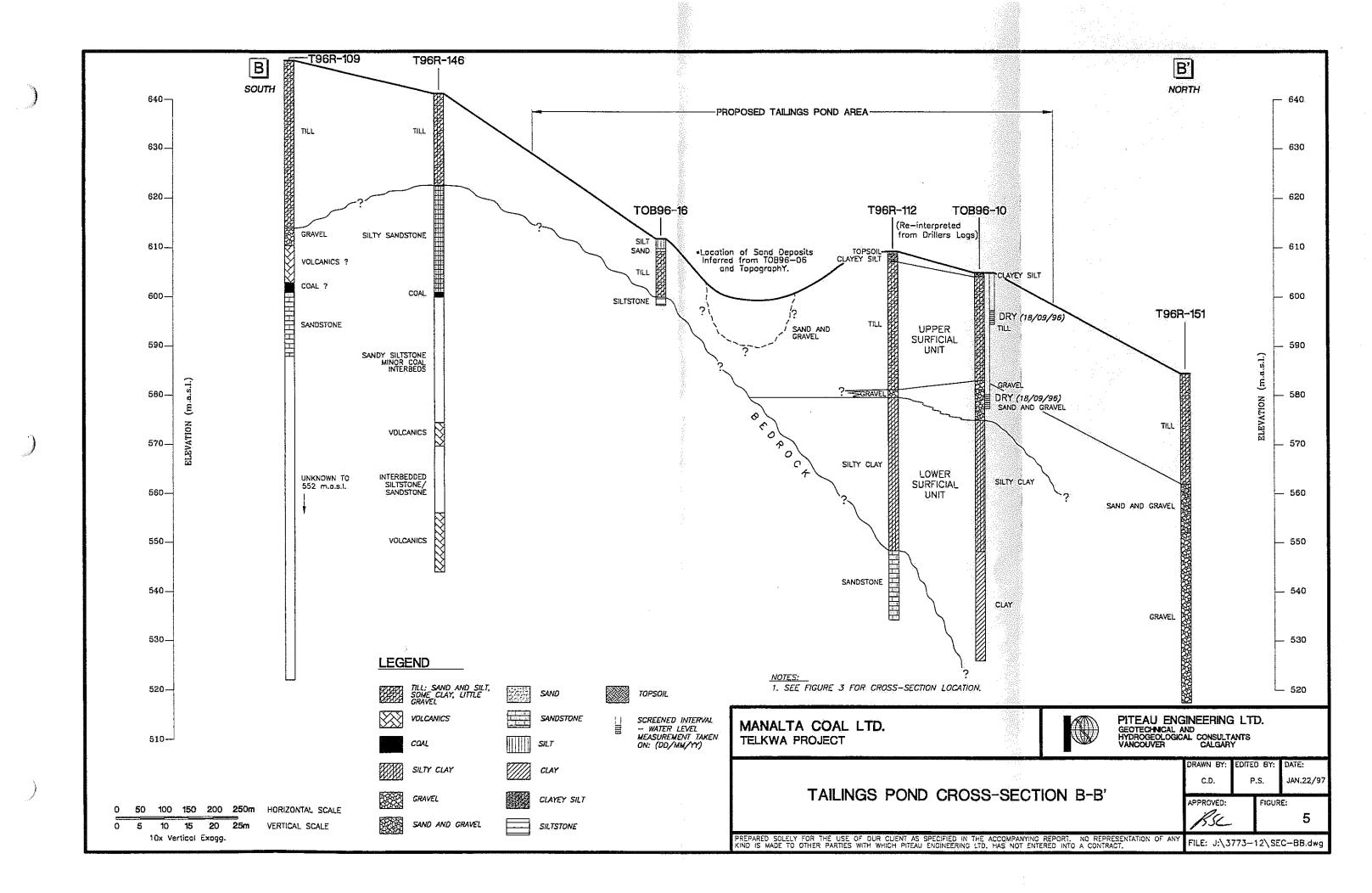


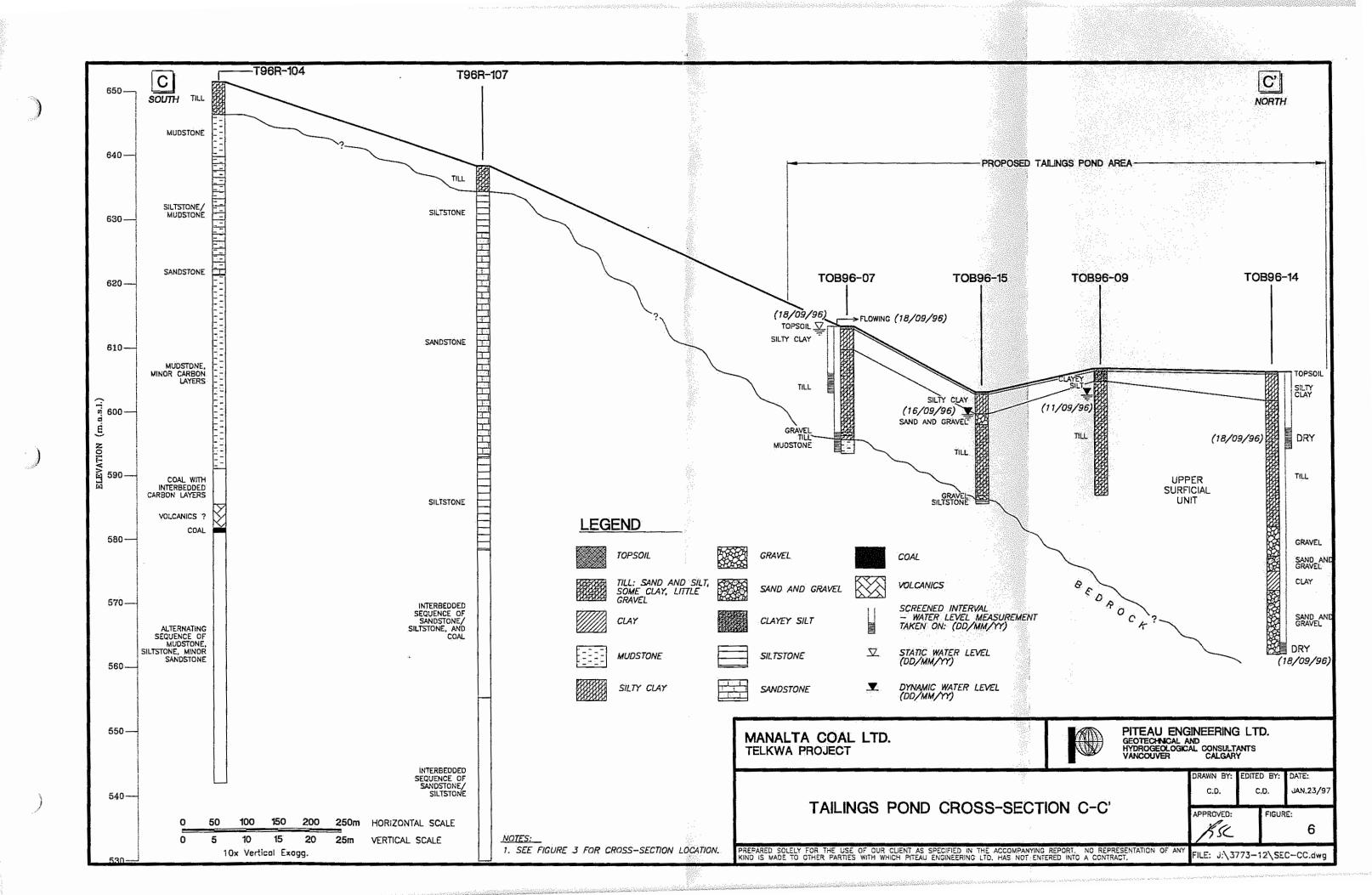


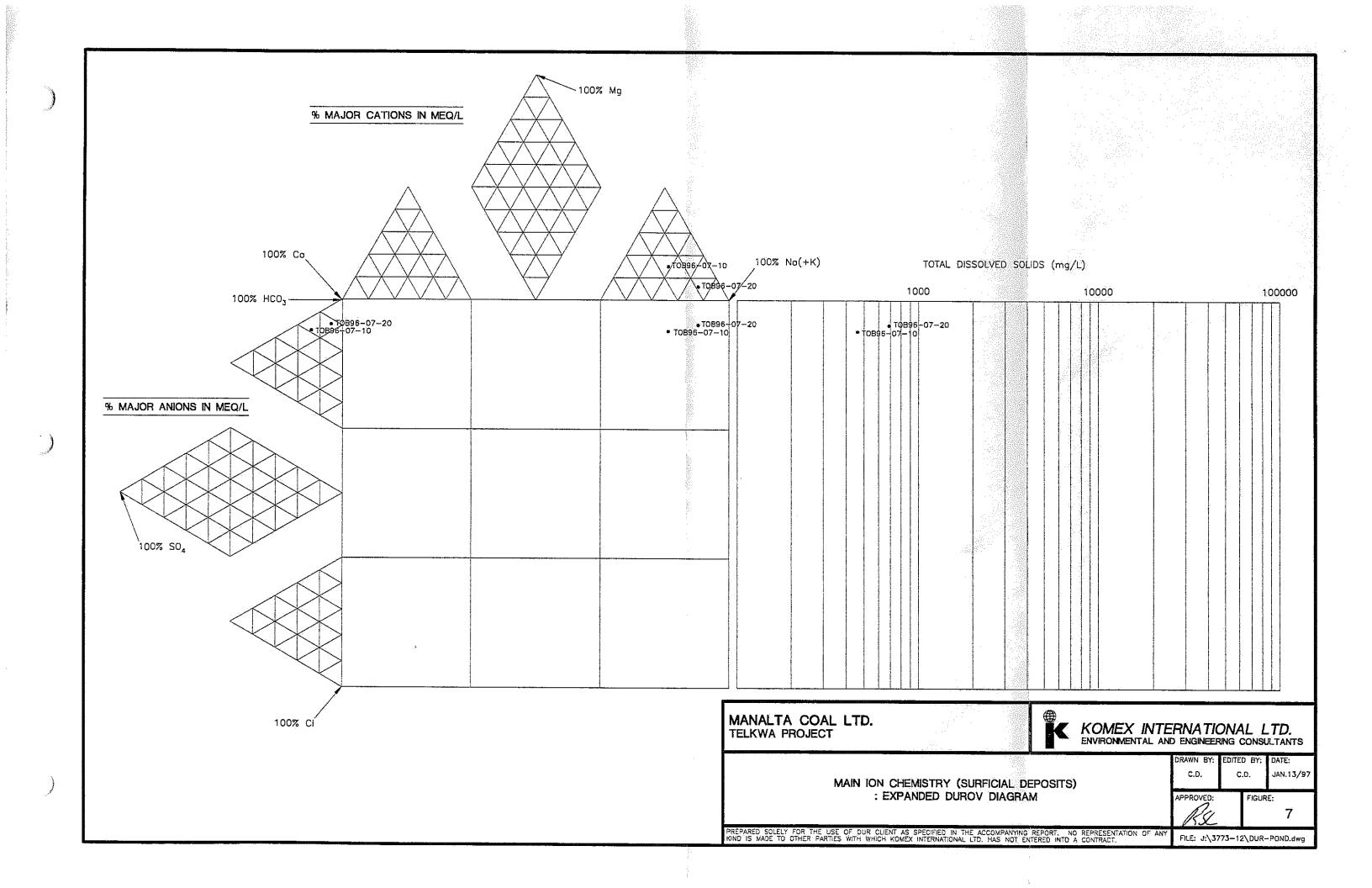


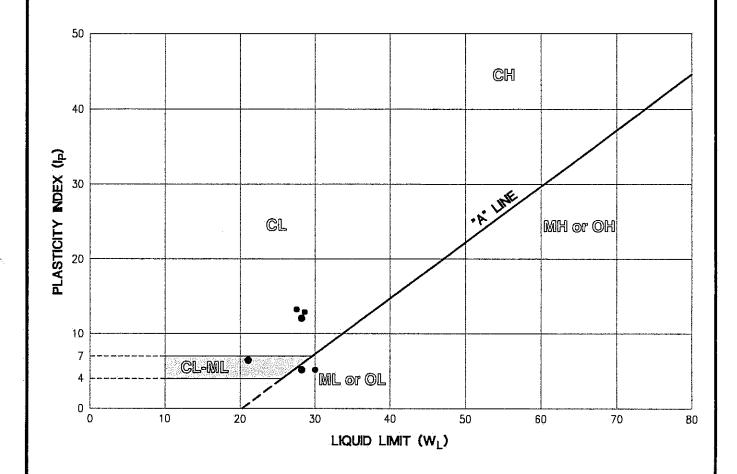












MANALTA COAL LTD. TELKWA PROJECT



KOMEX INTERNATIONAL LTD. ENVIRONMENTAL AND ENGINEERING CONSULTANTS

PLASTICITY INDEX vs LIQUID LIMIT

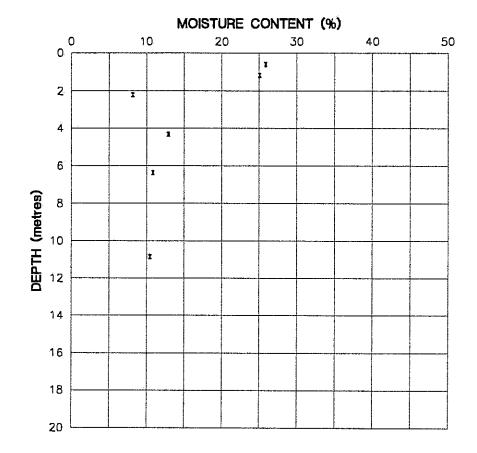
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APPROVED:

FIGURE:

PREPARED SOLELY FOR THE USE OF DUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH KOMEX INTERNATIONAL LTD. HAS NOT ENTERED INTO A CONTRACT.

FILE: J:\3773-12T2\PLAST-P.dwg



MANALTA COAL LTD. TELKWA PROJECT



KOMEX INTERNATIONAL LTD. ENVIRONMENTAL AND ENGINEERING CONSULTANTS

MOISTURE CONTENT vs DEPTH (TILL)

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EDITED BY: DATE:

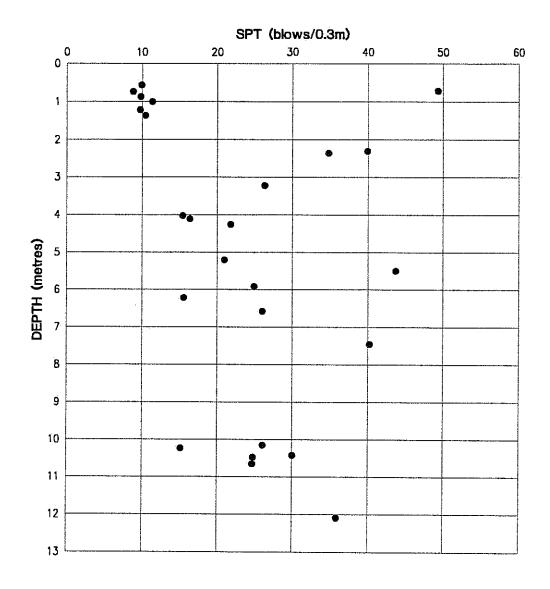
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MANALTA COAL LTD. TELKWA PROJECT



KOMEX INTERNATIONAL LTD. ENVIRONMENTAL AND ENGINEERING CONSULTANTS

SPT vs DEPTH

DRAWN BY: M.Z.

EDITED BY: DATE: C.D.

JAN.13/97

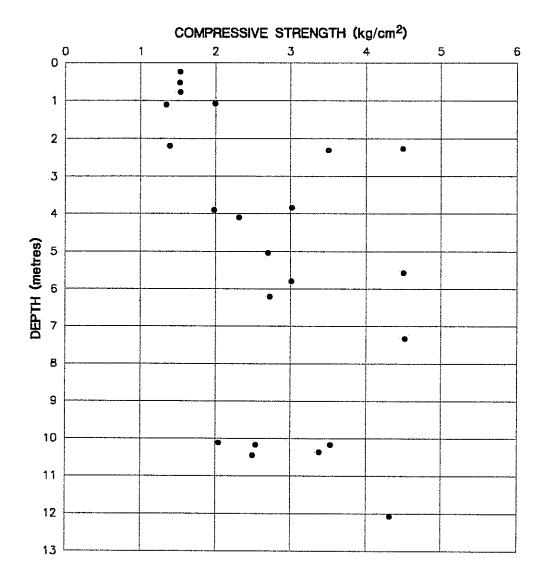
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PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH KOMEX INTERNATIONAL LTD. HAS NOT ENTERED INTO A CONTRACT.

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MANALTA COAL LTD. TELKWA PROJECT



KOMEX INTERNATIONAL LTD. ENVIRONMENTAL AND ENGINEERING CONSULTANTS

PENETROMETER vs DEPTH

DRAWN BY: M.Z.

EDITED BY: DATE: Ċ.D.

JAN.13/97

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FIGURE:

PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH KOMEX INTERNATIONAL LTD. HAS NOT ENTERED INTO A CONTRACT.

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APPENDIX I

FIELD PROGRAM PROTOCOLS

## **APPENDIX I - FIELD PROGRAM PROTOCOLS**

#### PIEZOMETER CONSTRUCTION

Piezometers were constructed using 51 mm (ID), schedule 40 PVC pipe supplied by Rice Engineering Ltd. of Edmonton. All sections were machined with threaded flush-joints (M/F 480) to avoid the use of PVC glue and primer for connections, since bonding materials can potentially introduce traces of organic contaminants. The screen sections of PVC pipe were constructed with three rows of No 20 slotting. The base of each screen section was closed with a heat-welded seal.

Following preparation, all piezometer pipe sections and screens were washed by the supplier using a non-phosphate detergent, and clean potable water. This procedure is in accordance with U.S. EPA recommended methods (Aller et al., 1989). After cleaning, each individual piece was sealed in a plastic bag to prevent contamination during transport.

All piezometers were constructed by placing a screen section of PVC pipe across a potential groundwater bearing interval. Shallow piezometers were constructed by placing a 3 m screen across the upper groundwater surface (water table). Deeper piezometers were constructed with a 1.5 m or 3.0 screen placed across the identified groundwater bearing zone.

Solid sections of pipe were then threaded onto the screen sections, and the entire string lowered to the desired depth of completion. High silica content frac sand of 10/20 grade was added to the annulus to approximately 0.3 m above the screened interval. A primary water-tight seal, of 1.0 m average thickness, was placed above the sand pack using high quality 6 mm peltonite tablets. Any remaining annual space was then backfilled with bentonite chips.

At surface, a 102 mm diameter, 1.5 m long steel casing with a lockable cap was inserted approximately 0.75 m into the open borehole. This provides some physical protection and enhanced visibility for the piezometer. A hydrated bentonite cap was placed around the base of the protective steel casing. Cuttings were mounded around the base of the piezometer to direct surface water runoff away from the borehole. Piezometer depths and screen intervals are listed in Table 1. Full construction details are included on the borehole logs in Appendix II.

# PIEZOMETER DEVELOPMENT AND HYDRAULIC CONDUCTIVITY TESTS

Shortly after installation, each piezometer was developed using the high volume, high pressure air compressor on the drill rig. Groundwater was air lifted from each piezometer until a sufficient volume was removed to purge any drilling fluids and remove fine materials from the sand pack. Where possible, air lifting was continued until the water was no longer turbid.

A hydraulic conductivity test was performed on each piezometer. The test was initiated by recording the static water level using a standard electric water level sounder. Standing water was then removed from the wellbore using a portable air compressor with a 46 m air line. Recovering water levels were measured at selected time intervals. Water level recovery versus time data are presented in Appendix III.

Hydraulic conductivity values obtained by this method are approximate due to the relatively small volume of water removed from the wellbore. As such, they only represent the zone within the immediate vicinity of the screened interval. Small variations such as fracture density in rock can greatly affect hydraulic conductivity values within zones of similar lithology. Nevertheless, this method of testing provides a useful indication of the order of magnitude of the local hydraulic conductivity.

For shallow piezometers completed in an unconfined groundwater bearing unit, the Bouwer and Rice method (1976) was used to interpret slug test results and estimate hydraulic conductivity values. For deeper piezometers completed in a confined groundwater bearing unit, the Cooper et al. (1967) method was used for interpretation of slug test results. Hydraulic conductivity data are summarized on Table 1 and presented in Appendix III.

### GROUNDWATER SAMPLING

Groundwater sampling was performed between September 19 to 22, 1996. At least three volumes of standing water were removed from each piezometer prior to sampling to ensure samples collected were representative of formation water. All sample bottles were rinsed with formation water prior to sample collection.

At each piezometer the following sub-samples were collected:

- A 500 mL aliquots, unpreserved, stored in polyethylene bottle for analysis of major ions and routine portability parameters. These include: alkalinity, bicarbonate, carbonate, calcium, chloride, conductivity, hydroxide, dissolved iron, magnesium, dissolved manganese, nitrate plus nitrite nitrogen, pH, potassium, sodium, sulphate, total dissolved solids, total suspended solids, and total hardness.
- A 250 mL aliquot, unfiltered and preserved with 5 mL 12.5% H<sub>2</sub>SO<sub>4</sub> for analyses of nutrients including total NH<sub>3</sub>-N, dissolved phosphorus (lab filtered), total phosphorus, and orthophosphorus.
- A 250 mL aliquot, unfiltered and preserved with 1.25 mL 1:1 HNO<sub>3</sub> for analyses of total metals.
- A 250 mL aliquot field filtered to 0.45μm and preserved with 1.25 mL 1:1 HNO<sub>3</sub> for analyses of dissolved metals.
- A 125 mL aliquot, unfiltered and preserved with 1 mL K<sub>2</sub>C<sub>4</sub>O<sub>7</sub>-HNO<sub>3</sub> for analyses of total mercury.
- A 125 mL aliquot field filtered to 0.45μm and preserved with 1 mL K<sub>2</sub>C<sub>4</sub>O<sub>7</sub>-HNO<sub>3</sub> for analyses of dissolved mercury.

All samples were packed in ice (cooled to approximately 4°C) and delivered to Chemex Labs in Calgary within 48 hours of program completion.

## SURVEY INFORMATION

All piezometers locations were surveyed by Manalta personnel using a portable differential global positioning system (GPS). Piezometer locations were surveyed in UTM. Elevations were surveyed as metres above mean sea level.

## REFERENCES

- Aller, L., T.W. Bennett, G. Hackett, R.J. Petty, J.H. Lehr, H. Sedoris, D.M. Nielsen and J.E. Denne (1989). Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells. Published by National Water Well Association, Dublin, Ohio, p. 398.
- Bouwer, H. and R.C. Rice, 1976. A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research, Vol.12, No. 3, pp. 423-428.
- Cooper, H.H., J.D. Bredehoeft, and S.S. Papadopulos, 1967. Response of a finite-diameter well to an instantaneous charge of water. Water Resources Research, Vol. 3, No.1, pp. 263-269.

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# APPENDIX II

BOREHOLE LOGS AND PIEZOMETER COMPLETION DETAILS

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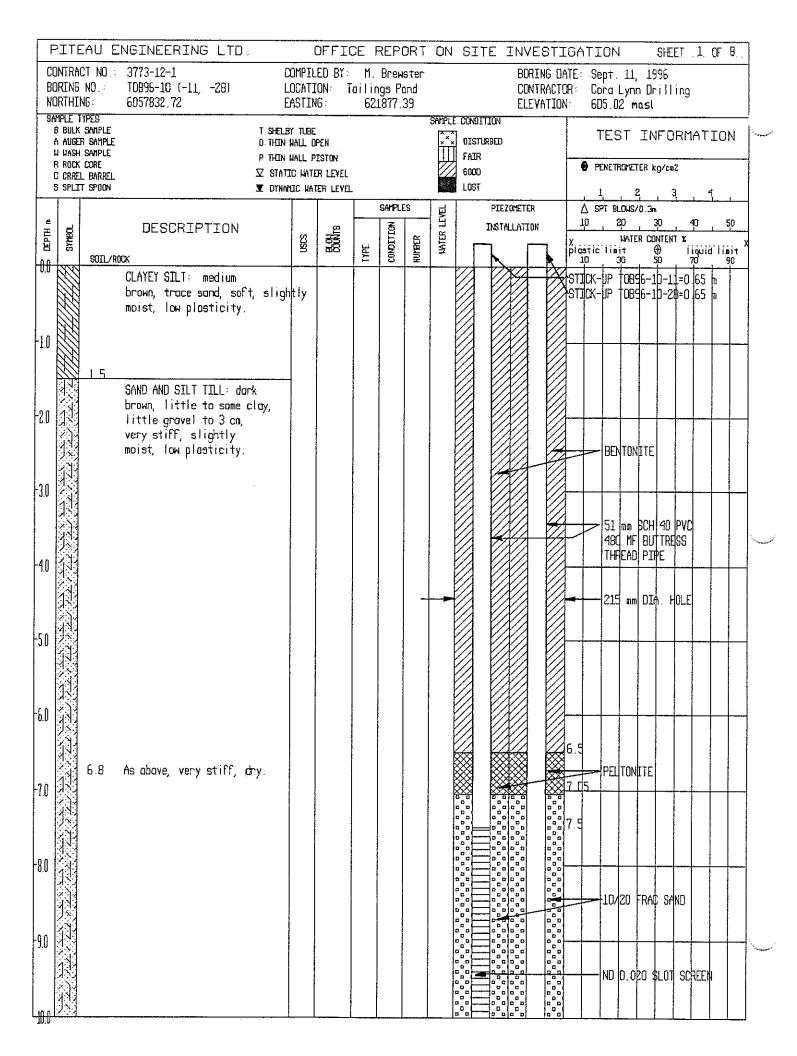
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9		NO.	T0B96-07 (-10, -20) i		ED 8Y: ION: Ti	ailin		ind 57	*****	BORING DA CONTRACTO ELEVATION	R: 1	Coro	9, 1 Lynn 8 mas	Drill	ing	
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DEPTH n	1	SOIL/RI	DESCRIPTION	SUSI	SON IS	TYPE	SAPLE	NUMBER 53	UNTER LEVEL	PIEZOMETER. INSTALLATION	10	íc lim	.DUS/0, 20 Water it 30	30	40 11 3x 11 qu 70	50 51d   fait 90
10.1		OCC III	SAND AND SILT TILL: dark grey brown, little to some cl little gravel, non-calcareous stiff, maist, low plasticity.	υ,		S		<u></u>			- 1	410.	120 FI	RAC S		
-11.[							:					BE	TONI			
-12.1					Control of the Contro						A STREET, ST. ASTRONOMY ST.	→ 51 PV(	mm S(	CH 40		
-13.0						Veriller addressed addressed by the design of the second s		-			<b>4</b>	- 159	mm (	Iń.	HOLE	The responding of the state of
-15.0											14,6			The state of the s		
-16.0											16 N	- PEI	TONIT	E		
-17.0		16.5	Grove!.								16.6					
-18.0		17.6	SILTY MUDSTONE (BEDROCK): black, waxy, finely laminated,	-								10/	20 FF	AC S	AND	
r 19,0			soft, brittle, carbonoceous,									- NO.	0,02	:0 SL	OT SCF	EEN.
	工		- A A A A A A A A A A A A A A A A A A A								19.6					
20.0	<u></u>		MATERIA DE MATERIA DE LA CONTRACTION DEL CONTRACTION DE LA CONTRAC							<u> </u>						

-			NGINEERING LTD. OFFICE RE 3773-12-1 COMPILED BY: M. B		,01	I S	ITE	INVESTI							1.	OF 2	2
80		NO. :	TOB96-08 LOCATION: Tailing					CONTRACT( ELEVATION	R:	Co	ro ( )0.9	Ĺynr	n Or	illin	19		
A		YPES R SAMPLE SAMPLE	T SHELBY TURE O THOM WALL OPEN		SAMPL	<u>.</u>	NDITIO ISTURB NIR			TE	ES,T	I	NF	ORM	LTA	ON	\
c		CORE BARREL SPOON	P THIN HALL PISTON  ▼ STATIC HATER LEVEL  ▼ DYNAMIC HATER LEVEL			6	000 0ST				ENETF L		ER kı	g/cm2 3		٩.	
оерти п	SYREOL		DESCRIPTION	S	AMPLES		MATER LEVEL	PIEZOMETER CONSTRUCTION DETAILS		İG	. 2	.0µs/	70 , 3m .3		40 v	5[	
	1777 SE	. <b>501</b> L/R00	c TOPSOIL, PEAT: dárk brown, наоду,	TYPE	CONDITION	NUMBER	MATER		Piá	átic 10	`iini	i t 30	5	-	1 i qui i 70	d limi 90	, X
		0.0	slightly moist, loose.  SILIY CLAY: light brown, little	s					4	\$		•			And White Williams and the state of the stat		
-1.0		1.0	iron oxidation, soft, slightly moist, low plosticity, slightly reactive.				To the control of the				ļ						
			SANO AND SILT TILL: medium brown, little to some clay, little gravel (to									3					
-2.0		2.0	3 cml, trace coal, iron oxide staining, slightly calcareous, very stiff, loose, dry, low plasticity.	T						X	X			_			
					777.									1			
-3.0																	
-4.0	1/1 1/1						¥										
ן עור	八 (1)			S								Δ	•				
-5.0																	
-6.0															-		_
				S													
-7.0		7.1	Grovels.														
														Asternation in the second			
-8,0	<u>沙</u> 身 	8 11	SILT: dark brown, little grovel,						-								
			trace sand, hard, dry,														Western Commence of the Commen
-9.0														+	-		

ſ	Ρ	ITE	EAU E	NGINEERING LTD. OFFICE RE	PORT	ΟN	9	SITE	INVESTI	GΑ	TIO	N		SHEE	T . ?	2. or	F 2.,
-	BO		NO.	3773-12-1         COMPILED BY: M. 8r           TDB96-08         LOCATION: Tailings           6057434.68         EASTING: 62251	Pond				BORING DA CONTRACTO ELEVATION	R:	Cord	10, Lyni 9D m	ı Ör	96 î H î	ng		
~ [	P L	AUGE Hasi-	TYPES TR SAMPLE I SAMPLE	t shelby tube O thin mall open P thom mall piston		SAMPL	E F.	ONDITIO ISTURB AIR				T I				IO	N
	C	CRRE	CORE L BARREL IT SPOON	✓ STATIC NATER LEVEL ▼ DYNAMIC NATER LEVEL			A.M.	.000 .09T				TROME				a	
-			1 0 0 0 0 0 0	20 0 1110 1 100 120	s	AMPLES			PIEZOMETER			BLOUS					- 1
	OEPTH 11	STITEOL.		DESCRIPTION		NOIT:	pr.	HATER LEVEL	CONSTRUCTION DETAILS	1		CS STAN		O NTENT	40 x		50
			.901L/R00	K	TYPE	CONDITION	NUMBER	HATER		pios 1	itlic'l	nit 30	R CO:	Ð,	1 i q 70	uid.	limit 90
ľ	10.0	1		SILT: as above.													
		, 			S								4		•		
	11 N				٦												
	11.0																
-	12.0	*****									_				$\dashv$	$\downarrow$	
			Andrew Street														
_	13,0	1		•								+					-
- "NI  -							:				- Martin Martin Martin						
	14.0																
	מיוֹד	-	14.2	Grovel, approximately 0.2 m.													
																	70-1-10-10-10-10-10-10-10-10-10-10-10-10-
-	15.D										-				+		
					- The state of the			th district the same									
-	16.0	-							444						_		
									reference of the second								
			17 በ												!		
+	17.0		<del> </del>	SILTSTONE (BEDROCK): dark grey, massive						$\dashv$							-
				hand, dry.											-		
-	18.D																
	au,U	313131							n. a.							-	
										**************************************							
	19.D		•													$\frac{+}{1}$	+
-				TOTAL DEPTH = 19.0 m					Andrew An	THE PERSON NAMED IN COLUMN NAM							
	20 <u>.0</u>															$\perp$	

F	TTE	EAU E	NGINEERING LTD.	OFFICE	REPORT	ON	S	ETE	INVESTI	GA	TIC	M		SHE	ET .	1. DF	- 2.				
BO		NO.:	3773-12-1 TDB96-09 6057636,23	COMPILED BY: M. LOCATION: Taili EASTING: 62					BORING DATE: Sept. 11, 1996 CONTRACTOR: Cora Lynn Drilling ELEVATION: 606.95 mask												
f L F	i nash Erock Crre	r sample I sample I core L barrel	0° P. ∑	SHELBY TUBE THIN HALL OPEN THIN HALL PISTON STATIC MATER LEYEL	HIN HALL OPEN XXX DISTURBED HIN WALL PISTON FAIR								TEST INFORMATION  PENETROMETER kg/cm2								
DEPTH o	SYMBOL	T SPOON	DESCRIPTI			SAMPLES NOTLICANO		AMPLES		HATER LEYEL "	PIEZOMETER CONSTRUCTION DETAILS		) .	2C	ATER C	30 ONTEN	3 4( T.X.	50			
0.0	.47.V	SOIL/R00	k SILT TOPSOIL: medium	brown slightly	1YPE	COND	NUMBER	HATE		pios 10	tic i	im i 1			i i i	) juid l	limit 90	_			
-1.0		0,3	moist, soft, grass roo CLAYEY SILT: medium b Fine sand laminations oxide staining along v stiff, slightly moist. calcareous, silt is sl	ts.  rown, thin ((I cm), iron ertical partings, Sand is highly	T					TO COME OF THE COM	$\dashv$	<b>⊕</b> × <b>⊕</b> × <b>⊕</b>						Antiversity of antibles of the control of the contr			
-30 -30			SAND AND SILT TILL: di to some cloy, little g stiff, dry, law plasti	ravel (to 1 cm),	s			2.5									<u> </u>				
-4.0					S.						33X	X	-	The state of the s							
-5.0					Videbbredit in de manuel de manuel de l'est de manuel de l'est de manuel de l'est de manuel de l'est de l'est																
-6.0					S					<b>+</b>	, X	X		•		A CONTRACTOR OF THE CONTRACTOR					
-7.0 -8.0		·						- SALP-Rest of subbot of data of Art of the State of Art of Art of State of Art of State of Art				and the state of t									
0.U -9.0								**************************************				- PART -						أرمر			
10.0												***************************************									

	Ρ.	ITE	AU EI	NGINEERING LTD.	OFFICE REP	ORT	ON	S	ITE	INVESTI	GAT.	ION		SHE	ET 2	2. OF	2.
	BOF		NO.	3773-12-1 T0896-09 6D57636 .23	COMPILED BY: M. Brew LOCATION: Toilings P. EASTING: 622295.					BORING DA CONTRACTO ELEVATION	R: C	ora l	11, Lynn 5 <b>ma</b>	Drill	ing		
		PLE T			T SHELBY TUBE		SAMPLI		NDİTIC ISTURB		Т	EST	IN	IFOR	MAT	10 I	4
	и	HRAIL	r sample Sample Core		O THIN WALL OPEN P THIN WALL PISTON		Ţ	] FA	ΔĪR		-	PENETE	ÖMETER	kg/ca	2		
	C	CRRE	BARREL T SPOON		STATED WATER LEYEL  TO DYNAMIC HATER LEVEL		//		)000 )ST			1	, 2		3	4	
ŀ						S	MPLES	}	_	PIEZOMETER			DUS/0				
	осртн в	SYMBOL		DESCRIP	TION		CONDITION	Æ	UNTER LEVEL	CONSTRUCTION DETAILS	70		NATER	30 CONTEN	<u>, 40</u> T <b>x</b>		50
			SOIL/ROO	К		14 PE	COND	NUMBER	HATE		X plasti 10	c'lin	it 30	<b>⊕</b> 50	1 i q 70	ùid ì	init 90
	<u>0.0</u>			SAND AND SILT TILL:	as above.												
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				TOTAL DEPTH, = 20.0 m	ì												
	<u>0.0</u>																



	F	ITI	EAU E	NGINEERING LTD	<u>.</u>	(	OFFIC	DE. F	REPO	DRT	ON	SITE INVEST	[GAT	ION	<u> </u>	Sł	EET	. Z. C	OF 8
Application .	BO	RING RTHI	NO. NG:	3773-12-1 TOB96-10 (-11, -2B) 6057832 72	Ĺ		ed by: On: Ti G:	ailin		nd 39		BORING D CONTRACT ELEVATIO	0R: 0	Bept. Cora 505.0	Lvnn	Dril	; Hing		
		BULK AUGE HASH ROCK CRRE	TYPES SAMPLE R SAMPLE I SAMPLE CORE L BARREL T SPOON		I SHELB I NIHT (I I NIHT 9 ITATO V	IALL DI IALL P C HATE	PEN Iston Ir Leyel				SAMPLE	CONDITION  DISTURBED  FAIR  6000  LOST	. 0	PONETI 1,	ROMETI 2	ER kg/	ORM	ATI	ON
	осрти п	SYTEROL	0077 (10	DESCRIPTION		SOSI	BONIES	TYPE	SAPLE	NUTBER 53	UATER LEVEL	PIEZONETER INSTALLATION	10 X plast	ic'lin	20	0.3n 30 R CONTI ⊕ 50	ÉNT %	10 Liquid	50 Timit 90
	10.0		SOIL/R	SAND AND SILT TILL: as above.					3	H			10.5	10, ND	20	FRAC	SAND DT SC		
	11.0																		
	-12.0																		
إريشامس	  -13.D																		
. 01 *	  -14.0													<del>-</del> BE)	TON	ITE		The state of the s	
	-15.0																		
	-16,0	- Andrews - Andrews - Andrews - Andrews - Andrews - Andrews - Andrews - Andrews - Andrews - Andrews - Andrews		·					Portilities - dela management					- 51 480 THF	min MF EAD	CH 4 BU T PIPE	D PYC RESS		
	-17.0																AND THE CASE OF TH		
	-18.0									_	-			- 215	met	DIA.	HOLE		
· Allendaria		And the state of t																· ·	
	-19.0	alemande allena vold e caselle e caselle e caselle e caselle e caselle e caselle e caselle e caselle e caselle												NAMES					
	20 <u>.</u> 0						<u></u> .					/////X/X \							

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BC NC	IRING IRTHI	NO.: NG:	T0896-10 (-11, -28) L0		ÉD BY: ON: To G:	ailin		and 39		CONTRACTO ELEVATION	DR: Cora	ept. 11, 1996 Drailynn Drilling 15.02 mask					
1 6 6	A AUGE I HASH ROCK C CRRE	SAMPLE R SAMPLE SAMPLE	SA NALL OPEN NALL PISTON IC WATER LEYEL IIC WATER LEYEL			SAMPLE	CONDITION DISTURBED FAIR 6000 LOST		T INFO	ORMATI n2 3 , 4	ON .						
S DEPTH a	SYMBOL.	90IL∕R	DESCRIPTION OCK	SOSO	Bounts	TYPE	SAMPLE	NUMBER	LATER LEYEL	PIEZOMETER Installation	X. ploatic lin	.OUS/O.3m O 30 HATER CONTE	10 NT ¥ Hiquid 70	50   1			
<del>20.0</del>		20 B	SAND AND SILT TILL: as above.								BE	TONITE	9.18	0.000			
-21.0			GRAVEL: coarse (3 cm+), little sand, minor clay, dry.	9							1   1480	ma BCH 40 MF BUTI EAD PIPE	REISS				
-22.0	050505050	22.0	Stopped drilling för 5 min, air lift, no groundwater.									nm DIA.		A CONTRACTOR OF THE CONTRACTOR			
-23.0		_23_8									23.6	TOÑITE					
-24.D <sub>.</sub>			SAND AND GRAVEL: interbedded with clay, dark brown, soft.								24.5	1 Old F & C					
-25.I	000000000											20 FRAC (	SÁND				
- <b>2</b> 6.0	03030308										חאַ	0.020 \$L!	ot screen				
-27.0	08080808																
-28.0	96980808										BF1	TONITE CI	HIPS				
-29.0	020202020						Stringston and the stringston an							6.70			
3,1	OX				L					V/////X//////							

ſ	P	ITE	AU E	NGINEERING LTD.		OFFIC	CE F	REP(	D <u>R</u> T	ON	SITE INVESTI	GATION	SHEET .4. OF 8.					
	90	RING.		3773-12-1 T0896-10 (-11, -28) 6057832.72		ED BY: [ON: T		gs Po	nnd		BORING DA CONTRACTO ELEVATION	NTE: Sept. 11, 1996 NR: Cord Lynn Drilling I: 6D5.012 mast						
	6 6 4 8 0	AUGE HASH ROCK CRREI	SAMPLE R SAMPLE SAMPLE	0 Т- Р Т- ▽ S	TATIC HAT	TUBE [*			SAMPLE	CONDITION  DISTURBED  FAIR  GOOD  LOST	TEST INFORMATION  PENETRUPETER kg/cm2  1, 2, 3, 4,							
	S DEPTH	SYMBOL	SOIL/RC	DESCRIPTION OCK	SOSIN	Books	TYPE	SAMPLE	NUMBER S	HATER LEVEL	PIEZOMETER INSTALLATION		20 30 40 50					
	<del>30.1</del>	389837	30.5	SAND AND GRAVEL: as above. Stopped for 30 min, air lif no groundwater.	ted													
	31.0			SILTY CLAY: nedium grey, trace sand, trace gravel, v stiff, dry	ery													
	<b>3</b> 2.0					With the state of	adityk-king paratek alamak kanana kanana anana											
	33.0			-		NAME OF THE PROPERTY OF THE PR	And Andrews Comment of the comment o					BEA	TONITE CHIPS					
	31.D				**************************************	Annaber Berlin -												
	3.1							-		_		215	nm DIA, HOLE					
-	<b>3</b> .0					**************************************												
-	37.0											37. D						
	<b>3</b> 3.0					**************************************				4		BAC	KFI_L T RUN)					
	39.0											Las	1 AUIV)					
	<del>1</del> .1																	

F	ITE	EAU E	NGINEERING LTD		.(	DFFIC	E F	REPO	DRT	ON	SITE INVESTI	GAT.	NOI		SHEE	T 5	OF	8, ,	
BORING NO.: TOB96-10 (-11, -2B) LC						ED BY: On: Ti G:	ailin		ind , 39		CONTRACTO ELEVATION	ATE Sept. 11, 1996 OR: Cora Lynn Drilling N: 605.02 mast							
	B BULK A AUGE W WASH	SAMPLE R SAMPLE SAMPLE		Y TUBE WALL OPEN WALL PISTON						CONDITION DISTURBED FAIR	TEST INFORMATIO							for South	
	R ROCK C CRRE S SPLJ	L BARREL T SPOON	☑ STATIC ☑ DYNAMI							LOST LOST		PENETR							
		11 SPOUN						SAMPLE	S	댿	PIEZOMETER	1		2 <sub>1</sub> 01/5/0.3	, <u>J</u> n	l	4	-	
DEPTH n	SYMBOL	DESCRIPTION			SCS	COUNTS		CONDITION	IR.	WATER LEVEL	INSTALLATION	10	<u>. 2</u>	IATER D	30 Ontent	40 x	;	50	
<u> </u>	1	SOIL/R			ह्य	ස්පි	TYPE	COND	NUMBER	₹		X picstic 10	ÉÌÌÌnií 30 I	<del>†</del>	⊕ 50	1 i qu 70	id lie	nit ^ 90	
I ISON			SILTY CLAY: as above.															The second secon	
-41.0																		Wilder of the Control	
-42.D														The state of the s	All respective property and the second				
-43.0																			
-41,0																			Second .
-5.0															AND THE PROPERTY OF THE PROPER			A THE RESIDENCE OF THE PARTY OF	
- <b>4</b> 5,D					And the second s								BACI (PI	(FILL (FIN)		-		The state of the s	
-47.D																			
øi n				5 de la constante de la consta					1.00										
-18.0										-			- 215	nm DI	A. H	DLE			
- <b>19.</b> 0				e de de de de de de de de de de de de de						in the state of th			***************************************						ic.
<del>50.0</del>																			

	F	ITEAU E	NGINEERING LTD.	(	OFFIC	DE F	REPO	DRT	ON	SITE INVEST	GATIC	)N S	SHEET , 6. C	F 8
-	BO NO	ONTRACT NO.: ORING NO.: ORTHING:	3773-12-1 T0896-10 (-11, -28) 6057832.72	COMPIL LOCATI EASTIN	ON: T	oilin		and 39		CONTRACTI ELEVATIO	DR: Cor	t. 11, 199 o Lynn Dri .02 masl	86 Iling	
w 2°	E A L	MPLE TYPES 3 BULK SAMPLE 4 AUGER SAMPLE 1 MASH SAMPLE	0	SHELBY TUBE THIN WALL OF THIN WALL P					SAMPLE XXX	CONDITION DISTURBED FAIR			ORMATI	ON
	Ċ	R ROCK CORE C CRREL BARREL S SPLIT SPOON		STATIC NATE						6000 LOST	₩ PEN	ETROMETER kg	/cm2 3 4	
	оертн а	ST/BOL	DESCRIPTION	SOSO	COUNTS		SAMPLE	NUMBER	HATER LEVEL	PIEZOMETER INSTALLATION	∆ SPT 10 X plastic 1	BLOUS/0,3m 20 30 NATER CON	TENT ¥	50
	<del>9</del> 1	0071 (0)	OCK SILTY CLÁY: as above,		860	TYPE	COM	<b>F</b>	3	1/4/4/4/	10	imit ⊕ 30 50	1 iquid	90
	-51.0													
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	OL; D													
	-31			en meneral de l'année de l'année de l'année de l'année de l'année de l'année de l'année de l'année de l'année d										
C. Williams											a de la companya de l		To the second se	
	·9.0													
	51					- Annual statement of the statement of t								
												AOKFILL PIT RUN)		
_	5.1			101441111111111111111111111111111111111									100	
				**************************************								de de la constante de la const		
	57.D	57 0	CLAY: medium grey, trace gravel, slightly majet;											
	58.0		łом to medium plasticity.	The state of the s										
				Tamanana nyyytty dia ty			100	_			2	15 mm 01A	. HOLE	
<u> </u>	59.0													
				Ardelina di erroldre (Arbalimaka										
L	60.0									المَّا المَّا المَّا المَّا				

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BC NC	IRING IRTHI	NG:	3773-12-1 T0B95-10 (-11, -2B) 6057832.72		ED BY: On: T IG:	ailir		ind 39.		BORING DI CONTRACTI ELEVATIOI	DR÷ Ce	ept. 1. ora Lyi 05.02.i	nn Dr	96 illing	***************************************	NATIONAL STREET, AND AND AND AND AND AND AND AND AND AND
- E	EBUA A	SAMPLE R SAMPLE SAMPLE	0 π	HELBY TUBE HIN WALL D	PEN				SAMPLE XX	CONDITION  DISTURBED  FAIR		TEST ENETRON		FORM	1ATI	DN
(	CRRE	L BARREL T SPOON		STATIC HATE						LOST		1	2	_3_	, 4	1
DEPTH n	SYMBOL		DESCRIPTION	SOST	SOUNTS	TYPE	NOILIGNOO	NUMBER 53	MATER LEVEL	PIEZOMETER INSTALLATION	10 X plastic	: limit	TER CO	0	40   iquid       70	50
<del>Ø.1</del>		SOIL/R	OCK CLAY: <b>a</b> s above,			Ĭ.	00	<u> </u>			10	30.		50	70	90
-61.0		61.0	Stopped Far night, water level at 56 m next morning.	A PLANTING A.		- PRINCE OF THE									And the state of t	
-62.5											V de marcona de la composição de la comp					The state of the s
-81														manufacture of the state of the		
-6A.D											The state of the s					
-65.D							not expe					BACKF	ILL RJN)	***************************************		
-6.0							The street of th								100	
-67.D											Value	100 m m m m m m m m m m m m m m m m m m				
-68.0								-	-			-215 r	m DIA	n. HÖLE	**	
-69,0 -20,0													AND THE RESIDENCE OF THE PARTY			

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*******	CO BO NO	NTRACT RING NO RTHING:	NO 377 TOB 605			0 U	OMPILI	ED BY ON: T	M. oilin	Brews	ter nd		BORING DA CONTRACTO ELEVATION	TE:	Sept.		96		1
	6 4 5 6	IPLE TYPE BULK SAN AUGER SA I MASH SAN ROCK COR CRREL BA SPLIT SA	IPLE MIPLE IPLE RE MRREL			T SHELB I MIHT O I MIHT 9 IZ STATI	HALL DE HALL PI IC HATE	eston R leyel			ŧ	SAMPLE	CONDITION  DISTURBED  FAIR  6000  LOST	•		T IN	g/cm2	ATI	ON
	осрти п	SYMBOL		DESCRIP	TION	₹ DIMIS	SOSO			SAMPLE	NUMBER	LIMITER LEVEL	PIEZOMETER INSTALLATION	ní Eo iq	) 2 I	ATER CO	O	10 10 10 10 10 10 10	.50
	70.0		OIL/ROCK CLA	Y: as above	, no gra	vel.	AMPLICATION OF THE PROPERTY OF		TY	03	אָת			10	3	5		70	90
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	-79.0										Maria de la companya de la companya de la companya de la companya de la companya de la companya de la companya							Maria della contra	iii da Ariya ya
	<del>-90.0</del> -		TOT	AL DEPTH = :	91.0 m,							•							

ŀF	PITEAU	ENGINEERING LTD.		OFFI	DE F	REPO	DRT	ON SITE INVESTIGATION SHEET 1 OF 5	i
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Ċ	C CRREL BARR			ER LEVEL TER LEVEL				600D	
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<del>0.0-</del>		/ROOK SILTY CLAY: dark brown, little sand, little gravel, highly reactive slightly		# : # : # : # : # : # : # : # : # : # :	E.	25	H	STICK-JP T0896-1H-10 = 0.38 m STICK-JP T0896-1H-43 = 0.38 m	
L.O		moist, stiff, lон plosticity.							
2.0	2.5							BENTONITE	
3.0		SAND AND SILT TILL: medium to dark brown, little clay, little gravel, very stiff, dry, low plasticity.				g-spring-regularity		51 mm BCH 40 PVC	
1.0			-					480 MF BUTRESS THEEAD PIPE  155 mm DIA HOLE	
			#						
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	-16,0		15.5	Boulder, light grey, finely crystalline 10.5	m).			NATIONAL PROPERTY OF THE PROPE						54	1 mm BO MF HFEAD	BU BU PIPE	10 PVC TRESS		
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							CAMPI E	·c		LOST				3,	. 4	
HE WAS SAFELE R ROCK CORE C CREE BARREL S SPLIT SPUON  DESCRIPTION S SOIL/ROCK  SAFELE S SOIL/ROCK  C CREE BARREL S STATE WHITE LEVEL  DESCRIPTION S SOIL/ROCK  C CREE BARREL S SPLIT SPUON  C CLAYEY SILT: medium brown, some gravel, dry.  BENTONITE																
-21. G -22. D			SAND AND SILT TILL:  as above.  CLAYEY SILT: medium brown,				22	H							70	90
-24.0 -25.0	\$0.50.50.50.50.44/1/H//H//H//H//H//H//H//H//H//H//H//H//H	<u> 24 9</u>	GRAVEL: dark grey, little fin sand and silt.	3								-51 mm		40 PVC TRESS		
-27.0 -23.0	030808	26. <u>9.</u>	FINE GRAVEL AND CDARSE SAND:  angular to well rounded, minor silt and clay.  NDTE: shut down overnight, air—lifted, no water.			The mark of the Control of the State of the						15S n	m OIA	1. HOLE		
3).1					-									OFFICE THE PROPERTY OF THE PRO		

Γ	P	ITEAU E	NGINEERING LTD.	Ĭ	OFFIC	Œ F	REPO	DRT	ON	SITE INVESTI	GATI	)N	SHEET .4.	DF 5.
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	B A H R C	PLE TYPES BULK SAMPLE AUGER SAMPLE HASH SAMPLE ROCK CORE CRREL BARREL SPLIT SPOON	T SÆLE O THIN P THIN ☑ STAT. ☑ DYNN	HALL D HALL P CC HATI	PEN Iston				SAMPLE XXX XXX	CONDITION  DISTURBED  FAIR  6000  LOST	<b>⊕</b> PE	EST IN		ION
	ОСРТН л	S11780,	DESCRIPTION	USCS	BONTS	TYPE	SAMPLE	NUMBER	HATER LEVEL	PIEZOMETER INSTALLATION	∆ SP1 10 X plestic	NATER CO	30 40 NTENT <b>X</b>	50 2 limit 90
•	90.0	SULLYM	FINE GRAVEL AND COARSE SAND: as above.			<u> </u>	3					30		50
	1.0	31.0	CLAY: dark brown, little grave trace sand and silt, moderate stiff, dry low plasticity.	/al,	Target shall develope the second stands to the seco									
	2.0		•									BENTONITE		
	Y.O.	34 N	Coarse sand and gravel :	One of Additional Marketine								100000000000000000000000000000000000000		
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17													7. FULC	
13		\$0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0									38 0			
3		300 00 00 00 00 00 00 00 00 00 00 00 00						i			39.]7	PELTONITE		
4	<u>H</u>	024										0/20 FRA	SAND	

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BO NO	RING RTHI	ND.± NG÷	3773-12-1 TDB95-14 (-10, -43) 6057804 07	Li		ED BY: On: T	ailir		and 2D			BORING DA CONTRACTO ELEVATION	ATE: DR:	Sept Cora 604.3	Ш, Lyni 39 г	199 1 Orî asl	6 Hing	3	,	_
6   6   4   6	AUGE HASH ROCK CRRE	Sample R Sample I Sample Core L Barrel		T SHELB O THIN I P THIN I V STATI	HALL D HALL P C NATE	PEN ISTON IR LEVEL				SAMPLE	CONDITION DISTURBED FAIR 6000		•	TE:	·—····			1AT]	CON	Some
5	SPLI	T 5P00N		▼ DYNAM	IC MAT	ER LEVEL		SAMPLI	 ES		LOST PIEZ	OMETER	;	l SPT B		2 10.3n	3	4		-
DEPTH a	SmBoL	\$011./R0	DESCRIPTION cx		SOSI	25 Sept. 12	TYPE	CONDITION	NUMBER	LIATER LEVEL		KOTTAL		o itlé lli	20	30 R CON ⊕ 50	CUT Y	40 Liquid 70	50 limit	X
9.1	98080	GOZE/ (IO	COARSE SAND AND GRAVEL	:									•	15	ig inn	DIA FRAC	. HOL	Ę	Î	
-41.0	00000	41.0	As above, little clay.							44,44			41	D.						
-2.0	080808													ND	0.0	20 \$	.01 S	CREEN		
						-														
-43.D			TOTAL DEPTH = 42.5 m.	,															-	
4.0																				253000000000000000000000000000000000000
- The state of the																				
- <b>1</b> 5:D																				
-46.0																			-	
PVVII-																			701000000000000000000000000000000000000	
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B(		5 NO.:	3773-12-1 T0B96-15 6057406 .00	COMPILED BY: M LOCATION: Tail EASTING: 6						BORING OF CONTRACTO ELEVATION	OR:	Co	ra L	16, _ynn _mas	Ori	J6 Uir	19	
THE PERSON NAMED IN COLUMN TAXABLE PARTY.	a aug U Wasi R Roci C Crri	TYPES ER SAMPLE H SAMPLE K CORE EL BARREL IT SPOON	0 ₽ ▽	SHELBY TUBE THIN HALL OPEN THIN HALL PISTON STATIC HATER LEVEL DYNAMIC HATER LEVEL			SAMPL	F/ G(	NDITIO ISTURB AIR DOD DST					II OHETE 2	R kg		ATI	ON 4
OEPTH na	SYMBOL		DESCRIPTI		10.54		NOTLIONO	NUMBER	WATER LEYEL	PIEZOTETER CONSTRUCTION DETAILS	X Pla	O stic	z I Iimii	OUS/O O HATER	).3n 30	TENT :	40 X Digui	50 d'ilimit 90
0.0		SOIL/ROS	TOPSOIL: silty, black loose, moist.			- T		Ī	'n			0	3	0	27		70	90
-1,0			SILTY CLAY: light to fine sandy partings, m medium stiff, maist, l	meanum brown, oderately calcareou ой plasticity.	JS,	S						\$		•	,			
-2.0					e conjunction de la constantina della constantin	S					Δ		•					
  -30	11000000	3.2	COARSE SAND AND GRAVEL little clay, poorly so	: medium bгонл, rted.	**OCT HEREO CONTROL **CONTROL STREET TO STREET, THE STREET TO STREET, THE STREET TO STREET, THE STREET				<b>X</b> 3.2							- Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna - Anna		
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-6.0			SAND AND SILT TILL: d to some clay, little g coal, stiff, maist, la	ravel, trace	The state of the s	S									Δ			THE PARTY AND ADDRESS AND ADDR
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f L F	I HASH ROCK CRREI	R SAMPLE SAMPLE CORE L BARREL		T SHELBY TUBE.  0 THIN HALL OPEN P THIN HALL PISTON  ☑ STATIC HATER LEVEL			AMPLE XX III	DIS FAL	00				ST IETROM				ΓIC	N	
	SPLT	T SPOON		▼ DYNAMIC WATER LEVEL	T	SÀ	HPLES	נמ	ST	DIEZOMETED.	<u> </u>	1 SPT	, BLONE	2 20.3	. 3		4	1.	-
ОЕРТН п	凝		DESCRIP	TION	-		8		MATER LEVEL	PIEZOMETER CONSTRUCTION DETAILS	10	) ,	20		30 Intent	40	) .	50	
ı	SYMBOL	SOIL/ROCK				TYPE	CONDITION	NUMBER	MATER		Ti Djas	tic I	HAI Limit 3D		⊕ 50	- 110   70	ould J	اندازا 90	<b>X</b>
10,0			SAND AND SILT TILL:	as above.		S								Δ		•	)		
-11.0																			_
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															NAT OF THE OWNER OWNER OWN				
-13.0				•	Control of the Contro														
-14.0																		_	_
- 15.0					and the second s														
10.0							:												
-16,0		16. D 16. 5	GRAVEL: coòrse, loi	ose.									- Maria - Mari				-		
-17.0			SILTSTONE BEDROCK: laminated	black, finely												_			
11.5				*****					-										
-18.0°			TOTAL DEPTH = 17.5 i	1.					Í										
עיענ												The state of the s		Manager of the latest of the l			VALUE AND THE PARTY OF THE PART	ribert of the stand of the standard of the sta	The second of th
-19,D		•										Semilitaria de la constitución d							
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COI	NTRAC RING	AU ENGINEERING T NO.: 3773-12-1 NO.: TOB96-16	COMPILEO BY: M. I LOCATION: Tailing	Brewster as Pond	ÓΝ	S	ITE	INVESTI  BORING DA  CONTRACTO ELEVATION	TE Se		, 1996 n Oril	ET , 1.	OF 2.
SAM A H R	HASH ROCK CRREL	(PES SAMPLE SAMPLE	EASTING 621  T SHELBY TUBE  O THIN WALL OPEN P THIN WALL PISTON  STATIC WATER LEVEL  TO DYNAMIC HATER LEVEL		SAMPLE	DI FA 60 LO	STURB IR OO	JN .	TE • P	EST I	ENFOF	RMATI	EON
ОЕРТИ п	SYMBOL	DE SOIL/ROCK	SCRIPTION	TYPE SI	CONDITION	NUMBER	NATER LEVEL	PIEZOMETER CONSTRUCTION DETAILS	X plastic 10	PT BLOUS 20 HAT Limit 30	70.3m 30 ER CONTE ⊕ 50	140 NT <b>X</b> Îiqu 70	50 id limi 90
<del>.0,0-</del>	  -  -	SILT: ligh	brown, little sond, es, loose, dry.	S							110000000000000000000000000000000000000		
-1.0													
20		2.0 SANO: dork grained, po loose, slig	brown, fine to medium orly sarted, little gravel, otly moist.										
3.0		to some cla	_T TILL: dark brown, little v, little gravel, moderately t, very low plasticity.						The state of the s				
4.0					erakeraken en kanalarakkan kanalaraken kanalaraken kanalaraken kanalaraken kanalaraken kanalaraken kanalaraken								
5.0		5.0 As above, to	race cool, very stiff.	S,						Δ	•		
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ſ	PITE	EAU EN	GINEERING LTD.	OFFICE REP	ORT	ON	S	ITE	INVESTI	GΑ	TI	DN		SH	EET	, <u>Z</u> , 1	OF ?	2
Ð			3773-12-1 F0895-15 5057145.00	COMPILED BY: M. Brew LOCATION: Toilings P EASTING: 621787.	ond				BORING DA CONTRACTO ELEVATION	R	Cor	ot ra L ) ma	ynn	199E Dril	ling			
		R SAMPLE I SAMPLE		T SHELBY TUBE O THIN WALL OPEN P THIN WALL PISTON		SAMPL	OI FA	STURB IR						NFO R kg/		TI	DN.	
	C CRRE	l Barrel It spoon		▼ STATIC MATER LEVEL ▼ DYNAMIC MATER LEVEL		27	L0				1		2,	1	3	t 4	!1	
-	_ 1		DESCRIP	TTON	Si	AMPLES		.VEL	PIEZOMETER CONSTRUCTION		∆ SP O	T BLC 20		.3n 30		40	51	0
DEPTH .		SOIL/ROCK	DESUNTE	1 1014	TYPE	CONDITION	NUMBER	UATER LEYEL	DETAILS	X Pla	stic O	lini 30	ŧ	CONTI	ENT %	iquid 70	ilia 9	it X
<del>-10.</del> -11.			CLAY AND SILT TILL:	as above, hard	S									•				
-12.		12.0	SILTSTONE BEDROCK:	dark grey, Finely		And the state of t												ANA VIII AMA ANA ANA ANA ANA ANA ANA ANA ANA ANA
-13.			lominated.															
-14.			TOTAL OEPTH = 13.5	1														
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-16.		An employment of the special					West-www.camper.com				And district the state of the s							
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					Painting Address of the Painti					Surrivates Courter of								
-19												-						

#### APPENDIX III

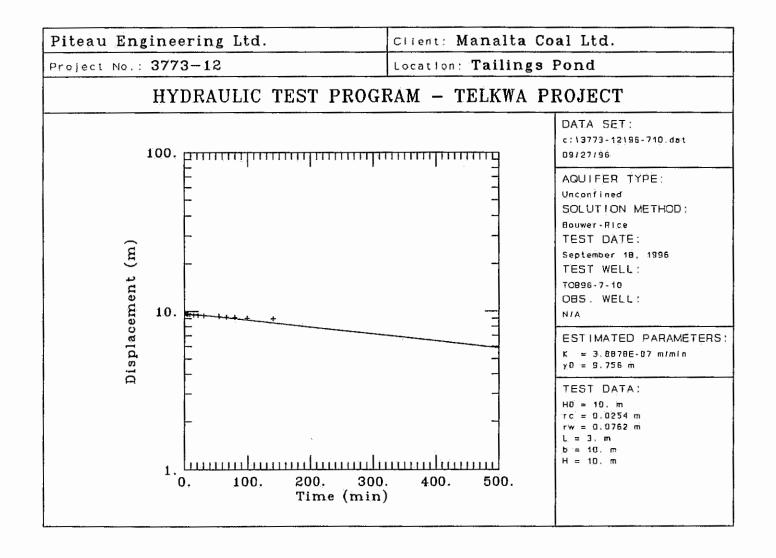
HYDRAULIC CONDUCTIVITY TEST DATA AND ANALYSES

Piezometer:	TOB96-07-10
Date:	96/09/18
Hydraulic Conductivity (m/s):	6.5 x 10 <sup>-9</sup>
Piezometer Stick-up (m):	0.65
Screened Interval (mbgs):	7.4 - 10.4
Static Water Level below top of PVC (mbtoc):	1.076

Elapsed Time	Drawdown	
(min:sec)	(m)	_
0:54	9.77	
1:30	9.74	
1:58	9.73	
2:48	9.73	
3:36	9.64	
3:55	9.61	
5:30	9.57	
8:25	9.52	
14:30	9.47	
21:30	9.42	
30:45	9.37	
55:00	9.27	
66:30	9.18	
79:34	9.12	
99:00	9.05	
140:00	8.94	
1370:00	2.14	

#### Notes:

- 1. mbgs = metres below ground surface
- 2. mbtoc = metres below top of casing

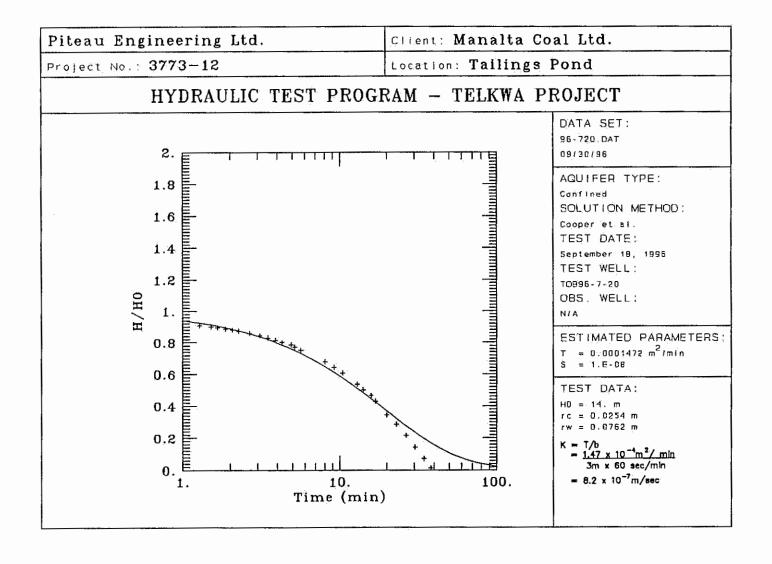


Piezometer:	TOB96-07-20
Date:	96/09/18
Hydraulic Conductivity (m/s):	$8.2 \times 10^{-7}$
Piezometer Stick-up (m):	0.65
Screened Interval (mbgs):	16.6 - 19.6
Static Water Level below top of PVC (mbtoc):	flowing

Elapsed Time	Drawdown
(min:sec)	(m)
1:17	12.70
1:31	12.60
1:40	12.50
1:52	12.40
2:04	12.30
2:16	12.20
2:40	12.00
3:05	11.80
3:29	11.60
3:54	11.40
4:18	11.20
4:45	11.00
5:10	10.80
5:39	10.50
8:03	9.50
9:13	9.00
10:25	8.50
12:55	7.50
14:05	7.00
15:53	6.50
16:55	6.00
20:00	4.80
23:00	4.00
26:30	3.00
30:20	2.00
34:35	1.00
38:20	0.20

#### Notes

- 1. mbgs = metres below ground surface
- 2. mbtoc = metres below top of casing



APPENDIX IV

LABORATORY REPORTS

Calgary: 2021 - 41st Avenue N.E., T2E 6P2, Telephone (403) 291-3077, FAX (403) 291-9468 Edmonton: 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

#### PITEAU ENGINEERING LIMITED SUSAN LECLERC

DATE

: October 9, 1996

CHEMEX PROJECT NO .: PITE192-0501-96-03529

CLIENT REFERENCE

CLIENT JOB NO.

: PROJ.#3773-12

Analytical Data Reviewed By

QA/QC Reviewed By

The above signatures indicate that the individuals identified have reviewed the enclosed documents.

NOTE: Soil samples and water samples (for stable parameters) will be retained for a period of 60 days after completion of analysis. Retention beyond this period can be arranged for a fee.

CHEMEX Labs Alberta Inc. is accredited by both the Canadian Association for Environmental Analytical Laboratories and the Standards Council of Canada for specific parameters registered with the Association and the Council.

algary: 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468 Edmonton: 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

Sample Description : TOB95-7-10 Sample Date & Time : 18-09-96

Sampled By : RSC Sample Type : GRAB

Sample Received Date: September 25, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number : 96-03529-3 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

WATER

Report Date

: October 9, 1996

Analysis Date : October 2, 1996

ARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	RESU	LIMIT DETECTION	MILLI EQUIVALENTS
lcium - (ICP) Total	020005	mg/L	26.	5 0.01	1.322
alcium - (ICP) Dissolved	020111	mg/L	26.	2 0.01	1.307
Magnesium - (ICP) Total	012005	mg/L	14.	4 0.01	1.185
Magnesium - (ICP) Dissolved	012111	mg/L	14.	2 0.01	1.169
Sodium - (ICP) Total	011005	mg/L	127.	0.01	5.525
Sodium - (ICP) Dissolved	011111	mg/L	127.	0.01	5.525
otassium - (ICP) Total		mg/L	2.	07 0.02	0.053
otassium -(ICP) Dissolved	019111	mg/L	ı.	73 0.02	0.044
hloride - Dissolved	017206	mg/L	13.	1 0.5	0.369
Sulphate - (IC) Dissolved	016309	mg/L	52.	i 0.1	1.084
P Alkalinity (as CaCO3)	010151	mg/L	< 0.	1.0	
otal Alkalinity (as CaCO3)	010111	mg/L	309,	0.5	
H.	010301	Units	7.	55 0.01	
arbonate	00,6301	mg/L	< 0.	5 0.5	
icarbonate	006201	mg/L	377.	0.5	6.177
otal Hardness (as CaCO3)	010602	mg/L	124.	0.5	
ydroxide	008501	mg/L	<· 0.	5 0.5	
ilicon - Total (ICP)		mg/L	10.	3 0.02	
ilicon - Dissolved (ICP)		mg/L	6.	3.4 0.02	
pecific Conductance	002041	uS/cm	713.	0.02	
otal Dissolved Solids	000201	mg/L	427.	1.	
otal Ammonia Nitrogen	007505	mġ/L	0.	17 0.01	0,012
itrite plus Nitrate Nitrogen as N	007110	mg/L	0.	902 0.003	
otal Dissolved Phosphate as P	015423	mg/L	0:	00B 0.003	
rtho Phosphate as P	015256	mg/L	<· 0.	0.003	
otal Phosphate as P	015406	mg/L	0.	110 0.003	
ulphur - (ICP) - Dissolved		mg/L	15.	9 0.2	
ulphur - (ICP) - Total		mg/L	15.	9. 0.2	
otal Filterable Residue (TDS)	010451	mg/L	460.	0 1,	
on-Filterable Residue (TSS)	010401	mg/L	101:	0.4	
luminum - Total (ICP-MS)	013016	mg/L	2.	78 0.001	
luminum - Dissolved (ICP-MS)		mg/L	< 04	001 0,001	
rsenic - Total (AA)	033005	mg/L	0 -	0015 0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-10 Sample Date & Time : 18-09-96

Sampled By

: RSC

Sample Type : GRAB

Sample Station Code :

Chemex Worksheet Number: 96-03529-3 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

: WATER

Report Date

: October 9, 1996

PARAMETER	DATE	QA/QC		MA	TRIX SPIK	ES	CALI	BRATION C	HECK
	ANALYZED	BATCH DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMITS	
	(DD-MM-YY)	NUM ANAL	Rr	ŧ	LOWER	UPPER	<b>₹</b> .	LOWER	UPPER
Calcium - (ICP) Total	02-10-96	10 SW	1.7	109.7	89.5	115.7	112.5	92.3	116.7
Calcium - (ICP) Dissolved	02-10-96	10 SW	1.7	109.7	89.5	115.7	112.5	92.3	116.7
Magnesium - (ICP) Total	02-10-96	. 10 SW	0.3	98,1	95.3	107.3	97.4	96.5	109.4
Magnesium - (ICP) Dissolved	02-10-96	10 SW	0.3	98.1	95.3	107.3	97.4	96.5	109.4
Sodium - (ICP) Total	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.3
Sodium - (ICP) Dissolved	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.3
Potassium - (ICP) Total	02-10-96	10 SW	0.2	101.3	88.2	112.4	100.8	90.2	112.6
Potassium - (ICP) Dissolved	02-10-96	10 SW	0.2	101.3	88.2	112.4	100.8	90.2	112.6
Chloride - Dissolved	3,0-09-96	10 LAD	1.2	102.2	90.8	108.8	102.8	94.3	105.6
Sulphate - (IC) Dissolved	30-09-96	10 LAD	0.0	103.2	91.3	108.3	104.7	90.7	104
PP Alkalinity (as CaCO3)	NOT APPLI	CABLE							
Total Alkalinity (as CaCO3)	26-09-96	3 AM	1,1	NOT	APPLICABI	Æ	TOM	APPLICAL	BLE
ЭН	26-09-96	3 AM	1.8	TOM	APPLICABI	Æ	TON	APPLICA	BLE
Carbonate	NOT APPLI	CABLE							
Bicarbonate	NOT APPLI	CABLE							
Total Hardness (as CaCO3)	NOT APPLI	CABLE							
Hydroxide	NOT APPLI	CABLE							
Silicon - Total (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60.9	147.
Silicon · Dissolved (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60, 9	147.
Specific Conductance	27-09-96	1 LG	0.2	TOM	APPLICABI	Æ	NOT	APPLICA	BLE
Total Dissolved Solids	NOT APPLI	CABLE							
Total Ammonia Nitrogen	30-09-96	1 PF	0,0	104.0	80, 8	117.3	100.0	90.0	107.
Nitrite plus Nitrate Nitrogen as N	04-10-96	1 PK	0.4	100.6	93.1	105.1	102.0	87.8	107.
Total Dissolved Phosphate as P	30-09-96	1 HO	0.0	96.4	80.9	118.0	94.5	82,2	116.
Ortho Phosphate as P	02-10-96	1 HO	0.0	86.2	80.7	116.6	102.0	86.1	118.
Togal Phosphate as P	30-09-96	7 HO	0.0	96.4	80.9	118.0	94.5	74.8	121.
Sulphur - (ICP) - Dissolved	02-10-96	10 SW	0.4	NOT	APPLICAB	Œ	NOT	APPLICA	BLE
Sulphur - (ICP) - Total	02-10-96	10 SW	0.4	104.0			0.0		
Total Filterable Residue (TDS)	02-10-96	1 BF	0.6	NOT	APPLICAB	LΕ	пои	APPLICA	BLE
Non-Filterable Residue (TSS)	30-09-96	2 BF	2.0	NOT	APPLICAB	ĻE	NO	APPLICA	BLE
Aluminum - Total (ICP-MS)	01-10-96	20 WEM	0.0	120.4	84.0	117.8	107.1	82.8	123.
Aluminum - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	120.4	B4.0	117.8	107.1	91.9	109.
Arsenic - Total (AA)	27-09-96	1 RJL	0.0	97.3	72.1	119.4	97.2	75.3	122.

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Sample Description : TOB96-7-10 Sample Date & Time : 18-09-96

Sampled By : RSC Sample Type : GRAB

Sample Received Date: September 25, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number 96.03529.3 Chemex Project Number PITE192.0501

Sample Access

Sample Matrix : WATER

Report Date : October 9, 1996 Analysis Date : September 27, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R	ESULTS	DETECTION LIMIT	MILLI EQUIVALENTS
Arsenic - Dissolved (AA)	033109	mg/L		0.0012	0.0002	
Barium - Total (ICP-MS)		mg/L		0,115	0.0002	
Barium - Dissolved (ICP-MS)		mg/L		0.0770	0.0002	
Beryllium - Total (ICP-MS)		mg/L	<	0.0002	0.0002	
Beryllium - Dissolved (ICP-MS)		mg/L	c	0,0002	0.0002	
Boron - Total (ICP-MS)		mg/L		0.10	0.01	
Boron - Dissolved (ICP-MS)		mg/L	<	0.01	0.01	
Cadmium - Total (ICP-MS)	048023	mg/L		0,0021	0.0002	
Cadmium - Dissolved (ICP-MS)		mg/L		0,0005	0.0002	
Chromium - Total (ICP-MS)		mg/L	<	0.001	0.001	
Chromium - Dissolved (ICP-MS)	•	mg/L	<	0.001	0.001	
Cobalt - Total (ICP-MS)	027016	mg/L		0.0011	0',0003	
Cobalt - Dissolved (ICP-MS)		mg/L		0.0003	0.,0003	
Copper - Total (ICP-MS)	029016	mg/L		0.0044	0.0002	
Copper - Dissolved (ICP-MS)		mg/L		0.0040	0.0002	
Iron - Total (ICP-AES)	026009	mg/L		3.80	0.01	
Iron - Dissolved (ICP-AES)	026109	mg/L		0.06	0.01	
Lead - Total (ICP-MS)	082016	mg/L		0.0042	0.0003	
Lead - Dissolved (ICP-MS)		mg/L	<	0,0003	0.0003	
Lithium - Total (ICP-AES)	003009	mg/L		0.012	0.001	
Lithium - Dissolved (ICP-AES)	003109	mg/L		0.011	0.001	
Manganese - Total (ICP-MS)		mg/L		0.161	0.001	
Manganese - Dissolved (ICP-MS)		mg/L		0.079	0.001	
Mercury - Total (CVAA)	080011	ug/L	<	0.05	0.05	
Mercury - Dissolved (CVAA)	080101	ug/L	¢	0.05	0.05	
Molybdenum - Total (ICP-MS)		mg/L		0.0058	0.0002	
Molybdenum - Dissolved (ICP-MS)		mg/L		0.0035	0.0002	ч
Nickel - Total (ICP-MS)	028016	mg/L	<	0.0005	0.0005	
Nickel - Dissolved (ICP-MS)		mg/L	<	0.0005	0.0005	
Phosphorus - Total (ICP-AES)		mg/L	<	0.1	0.1	
Phosphorus - Dissolved (ICP-AES)	015450	mg/L	·<	0.1	0.1	
Selenium - Total (AA)	034005	mg/L	<	0.0002	0.0002	
Selenium - Dissolved (AA)	034105	mg/L	<	0.0002	0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-10 Sample Date & Time : 18-09-96

Sampled By

: RSC GRAB

Sample Type Sample Station Code : Chemex Worksheet Number : 96-03529-3

Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

: WATER

Report Date

: October 9. 1996

PARAMETER	DATE	QA/QC		MA	TRIX SPIKES		CALIBRATION CH		HECK
	ANALYZED	BATCH	DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMITS
	(DD-MM-YY)	LANA MUN	Rr	¥	LOWER	UPPER	<b>*</b>	LOWER	UPPER
Arsenic - Dissolved (AA)	27-09-96	1 RJL	00	973	72.1	119.4	97.2	75.3	122.4
Barium - Total (ICP-MS)	01-10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Barium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Beryllium - Total (ICP-MS)	01-10-96	20 WEM	2.0	138.6	75.3	121.2	93.5	80.1	120.
Beryllium - Dissolved (ICP-MS)	01-10-96	20 WEM	2.0	138.6	75.3	121.2	93.5	80.1	120.
Boron - Total (ICP-MS)	01-10-96	20 WEM	0.0	85.4	71.5	136.2	98.2	76.3	127.
Boron - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	85.,4	71.5	136.2	98.2	76.3	127.
Cadmium - Total (ICP-MS)	01-10-96	20 WEM	3.2	108.5	78.1	120.3	113.6	83.4	114.
Cadmium - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	108.5	78.1	120.3	113.6	83.4	114.
Chromium - Total (ICP-MS)	01-10-96	20 WEM	0.0	103.2	76.8	117.8	87.3	87.7	113.
Chromium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	103.2	76.8	117.8	87.3	87.7	113.
Cobalt - Total (ICP-MS)	01-10-96	20 WEM	3.2	97.1	80.1	114.1	96.4	86.0	113.
Cobalt - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	97.1	80.1	114.1	96.4	86.1	113.
Copper - Total (ICP-MS)	01-10-96	20 WEM	0.0	114.2	79.0	115.4	80.6	83.5	115.
Copper - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	114.2	79.0	115.4	80.6	83.7	115.
iron - Total (ICP-AES)	02-10-96	10 SW	0.0	110.5	88.8	114.6	110.0	92.2	112.
Iron - Dissolved (ICP-AES)	02~10-96	10 SW	0.0	110.5	8.88	114.6	110.0	92.2	112.
Lead - Total (ICP-MS)	01-10-96	.20. WEM	3.2	100.2	80.5	116.9	103.2	77.8	129.
Lead - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	100.2	80.5	116.9	103.2	85.3	113.
Lithium - Total (ICP-AES)	02-10-96	10 SW	0.0	95.2	74.2	111.3	95.2	82.6	107.
Lithium - Dissolved (ICP-AES)	02-10-96	10 SW	0.0	95.2	74.2	111.3	95.2	82.6	107.
Manganese - Total (ICP-MS)	01-10-96	20 WEM	0:.0	117.6	80.8	119.6	102.9	87.4	114.
Manganese - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	117.6	80.8	119.6	102.9	87.4	114.
Mercury - Total (CVÁA)	02-10-96	1 CH	Ö . O,	100.0	66.0	132.7	95.6	69.9	131.
Mercury - Dissolved (CVAA)	02-10-96	1 CH	0;.0	100.0	66.0	132.7	95.6	69.9	131.
Molybdenum - Total (ICP-MS)	01-10-96	20 WEM	3.2	91.1	87.0	117.6	107.3	90.5	109.
Molybdenum - Dissolved (ICP-MS)	01-10-96	20 WEM	3,.2	91.1	87.0	117.6	107.3	90.5	109.
Nickel - Total (ICP-MS)	01-10-96	20 WEM	0.0	101.4	78.4	116.6	105.9	83.3	118.
Nickel - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	101.4	78.4	116.6	105.9	83.3	118.
Phosphorus - Total (ICP-AES)	02-10-96	10 SW	0.8	99.5	84.0	113.4	101.6	85.1	110,
Phosphorus - Dissolved (ICP-AES)	02-10-96	10 SW	0 : 8	99.5	84.0	113.4	101,6	85.1	110.
Selenium - Total (AA)	27-09-96	1 RJL	0.0	88.0	79.2	120.7	97.2	76.6	122.
Selenium - Dissolved (AA)	27-09-96	1 RJL	0.0	B8.0	79.2	120.7	97.2	76.6	122.

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Sample Description : TOB96-7-10 Sample Date & Time : 18-09-96 Sampled By : RSC

Sample Type : GRAB

Sample Received Date: September 25, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number : 96-03529-3 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix : WATER

Report Date : October 9, 1996 Analysis Date : October 1, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R	ESULTS	DETECTION	MILLI EQUIVALENTS
Silver - Total (ICP-MS)	047016	mg/L	٠.	0.0001	0.0001	
Silver - Dissolved (ICP-MS)		mg/L	<	0.0001	0.0001	
Strontium - Total (ICP-MS)		mg/L		0.380	0.002	
Strontium - Dissolved (ICP-MS)		mg/L		0.361	0.002	
Titanium - Total (ICP-MS)		mg/L		0.079	0.001	
Titanium - Dissolved (ICP-MS)		mg/L		0.036	0.001	
Uranium - Total (ICP-MS)		mg/L		0.0094	0.0004	
Uranium - Dissolved (ICP-MS)		mg/L		0.0090	0.0004	
Vanadium - Total (ICP-MS)		mg/L		0.011	0.001	
Vanadium - Dissolved (ICP-MS)		mg/L		0.004	0.001	
Zinc - Total (ICP-MS)		mg/L		0.0479	0.0006	
Zinc - Dissolved (ICP-MS)		mg/L	<	0.0006	0.0006	
Ion Balance		Balance		1.05	0,01	

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PROJ.#3773-12

Sample Description : TOB96-7-10 Sample Date & Time : 18-09-96

Sampled By : RSC

: GRAB

Sample Type Sample Station Code : Chemex Worksheet Number: 96-03529-3 Chemex Project Number : PITE192-0501

PITEAU ENGINEERING LIMITED

ATTENTION : SUSAN LECLERC

Sample Access

Sample Matrix

: WATER

Report Date

: October 9, 1996

PARAMETER	DATE	QA/QC		MATRIX SPIKES			CALIBRATION CHECK		
	ANALYZED BATCH		DUP	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMITS	
	(DD-MM-YY)	NUM ANAL	Rr	¥	LOWER	UPPER	*	LOWER	UPPER
Silver - Total (ICP-MS)	01-10-96	20 WEM	0.0	78.9	77.7	117.7	94.7	87.3	111.0
Silver - Dissolved (ICP-MS)	01-10-96	20 WEM	D.0	78.9	77.7	117,7	94.7	87.3	111.0
Strontium - Total (ICP-MS)	01-10-96	20 WEM	0.0	98.2	87.5	111.6	105.4°	86.4	111.2
Strontium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	98.2	87.5	111.6	105.4	86.4	111.2
Titanium - Total (ICP-MS)	01-10-96	20 WEM	0.0	73.8	68.1	123.7	109.1	82.2	114.9
Titanium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	73.8	68.1	123.7	109.1	82.2	114.9
Uranium - Total (ICP-MS)	01-10-96	20 WEM	1.6	98.6	77.0	125.0	99.1	81.5	114.2
Uranium - Dissolved (ICP-MS)	01-10-96	20 WEM	1.6	98.6	77.0	125.0	99.1	81.5	114.2
Vanadium - Total (ICP-MS)	01-10-96	20 WEM	0.0	101.2	74.5	119.8	89.5	88.5	111.9
Vanadium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	101.2	74.5	119.8	89.5	88.5	111.9
Zinc - Total (ICP-MS)	01-10-96	20 WEM	3.2	85.6	57.4	147.3	110.0	84.3	119.6
Zinc - Dissolved (ICP-MS)	01-10-96	20 WEM	3,2	85.6	57.4	147.3	110.0	84.3	119.6

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Sample Description : TO896-7-20 Sample Date & Time : 18-09-96

Sampled By : RSC
Sample Type : GRAB

Sample Received Date: September 24, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number : 96-03529-1. Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix : WATER

Report Date

: November 21, 1996

Analysis Date : October 2. 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	RESULTS	DETECTION LIMIT	MILLI EQUIVALENTS
Calcium - (ICP) Total	020005	mg/L	23.2	0.01	1.158
Calcium - (ICP) Dissolved	020111	mg/L	23.0	0.01	1.148
agnesium - (ICP) Total	012005	mg/L	10.8	0.01	0.889
Magnesium - (ICP) Dissolved	012111	ωā∖Γ	9.84	0.01	0.810
odium - (ICP) Total	011005	mg/L	244.	0.01	10.614
odium - (ICP) Dissolved	011111	mg/L	244.	0.01	10.614
otassium - (ICP) Total		mg/L	3.71	0.02	0.095
otassium - (ICP) Dissolved	019111	mg/L	3'.66	0.02	0.094
hloride - Dissolved	017206	mg/L	29.2	0.5	0.823
ulphate - (IC) Dissolved	016309	mg/L	16.3	0.1	0.339
P Alkalinity (as CaCO3)	010151	mg/L	< 0.1	0.1	
otal Alkalinity (as CaCO3)	010111	mg/L	550.	0.5	
н	010301	Units	7.99	0.01	
arbonate	006301	mg/L	< 0.5	0.5	
icarbonate	006201	mg/L	670.	0.5	10.995
otal Hardness (as CaCO3)	010602	mg/L	98.0	0.5	
ydroxide	008501	mg/L	< 0.5	0.5	
ilicon - Total (ICP)	W	mg/L	5.10	0.02	
ilicon - Dissolved (ICP)		mg/L	4.59	0.02	
pecific Conductance	002041	uS/cm	1084.	0.02	
otal Dissolved Solids	000201	mg/L	676.	.1.	
otal Ammonia Nitrogen	007505	mg/L	0.50	0.01	0.036
itrite plus Nitrate Nitrogen as N	007110	mg/L	0.037	0.003	
otal Dissolved Phosphate as P	015423	mg/L	0.004	0.003	
rtho Phosphate as P	015256	mg/L	< 0.003	0.003	
otal Phosphate as P	015406	mg/L	0.027	0.003	
ulphur - (ICP) - Dissolved	*4	mg/L	5.4	0.2	
ulphur - (ICP) - Total		mg/L	9.0	0.2	
otal Filterable Residue (TDS)	010451	mg/L	688.	1.	
on-Filterable Residue (TSS)	010401	mg/L	21.0	0.4	
luminum - Total (ICP-MS)	013016	mg/L	0.713	0.001	
luminum - Dissolved (ICP-MS)		mg/L	< 0.001	0.001	
rsenic - Total (AA)	033,005	mg/L	0.0007	0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-20 Sample Date & Time : 18-09-96

Sample Type : GRAB

Sampled By

Sample Station Code :

Chemex Worksheet Number: 96-03529-1 Chemex Project Number : PITE192-0501

Sample Access

: WATER

Sample Matrix Report Date

: November 21, 1996

PARAMETER	DATE QA/QC			MATRIX SPIKES			CALI	BRATION C	HECK
	ANALYZED	BATCH	DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMIT
	(DD-MM-YY)	AMAL MUM	Rr	ŧ	LOWER	UPPER	*	LOWER	UPPE
Calcium - (ICP) Total	02-10-96	10 SW	1.7	109.7	89.5	115.7	112.5	92.3	116.
Calcium - (ICP) Dissolved	02-10-96	10 SW	1.7	109.7	89.5	115.7	112.5	92.3	116.
Magnesium - (ICP) Total	02-10-96	10 SW	0.3	98.1	95.3	107.3	97.4	96.5	109.4
Magnesium - (ICP) Dissolved	02-10-96	10 SW	0.3	98.1	95.3	107.3	97.4	96.5	109.
Sodium - (ICP) Total	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.
Sodium - (ICP) Dissolved	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.3
Potassium - (ICP) Total	02-10-96	10 SW	0.2	101.3	88,2	112.4	100.8	90.2	112.6
Potassium - (ICP) Dissolved	02-10-96	10 SW	0.2	101.3	88.2	112.4	100.8	90.2	112.
Chloride - Dissolved	30-09-96	10 LAD	1.2	102.2	90.8	108.8	102.8	94.3	.105.
Sulphace ~ (IC) Dissolved	20-11-96	10 AM	0.0	100.8	91.3	108.3	98.4	90.7	104.
PP Alkalinity (as CaCO3)	NOT APPLI	CABLE							
Total Alkalinity (as CaCO3)	26-09-96	3 AM	1.1	NOT	APPLICABL	E	NOT	APPLICAE	BLE
PH	26-09-96	3 AM	1.8	NOT	APPLICABL	E	NOT	APPLICAE	LE
Carbonate	NOT APPLI	CABLE							
Bicarbonate	NOT APPLI	CABLE							
Total Hardness (as CaCO3)	NOT APPLI	CABLE							
Hydroxide	NOT APPLI	CABLE							
Silicon - Total (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60.9	147.
Silicon - Dissolved (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60.9	147.
Specific Conductance	27-09-96	1 LG	0.2	NOT	APPLICABL	Æ	NOT	APPLICAE	LE
Total Dissolved Solids	NOT APPLI	CABLE							
Total Ammonia Nitrogen	30-09-96	1 BF	0.0	104.0	80.8	117.3	100.0	90.0	107.
Nitrite plus Nitrate Nitrogen as N	04-10-96	1 PK	0.4	100.6	93.1	105.1	102.0	87.8	107.
Total Dissolved Phosphate as P	30-09-96	1 HO	0.0	96.4	80.9	118.0	94.5	82.2	116.
Ortho Phosphate as P	02-10-96	1 HO	0.0	86.2	80.7	116.6	102.0	86.1	118.
Total Phosphate as P	30-09-96	1 HO	0.0	96.4	80.9	118.0	94.5	74.8	121.
Sulphur - (ICP) - Dissolved	02-10-96	10 SW	0.4	NOT	APPLICABL	E	NOT	APPLICAE	LE
Sulphur - (ICP) - Total	02-10-96	10 SW	0.4	104.0			0.0		
Total Filterable Residue (TDS)	02-10-96	1 BF	0.6	NOT	APPLICABL	E	NOT	APPLICAE	BLE
Non-Filterable Residue (TSS)	30-09-96	2 BF	2.0	NOT	APPLICABL	E	NOT	APPLICAE	LE
Aluminum - Total (ICP-MS)	01-10-96	20 WEM	0.0	120.4	84.0	117.8	107.1	82.8	123.
Aluminum - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	120.4	84.0	117.8	107.1	91.9	109.
Arsenic - Total (AA)	27-09-96	1 RJL	0.0	97.3	72.1	119.4	97.2	75.3	122.

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Sample Description : TO896-7-20

Sample Date & Time : 18-09-96

Sampled By Sample Type : RSC : GRAB

Sample Received Date: September 24, 1996

Sample Station Code :

# PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number: 96-03529-1 Chemex Project Number: PITE192-0501

Sample Access

Sample Matrix

: WATER

Report Date

: November 21, 1996

Analysis Date

: September 27, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R	ESULTS	DETECTION LIMIT	MILLI EQUIVALENTS
Arsenic - Dissolved (AA)	033109	mg/L		0.0002	0.0002	
Barium - Total (ICP-MS)	•	mg/L		0.140	0.0002	
Barium - Dissolved (ICP-MS)		mg/L		0.0320	0.0002	
Beryllium - Total (ICP-MS)		mg/L	<	0.0002	0.0002	
Beryllium - Dissolved (ICP-MS)		mg/L	<	0.0002	0.0002	
Boron - Total (ICP-MS)		mg/L		0.24	0.01	
Boron - Dissolved (ICP-MS)		mg/L		0.10	0.01	
Cadmium - Total (ICP-MS)	048023	mg/L		0.0007	0.0002	
Cadmium - Dissolved (ICP-MS)		mg/L	ͺ <	0.0002	0.0002	
Chromium - Total (ICP-MS)		mg/L	•	0.039	0.001	
Chromium - Dissolved (ICP-MS)	-	mg/L	·<	0.001	0.001	
Cobalt - Total (ICP-MS)	027016	mg/L		0.0290	0.0003	
Cobalt - Dissolved (ICP-MS)		mg/L	<	0.0003	0.0003	
Copper - Total (ICP-MS)	029016	mg/L		0.0040	0.0002	
Copper - Dissolved (ICP-MS)		mg/L	<	0.0002	0.0002	
Iron - Total (ICP-AES)	026009	mg/L		1.26	0.01	
Iron - Dissolved (ICP-AES)	026109	mg/L		0.03.	0.01	
Lead - Total (ICP-MS)	082016	mg/L		0.0021	0.0003	
Lead - Dissolved (ICP-MS)	•	mg/L	<	0.0003	0,0003	
Lithium - Total (ICP-AES)	003009	mg/L		0.013	0.001	
Lithium - Dissolved (ICP-AES)	003109	mg/L		0.011	0.001	
Manganese - Total (ICP-MS)		mg/L		0.752	0.001	
Manganese - Dissolved (ICP-MS)		mg/L		0.019	0,001	
Mercury - Total (CVAA)	080011	ug/L	¢.	0.05	0.05	
Mercury - Dissolved (CVAA)	080101	ug/L	<	0.05	0.05	
Molybdenum - Total (ICP-MS)		mg/L	<	0.0002	0.0002	
Molybdenum - Dissolved (ICP-MS)	4	mg/L	<	0,0002	0.0002	
Nickel - Total (ICP-MS)	028016	mg/L	<	0.0005	0.0005	
Nickel - Dissolved (ICP-MS)		mg/L	<	0.0005	0.0005	
Phosphorus - Total (ICP-AES)		mg/L	ج.	0.1	0.1	
Phosphorus - Dissolved (ICP-AES)	015450	mg/L	ċ	0.1	0.1	
Selenium - Total (AA)	034005	mg/L	<	0.0002	0.0002	
Selenium - Dissolved (AA)	034105	mg/L	č	0.0002	0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION: SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-20 Sample Oate & Time : 18-09-96

Sampled By

: RSC

Sample Type

: GRAB

Sample Station Code :

Chemex Worksheet Number: 96-03529-1 Chemex Project Number : PITE192-0501

Sample Access

: WATER

Sample Matrix Report Date

: November 21, 1996

PARAMETER	DATE	QA/QC		MA	TRIX SPIR	ES	CALI	BRATION C	HECK
	ANALYZED	BATCH	DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMITS
	(DD-MM-YY)	NUM ANAL	Rr.	ŧ	LOWER	UPPER	*	LOWER	UPPER
Arsenic - Dissolved (AA)	27-09-96	1 RJL	0.0	97.3	72.1	119.4	97.2	75.3	122.4
Barium - Total (ICP-MS)	01-10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Barium - Dissolved (ICP-MS)	01~10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Beryllium - Total (ICP-MS)	01-10-96	20 WEM	2.0	138.6	75.3	121.2	93.5	80.1	120.4
Beryllium - Dissolved (ICP-MS)	01-10-96	20 WEM	2.0	138.6	75.3	121.2	93.5	80.1	120.4
Boron - Total (ICP-MS)	01-10-96	20 WEM	0.0	85.4	71.5	136.2	98.2	76.3	127.8
Boron - Dissolved (ICP-MS)	01-10-96	20. WEM	0.0	85.4	71.5	136.2	98.2	76.3	127.8
Cadmium - Total (ICP-MS)	01-10-96	20 WEM	32	108.5	78.1	120.3	113.6	83.4	114.8
Cadmium - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	108.5	78.1	120.3	113.6	83.4	114.8
Chromium - Total (ICP-MS)	01-10-96	20 WEM	0.0	103.2	76.8	117.8	87.3	87.7	113.8
Chromium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	103.2	76.8	117.8	87.3	87.7	113.8
Cobalt - Total (ICP-MS)	01-10-96	20 WEM	3.2	97.1	80.1	114.1	96.4	86.0	113.1
Cobalt - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	97.1	80.1	114.1	96.4	86.1	113.1
Copper - Total (ICP-MS)	01-10-96	20 WEM	0.0	114.2	79.0	115.4	80,6	83.5	115.1
Copper - Dissolved (ICP-MS)	01-10-96	20 WEM	00	114.2	79.0	115.4	80.6	83.7	115.1
Iron - Total (TCP-AES)	02-10-96	10 SW	0.0	110.5	88.8	114.6	110.0	92.2	112.0
Iron - Dissolved (ICP-AES)	02-10-96	10 SW	0.0	110.5	88.8	114.6	110.0	92.2	112.0
Lead - Total (ICP-MS)	01~10~96	20 WEM	3.2	100.2	80.5	116.9	103.2	77.8	129.8
Lead - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	100.2	80.5	116.9	103.2	85.3	113.9
Lithium - Total (ICP-AES)	02-10-96	10. SW	0.0	95.2	74.2	111.3	95.2	82.6	107.0
Lithium - Dissolved (ICP-AES)	02-10-96	10 SW	0.0	952	74.2	111.3	95.2	82.6	107.0
Manganese - Total (ICP-MS)	01-10-96	20 WEM	0.0	117.6	80.8	119.6	102.9	87.4	114.7
Manganese - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	117.6	80, 8	119.6	102.9	87.4	114.7
Mercury - Total (CVAA)	02-10-96	1 CH	0.0	100.0	66.0	132.7	95.6	69.9	131.2
Mercury - Dissolved (CVAA)	02-10-96	1 CH	0.0	100.0	66.0	132.7	95.6	69.9	131.2
Molybdenum - Total (ICP-MS)	01-10-96	20 WEM	3.2	91.1	87.0	117.6	107.3	90.5	109.8
Molybdenum - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	91.1	87.0	117.6	107.3	90.5	109.8
Nickel - Total (ICP-MS)	01-10-96	20 WEM	0.0	101,.4	78.4	116.6	105.9	83.3	118.4
Nickel - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	101.4	78.4	116.6	105.9	83.3	118.4
Phosphorus - Total (ICP-AES)	02-10-96	10 SW	0 ; 8.	99.5	84.0	113.4	101.6	85.1	110.0
Phosphorus - Dissolved (ICP-AES)	02-10-96	10 SW	0.8	99.5	84.0	113.4	101.6	85.1	110.0
Selenium - Total (AA)	27-09-96	1 RJL	0.0	88.0	79.2	120.7	97.2	76.6	122.4
Selenium - Dissolved (AA)	27-09-96	1 RJL	0.0	88.0	79.2	120.7	97.2	76.6	122.4

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Sample Date & Time : 18-09-96

Sampled By : RSC Sample Type : GRAB

Sample Received Date: September 24, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number : 96-03529-1 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix : WATER

Report Date Analysis Date : November 21, 1996

e : October 1, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R	ESULTS	DETECTION	MILLI EQUIVALENTS
Silver - Total (ICP-MS)	047016	mg/L	<	0.0001	0.0001	
Silver - Dissolved (ICP-MS)		mg/L	<	0.0001	0.0001	
Strontium - Total (ICP-MS)		mg/L		0.860	0.002	
Strontium - Dissolved (ICP-MS)		mg/L		0.719	0.002	
Titanium - Total (ICP-MS)		mg/L		0.024	0.001	
Titanium - Dissolved (ICP-MS)		mg/L		0.113	0.001	
Uranium - Total (ICP-MS)		mg/L		0.0074	0.0004	
Uranium - Dissolved (ICP-MS)	ь.	mg/L		0.0074	0.0004	
Vanadium - Total (ICP-MS)		mg/L	<	0.001	0.001	
Vanadium - Dissolved (ICP-MS)		mg/L	<	0.001	0.001	
Zinc - Total (ICP-MS)		mg/L		0.0556	0.0006	
Zinc - Dissolved (ICP-MS)		mg/L	<	0.0006	0.0006	
Ion Balance		Balance		1.02	0.01	

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Sample Description : TOB96-7-20 Sample Date & Time : 18-09-96

Sampled By

Sample Type

: RSC : GRAB

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number: 96-03529-1

Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

: WATER

Report Date

: November 21, 1996

PARAMETER	DATE	QA/QC		MATRIX SPIKES			CALIBRATION CHECK		
	ANALYZED	BATCH	פטם	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMIT	
	(DD-MM-YY)	IANA MUN	Rr	*	LOWER	UPPER	¥	LOWER	UPPER
Silver - Total (ICP-MS)	01-10-96	20 WEM	0.0	78.9	77.7	117.7	94.7	87.3	111.0
Silver - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	78.9	77.7	117.7	94.7	87.3	111.0
Strontium - Total (ICP-MS)	01-10-96	20 WEM	0.0	98.2	87.5	111.6	105.4	86.4	111.2
Strontium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	98.2	87.5	111.6	105.4	86.4	111.2
Titanium - Total (ICP-MS)	01-10-96	20 WEM	0.0	73.8	68.1	123.7	109.1	82.2	114.9
Titanium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	73.8	68.1	123.7	109.1	82.2	114.9
Uranium - Total (ICP-MS)	01-10-96	20 WEM	1.6	98.6	77.0	125.0	99.1	81,.5	114.2
Uranium - Dissolved (ICP-MS)	01-10-96	20 WEM	1.6	98.6	77.0	125.0	99.1	81.5	114.2
Vanadium - Total (ICP-MS)	01-10-96	20 WEM	D.0	101.2	74.5	119.8	89.5	88.5	111.9
Vanadium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	101.2	74.5	119.8	89.5	88.5	111.9
Zinc - Total (ICP-MS)	01-10-96	20 WEM	3.2	85.6	57.4	147.3	110.0	84.3	119.6
Zinc - Dissolved (ICP-MS)	01-10-96	20 WEM	3.2	85.6	57.4	147.3	110.0	84.3	119.6

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Sample Description : TOB96-7-21 (Du, Locale Ja, 7 0 Bab- 7-20)
Sample Date & Time - 20-00:06

Sample Date & Time : 20-09-96

Sampled By : RSC : GRAB Sample Type

Sample Received Date: September 25, 1996

Sample Station Code :

PROJ.#3773-12

Chemex Worksheet Number: 96-03529-20 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

WATER

Report Date

: October 9, 1996

Analysis Date

: October 2, 1996

RAMETER DESCRIPTION	NAQUADAT CODE	UNITS	F	RESULTS	DETECTION LIMIT	MILLI EQUIVALENTS
lcium - (ICP) Total	020005	mg/L		22,7	0.01	1.133
lcium - (ICP) Dissolved	020111	mg/L		22.7	0.01	1.133
gnesium - (ICP) Total	012005	mg/L		10.9	0.01	0.897
gnesium - (ICP) Dissolved	012111	mg/L		10.9	0.01	0.897
dium - (ICP) Total	011005	mg/L		241.	0.01	10.484
dium - (ICP) Dissolved	011111	mg/L		241.	0.01	10.484
tassium -{ICP} Total		mg/L		3.59	0.02	0.092
tassium - (ICP) Dissolved	019111	mg/L		3.59	0.02	0.092
loride - Dissolved	017206	mg/L		30.7	0.5	0.866
lphate - (IC) Dissolved	016309	mg/L		16.3	0.1	0.339
Alkalinity (as CaCO3)	010151	mg/L	ď	0.1	0.1	
tal Alkalinity (as CaCO3)	010111	mg/L		556.	0.5	
	.010301	Units		8.24	0.01	
rbonate	006301	mg/L	١<	05	0.5	
carbonate	006201	mg/L		678.	0.5	11.115
tal Hardness (as CaCO3)	010602	mg/L		102.	0.5	
droxide	008501	mg/L	<	Q., 5	0 .,5	
licon - Total (ICP)		mg/L		4.93	0.02	
licon - Dissolved (ICP)		mg/L		4.53	0.02	
ecific Conductance	002041	uS/cm		1064.	0.02	
tal Dissolved Solids	000201	mg/L		664.	1.	
tal Ammonia Nitrogen	007505	mg/L		0.51	0.01	0.036
trite plus Nitrate Nitrogen as N	007110	mg/L		0.058	0.003	
tal Dissolved Phosphate as P	015423	mg/L		0.015	0.003	
tho Phosphate as P	015256	mg/L		0.011	0.003	
tal Phosphate as P	015406	mg/L		0.025	0.003	
lphur - (ICP) - Dissolved		mg/L		5.3	0.2	
lphur - (ICP) - Total		mg/L		53	0.2	
tal Filterable Residue (TDS)	010451	mg/L		688.0	1.	
n-Filterable Residue (TSS)	010401	mg/L		21.0	0.4	
uminum - Total (ICP-MS)	013016	mg/L		0.379	0.001	
uminum - Dissolved (ICP-MS)		mg/L	<	0.001	0.001	
senic - Total (AA)	03,3005	mg/L		0,,000.7	0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION: SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-21 Sample Date & Time : 20-09-96

Sampled By

: RSC

Sample Type

: GRAB Sample Station Code :

Chemex Worksheet Number: 96-03529-20

Chemex Project Number : PITE192-0501

Sample Access

: WATER

Sample Matrix Report Date

: October 9, 1996

PARAMETER	DATE	QA/QC		MA	TRIX. SPIR	ŒS	CALI	BRATION C	HECK
	ANALYZED	BATCH	DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMITS
	(DD-MM-YY)	NUM ANAL	Rr	*	LOWER	UPPER	*	LOWER	UPPER
Calcium - (ICP) Total	02-10-96	10 SW	1,7	109.7	89.5	115.7	112.5	92.3	116.7
Calcium - (ICP) Dissolved	02-10-96	10 SW	1.7	109.7	89.5	115.7	112.5	92.3	116.7
Magnesium - (ICP) Total	02-10-96	10 SW	0.3	98.1	95.3	107.3	97.4	96.5	109.4
Magnesium - (ICP) Dissolved	02-10-96	10 SW	0.3	98.1	95.3	107.3	97.4	96.5	109.4
Sodřum - (ICP) Total	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.3
Sodium - (ICP) Dissolved	02-10-96	10 SW	0.0	102.1	92.5	109.6	103.0	93.2	111.3
Potassium - (ICP) Total	02-10-96	10 SW	0.2	101.3	88.2	112.4	100.8	90.2	112.6
Potassium - (TCP) Dissolved	02-10-96	10 SW	0.2	101.3	88.2	112.4	100.8	90.2	112.6
Chloride - Dissolved	30-09-96	10 LAD	1.2	102.2	90.8	108.8	102.8	94.3	105.6
Sulphate - (IC) Dissolved	30-09-96	10 LAD	0.0	103.2	91.3	108.3	104.7	90.7	104.7
PP Alkalinity (as CaCO3)	NOT APPLI	CABLE							
Total Alkalinity (as CaCO3)	26-09-96	3 AM	1.1	TOM	APPLICABI	Ē.	NOT	APPLICA	BLE
рH	26-09-96	3 AM	1.5	NOT	APPLICABI	E.	TON	APPLICA	BLE
Carbonate	NOT APPLI	CABLE							
Bicarbonate	NOT APPLI	CABLE							
Total Hardness (as CaCO3)	NOT APPLI	CABLE							
Hydroxide	NOT APPLI	CABLE							
Silicon - Total (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60.9	147.
Silicon - Dissolved (ICP)	02-10-96	10 SW	1.8	108.9	59.1	142.3	110.8	60.9	147.
Specific Conductance	27-09-96	1 LG	0.2	NOT	APPLICABI	Æ	NOT	APPLICA	BLE
Total Dissolved Solids	NOT APPLI	CABLE							
Total Ammonia Nitrogen	02-10-96	1 BF	0.4	101.0	80.8	117.3	102.0	90.0	107.
Nitrite plus Nitrate Nitrogen as N	04-10-96	1 PK	0.4	100.6	93.1	105.1	102.0	87.8	107.
Total Dissolved Phosphate as P	01-10-96	1 HO	0.0	95.:6	80.9	118.0	98.5	82.2	116.
Ortho Phosphate as P	02-10-96	1 HO	0.0	86.2	80.7	116.6	102.0	86.1	118.
Total Phosphate as P	01-10-96	1 HO	0.0	95., 6	80.9	118.0	98.5	74.8	121.
Sulphur - (ICP) - Dissolved	02-10-96	10 SW	0.4	NOT	APPLICABI	LE	NOT	APPLICA	BLE
Sulphur - (ICP) - Total	02-10-96	10 SW	0.4	104.0	,	,	0.0		
Total Filterable Residue (TDS)	07-10-96	1 BF	1.2	NOT	APPLICABL	LE	NOT.	APPLICA	BLE
Non-Filterable Residue (TSS)	02-10-96	1 BF	0.0	NOT	APPLICABI	LΞ	гои	APPLICA	BLE
Aluminum - Total (ICP-MS)	01-10-96	20 WEM	0.0	120.4	84.0	117.8	107.1	82.8	123.
Aluminum - Dissolved (ICP-MS)	04-10-96	20 WEM	0.0	94.4	84.0	117.8	89.3	91.9	109.
Arsenic - Total (AA)	27-09-96	1 RJL	0.0	97.3	72.1	119.4	97.2	75.3	122.

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Sample Description : TOB96-7-21 Sample Date & Time : 20-09-96 : RSC Sampled By

: GRAB Sample Type Sample Received Date: September 25, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number : 96-03529-20 Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix

: WATER

Report Date

: October 9, 1996

Analysis Date

: September 27, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R	ESULTS	DETECTION	MILLI EQUIVALENTS
Arsenic - Dissolved (AA)	033109	mg/L	<	0.0002	0.0002	
Barium - Total (ICP-MS)		mg/L		0.164	0.0002	
Barium - Dissolved (ICP-MS)		mg/L		0.146	0.0002	
Beryllium - Total (ICP-MS)		mg/L		0.0004	0.0002	
Beryllium - Dissolved (ICP-MS)		mg/L	<	0.0002	0.0002	
Boron - Total (ICP-MS)		mg/L		01.16	0.01	
Boron - Dissolved (ICP-MS)		mg/L		0.07	0.01	
Cadmium - Total (ICP-MS)	048023	mg/L		0.0032	0,0002	
Cadmium - Dissolved (ICP-MS)		mg/L	·<	0.0002	0.0002	
Chromium - Total (ICP-MS)		mg/L	< -	0.001	0.001	
Chromium - Dissolved (ICP-MS)		mg/L	<	0.001	0.001	
Cobalt - Total (ICP-MS)	027016	mg/L		0.0008	0.0003	
balt - Dissolved (ICP-MS)		mg/L		0.0004	0.0003	
Copper - Total (ICP-MS)	029016	mg/L	<	0.0002	0., 0002	
Copper - Dissolved (ICP-MS)		mg/L	<	0.0002	0,0002	
Iron - Total (ICP-AES)	026009	mg/L		0.94	0.01	
Iron - Dissolved (ICP-AES)	026109	mg/L	<.	0.01	0.01	
Lead - Total (ICP-MS)	082016	mg/L		0.0023	0.0003	
Lead - Dissolved (ICP-MS)		mg/L	<.	0.0003	0.0003	
Lithium - Total (ICP-AES)	003009	mg/L		0.012	0.001	
Lithium - Dissolved (ICP-AES)	003109	mg/L		0.012	0.001	
Manganese - Total (ICP-MS)		mg/L		0.040	0.001	
Manganese - Dissolved (ICP-MS)		mg/L		0.025	0.001	
Mercury - Total (CVAA)	080011	ug/L	<	0.05	Ö.05	
Mercury - Dissolved (CVAA)	08,0101	ug/L	<	0.05	0.05	
Molybdenum - Total (ICP-MS)		mg/L		0.0023	0,0002	
Molybdenum - Dissolved (ICP-MS)		mg/L		0.0020	00002	
Nickel - Total (ICP-MS)	028016	mg/L	<	0.0005	00005	
Nickel - Dissolved (ICP-MS)		mg/L	<	0.0005	0.0005	
Phosphorus - Total (ICP-AES)		mg/L	<	0.1	0.1	
Phosphorus - Dissolved (ICP-AES)	015450	mg/L	<	0.1	0.1	
Selenium - Total (AA)	034005	mg/L		0.,0007	0.0002	
Selenium - Dissolved (AA)	034105	mg/L	<	0.0002	0.0002	

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PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-21 Sample Date & Time : 20-09-96

Sampled By

: RSC : GRAB

Sample Type Sample Station Code :

Chemex Worksheet Number: 96-03529-20

Chemex Project Number : PITE192-0501

Sample Access

Sample Matrix : WATER

Report Date : October 9, 1996

PARAMETER	DATE	QA/QC		MATRIX SPIKES			CALIBRATION CHECK		
	ANALYZED	BATCH	DUP	RECOV	CONTROL	LIMITS	RECOV	CONTROL	LIMITS
	(DD-MM-YY)	NUM ANAL	R:	*:	LOWER	UPPER	专	LOWER	UPPER
Arsenic - Dissolved (AA)	27-09-96	1 RJL	0.0	97.3	72.1	119.4	97.2	75.3.	122.4
Barîum - Total (ICP-MS)	01-10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Barium - Dissolved (ICP-MS)	01-10-96	20 WEM	0.0	106.1	75.8	123.5	98.0	87.1	113.2
Beryllium - Total (ICP-MS)	01-10-96	20 WEM	2.0	138.6	75.3	121.2	93.5	80.1	120.4
Beryllium - Dissolved (ICP-MS)	04-10-96	20 WEM	0.0	93.5	75.3	121.2	84.5	80.1	120.4
Boron - Total (ICP-MS)	01-10-95	20 WEM	0.0	854	71.5	136.2	98.2	76.3	127.8
Boron - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	97.8	71.5	136.2	103.8	76.3	127.8
Cadmium - Total (ICP-MS)	01-10-96	20 WEM	3.2	108.5	7.8.1	120.3	113.6	83.4	114.8
Cadmium - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	86.2	78.1	120.3	91.6	83.4	114.8
Chromium - Total (ICP-MS)	01-10-96	20 WEM	0.0	103.2	76.8	117.8	87.3	87.7	113.6
Chromium - Dissolved (ICP-MS)	04-10-96	20 WEM	0.0	85.1	76.8	117.8	95.1	87.7	113.8
Cobalt - Total (ICP-MS)	01-10-96	20 WEM	3.2	97.1	80.1	114.1	96.4	86.0	113.3
Cobalt - Dissolved (ICP-MS)	04-10-96	20 WEM	2.5	84.,9	80.1	114.1	95.5	86.1	113.
Copper - Total (ICP-MS)	01-10-96	20 WEM	0.0	114.2	79.0	115.4	80.6	83.5	115.
Copper - Dissolved (ICP-MS)	04-10-96	20 WEM	0.≟	89.0	79.0	115.4	94.5	83.7	115.
Iron - Total (ICP-AES)	02-10-96	10 SW	0.0	110.5	88.8	114.6	110.0	92.2	112.
Iron - Dissolved (ICP-AES)	02-10-96	10 SW	Ģ., C	110.5	88.8	114.5	110.0	92.2	112.0
Lead - Total (ICP-MS)	01-10-96	20 WEM	3.2	100.2	80.5	116.9	103.2	77.B	129.0
Lead - Oissolved (ICP-MS)	04-10-96	20 WEM	0.0	93.4	80.5	116.9	95.0	85.3	113.9
Lithium - Total (ICP-AES)	02-10-96	10 SW	0.3	95.2	74.2	111.3	95.2	82.6	107.0
Lithium - Dissolved (ICP-AES)	02-10-96	10 SW	0.2	95.2	74.2	111.3	95.2	82.6	107.
Manganese - Total (ICP-MS)	01-10-96	20 WEM	0.0	117.6	80.8	119.6	102.9	874	114.
Manganese - Dissolved (ICP-MS)	04-10-96	20 WEM	0.2	90.4	80.8	119.6	93.5	87.4	114.
Mercury - Total (CVAA)	03-10-96	1 ÇH	0.0	100.0	66.0	132.7	88.5	69.9	131.
Mercury - Dissolved (CVAA)	03-10-96	1 CH	0.2	100.0	66.0	132.7	88.5	69.9	131.
Molybdenum - Total (ICP-MS)	01-10-96	20 WEM	3.2	91.1	87.0	117.6	107.3	90.5	109.
Molybdenum - Dissolved (ICP-MS)	04-10-96	2,0 WEM	3.2	8,9.9	:87.0	117.6	96.6	90.5	109.
Nickel - Total (ICP-MS)	01-10-96	20 WEM	c.:	101.4	78.4	116.6	105.9	83.3	118.
Nickel - Dissolved (ICP-MS)	04-10-96	20 WEM	0.3.	95.5	78.4	116.6	91.6	83.3	118.
Phosphorus Total (ICP-AES)	02-10-96	10 SW	0.≘	99.5	84.0	113.4	101.6	85.1	110.
Phosphorus - Dissolved (ICP-AES)	02-10-96	10 SW	C.3	99.5	84.0	113.4	101.6	85.1	110.
Selenium - Total (AA)	27-09-96	1 RJL	p.5	58.0	79.2	120.7	97.2	75.6	122.
Selenium - Dissolved (AA)	27-09-96	1 RJL	0.1	.88.0	79.2	120.7	97.2	76.6	122.

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PITEAU ENGINEERING LIMITED ATTENTION: SUSAN LECLERC

PROJ.#3773-12

Sample Description : TOB96-7-21 Sample Date & Time : 20-09-96

Sampled By : RSC

: GRAB Sample Station Code :

Sample Type

Chemex Worksheet Number: 96-03529-20 Chemex Project Number : PITE192-0501

Sample Access

: WATER

Sample Matrix Report Date

: October 9. 1996

PARAMETER	DATE	QA/QC		MA	TRIX SPIK	ES.	CALI	BRATION C	HECK
	ANALYZED	BATCH	DUP:	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMIT	
	(DD-MM-YY)	LANA MUN	Rr	ł	LOWER	UPPER	. ት	LOWER	UPPER
Silver - Total (ICP-MS)	01-10-96	20 WEM	0.0	78.9	77.7	117.7	94.7	87.3	111.0
Silver - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	83.6	77.7	117.7	92.1	87.3.	111.0
Strontium - Total (ICP-MS)	01-10-96	20 WEM	0.0	98.2	87.5	111.6	105.4	86.4	111.2
Strontium - Dissolved (ICP-MS)	04-10-96	20 WEM	0.0	100.5	87.5	111.6	97.3	86.4	111.2
Titanium - Total (ICP-MS)	01-10-96	20 WEM	0.0	73.8	68.1	123.7	109.1	82.2	114.9
Titanium - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	71.1	68.1	123.7	84.8	82.2	114.9
Uranium - Total (ICP-MS)	01-10-96	20 WEM	1.6	98.6	77.0	125.0	99.1	81.5	114.2
Uranium - Dissolved (ICP-MS)	04-10-96	20 WEM	0.6	95:0	77.0	125.0	95.7	81.5	114.2
Vanadium - Total (ICP-MS)	01-10-96	20 WEM	0.0	101.2	74.5	119.8	89.5	88.5	111.9
Vanadium - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	82.2	74.5	119.8	89.5	88.5	111.9
Zinc - Total (ICP-MS)	04-10-96	20 WEM	3.2	113.7	57.4	147.3	94.8	84.3	119.6
Sinc - Dissolved (ICP-MS)	04-10-96	20 WEM	3.2	113.7	57.4	147.3	94.8	84.3	119.6

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Sample Description : TOB96-7-21 Sample Date & Time : 20-09-96

Sampled By : RSC Sample Type : GRAB

Sample Received Date: September 25, 1996

Sample Station Code :

PITEAU ENGINEERING LIMITED ATTENTION : SUSAN LECLERC

PROJ.#3773-12

Chemex Worksheet Number: 96-03529-20 Chemex Project Number: PITE192-0501

Sample Access

Sample Matrix : WATER

Report Date Analysis Date : October 9, 1996

: October 1, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R I	ESULTS	DETECTION	MILLI EQUIVALENTS
Silver - Total (ICP-MS)	047016	mg/L	<	0.0001	0.0001	
Silver - Dissolved (ICP-MS)		mg/L	<:	0.0001	0.0001	
Strontium - Total (ICP-MS)		mg/L		0.754	0.002	
Strontium - Dissolved (ICP-MS)		mg/L		0.700	0.002	
Titanium - Total (ICP-MS)		mg/L		0.062	0.001	
Titanium - Dissolved (ICP-MS)		mg/L		0.007	0.001	
Uranium - Total (ICP-MS)		mg/L		0.0073	0.0004	
Uranium - Dissolved (ICP-MS)		mg/L	<	0.0004	0.0004	
Vanadium - Total (ICP-MS)		mg/L	<	0.001	0.001	
Vanadium - Dissolved (ICP-MS)		mg/L	₹.	0.001	0.001	
Zinc - Total (ICP-MS)		mg/L		0.0053	0.0006	
Zinc - Dissolved (ICP-MS)		mg/L		0.0050	0.0006	
Ion Balance		Balance		1:03	0.01	

#### APPENDIX V

B.C. MINISTRY OF ENVIRONMENT LAND AND PARKS WATER NUMERICAL CRITERIA

#### Water Numerical Criteria<sup>1</sup>

COLUMNI	COLUMN II	COLUMNIII	COLUMNIV	COLUMN V
Substance	Aquatic Life <sup>2</sup> (AW)	Irrigation <sup>2,3</sup> (IW)	Livestock <sup>2</sup> (LW)	Drinking Water <sup>4</sup> (DW)
Inorganic Substances alummum	5 @ pH<4.5 7 @ pH=5.0 11 @ pH=5.5 20 @ pH=6.0 50 @ pH>6.0	5000	5000	200
ammonia	131 @ pH=9.0 <sup>7</sup> 370 @ pH=8.5 <sup>7</sup> 1130@pH=8.0 <sup>7</sup> 1840@pH≤7.7 <sup>7</sup>			
arsenic	50	100	5005	25
barrum beryllium	1000 5.3	100	100	1000
boron	1 3.3	500 - 6000 <sup>6</sup>	5000	5000
cadmum	0.2 @ H <sup>23</sup> =0-60 (0.01 @ H=30) 0.8 @ H=60-120 (0.03 @ H=90) 1.3 @ H=120-180 (0.05 @H=150)	10	20	5
calcium	1.8 @ H>180 (0.06 @ H=210)		1000 mg/l	}
chloride	_	100 - 700mg/16		250 mg/l
chlorine chromium	2 2	1000	1000	50
cobalt	50	50	1000	
copper	2 @ H<50mg/1 CaCO3 4 @ H=100mg/1 CaCO3 6 @ H=150mg/1 CaCO3 8 @ H=200 mg/1	2006	300	1000
cyanide (WAD) <sup>9</sup>	5			i .
cvanide (SAD) <sup>15</sup>	1	i	l .	200
fluoride	200 @ H<50mg/l 300 @ H≥50mg/l	1000	10005,8	1500
iron lead	300 3 ® H≤40 mg/l CaCO3 5 @ H=50mg/l CaCO3 6 @ H=100mg/l CaCO3 11 @ H=180 mg/l	5000 200	100	300 10
lithium		2500	5000	
manganese mercury	100 0.1	200	2	50 1
molybdenum	1000	10 - 30 <sup>10</sup>	50	1
nickel	25 @ H-0.60mg/l CaCO3 65 @ H=60-120mg/l CaCO3 110@H=120-180mg/l CaCO3 150 @ H≥180mg/l CaCO3	200	1000	
rutrate - N (or as N)	40mg/l		1000011	1000011
nitrate and nitrite (as N)	40mg/1		1000011	1000011
nitrite - N (or as N) selenium	20 (chloride < 2mg/1) - 60 <sup>12</sup>	2013, 5014	10000 50	3200 10
silver	0.1	20.0, 50.4	30	10
sodium sulphate sulphide as H <sub>2</sub> S	100 mg/l		1000000	200 mg/l 500 mg/l
uranium	300	1.0	200	100
vanadium	30	100	100	
zinc	30	1000-500014,16	50000	5000

#### Water Numerical Criteria1

COLUMN I	COLUMNII	COLUMN III	COLUMNIV	COLUMN V
			COLONIATE	Drinking
Substance	Aquatic Life <sup>2</sup> (AW)	Irrigation <sup>2,3</sup> (IW)	Livestock <sup>2</sup> (LW)	Water <sup>4</sup> (DW)
Monocyclic Aromatic Hydrocarbons (MAHs) benzene ethylbenzene toluene xylenes	300 700 300			5 2.4 2.4 300
Polycyclic Aromatic Hydrocarbons (PAHs) naphthalene acenaphthene fluorene anthracene phenanthrene	1 6 12 0.1 0.3			330
acridine fluoranthene pyrene benzo[a]anthracene benzo[a]pyrene	0.05 0.2 0.02 0.02 0.1 0.01		-	0.01
Phenolic Substances phenols (total) chlorinated phenols monochlorophenol dichlorophenols	0.5 - 0.9 <sup>17</sup> 0.12 - 0.35 <sup>17</sup>		0.1 <sup>9</sup> 0.3 <sup>9</sup>	0.3
trichlorophenols tetrachlorophenols pentachlorophenol	0.06 - 0.5 <sup>17</sup> 0.02 - 0.3 <sup>17</sup> 0.02 - 0.3 <sup>17</sup>		2 <sup>9</sup> 1 <sup>9</sup> 30 <sup>9</sup>	2 1 30
Chlorinated Hydrocarbons chlorinated aliphatics dichloroethane, 1,2-dichloromethane hexachlorobutadiene hexachlorocyclohexane isomers tetrachloroethylene	100 0.1 0.01 260			5 50
trichloroethylene vinyl chloride	20			. 50 2
chlorinated benzenes monochlorobenzene dichlorobenzene, 1,2- dichlorobenzene 1,3- dichlorobenzene, 1,4- trichlorobenzene, 1,2,3- trichlorobenzene, 1,2,4- trichlorobenzene, 1,3,5-	15 2.5 2.5 4 0.9 0.5 0.65			30 3 1
tetrachlorobenzene, 1.2,3,4- tetrachlorobenzene, 1.2,3,5- tetrachlorobenzene, 1.2,4,5- pentachlorobenzene hexachlorobenzene	0.1 0.1 0.15 0.03 0.0065			
PCBs	0.0001	0.5		
Halogenated Methanes carbon tetrachloride trihalomethanes				5 100
Phthalate Esters DBP DEHP other phthalate esters	4 0.6 0.2			

#### Water Numerical Criteria<sup>1</sup>

COLUMNI	COLUMN II	COLUMNIII	COLUMNIV	COLUMN V
Substance	Aquztic Life <sup>2</sup> (AW)	Irrigation <sup>2,3</sup> (IW)	Livestock <sup>2</sup> (LW)	Drinking Water <sup>4</sup> (DW)
Pesticides aldicarb	0.1518,19	54.920, 67.521	11	9
aldrin and dieldrin atrazine	0.004 2 <sup>19</sup> , 10 <sup>18</sup>	10	0.7 60	0. <i>7</i> 5
azinphos-methyl bendiocarb	215, 1016	10		20 40
bromoxynil carbaryl carbofuran chlordane chlorpyrifos	1.75 0.006		45	5 90 90 7 90
cyanazine 2.4-D DDT	2 4 0.001	0.5	10	10 100
diazinon dicamba	0.01		-14	30 <sup>22</sup> 20 120
diclofop-methyl dimethoate dinoseb diquat diuron	6.2		3	9 20 10 70 150
endosulfan endrin glyphosate heptachlor & heptachlor epoxide lindane	0.02 0.0023 65 0.01		280	2,8,0. 3 4
malathion methoxychlor metolachlor metribuzin paraquat	8 1	28 0.5	50 80	190. 900. 50 80 10
parathion phorate picloram simazine	29 .10.	0.5 0.5	190 10	50 2 190 10
2,4,5-T temephos terbufos			,	20 280
toxaphene triallate trifluralin	0.008 0.24 0.1		230 45	1 230 45
Radioactive Substances 137 <sub>cesium</sub> 131 <sub>iodine</sub> 226 <sub>radium</sub> 90 <sub>strontium</sub> 3 <sub>tritium</sub>				50 Bq/l 10 Bq/l 1 Bq/l 10 Bq/l 40000 Bq/l

#### Water Numerical Criterial

#### Footnotes

- All values are in ug/l unless otherwise stated.
- <sup>2</sup>For surface water samples, samples must be tested to determine total combined particulate and dissolved substance concentrations. For groundwater samples, samples must be tested to determine dissolved substance concentrations.
- <sup>3</sup>Applies to irrigation of all soil types.
- <sup>4</sup>Drinking water criteria are for unfiltered samples obtained at the point of consumption. Heavy metals, metalloids and inorganic ions are expressed as total concentrations (particulate and dissolved) unless otherwise indicated.
- <sup>5</sup>Criterion applies where dietary intakes or natural levels are high. Consult Director for further advice.
- \*Criterion varies depending on crop. Consult Director for further advice.
- <sup>7</sup>Criterion varies with pH and temperature. 10°C is assumed. Consult Director for further advice.
- <sup>8</sup>Criterion varies with type of livestock. Consult Director for further advice.
- 9WAD means weak acid dissociable.
- <sup>10</sup>Criterion varies with crop, soil drainage and Mo:Cu ratio. Consult Director for further advice.
- Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.
- <sup>12</sup>Criterion varies with chloride concentration. Consult Director for further advice.
- <sup>13</sup>Criterion for intermittent applications on crops.
- <sup>14</sup>Criterion for continuous application on crops.
- 15SAD means strong acid dissociable.
- <sup>16</sup>Criterion varies with soil pH. Consult Director for further advice.
- <sup>17</sup>Criterion varies with pH and substance isomer. Consult Director for further advice.
- <sup>18</sup>Criterion to protect marine aquatic life.
- <sup>19</sup>Criterion to protect freshwater aquatic life.
- <sup>20</sup>Criterion to protect crops other than legumes.
- <sup>21</sup>Criterion to protect legumes.
- 22Includes DDT metabolites.
- <sup>23</sup>H means water hardness in mg/1 CaCO3.

#### ERRATUM

The reference to footnote 9 for chlorinated phenols - livestock watering criteria (column IV) is incorrect. Footnote reference should be to footnote 24 below:

<sup>&</sup>lt;sup>24</sup> Criterion to protect against taste and odor concerns.