DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL INVESTIGATION

PROPOSED EXPANSION

WEST END WATER POLLUTION CONTROL CENTRE

WINNIPEG, MANITOBA

Prepared for

EARTH TECH (CANADA) INC.

on behalf of the

CITY OF WINNIPEG

JULY 2005

FILE 252725

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1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov Consultants for the proposed expansion of the West End Water Pollution Control Centre. The study was undertaken at the request of Earth Tech (Canada) Inc., the Engineers of Record for the project, on behalf of the City of Winnipeg. Authorization to proceed with the study was received from Earth Tech (Canada) Inc. under the signature of Mr. J. Eric Hutchison, P.Eng., dated July 7, 2005.

2.0 BACKGROUND

The location of the West End Water Pollution Control Centre is to the southwest of the intersection of the west Perimeter Highway and Wilkes Avenue. The general layout of the facility is illustrated on Figure 1 as is the location of the proposed works. A U/V facility is included with the proposed work and is located south of Wilkes Avenue along the Manitoba Hydro tower transmission line which is to the west of the existing Control Centre.

The construction of the existing facility began in 1991. It had been preceded by earlier facilities, located to the west, which had be built in the late 1970's. A geotechnical investigation for the 1970's plant had been undertaken by Ripley Klohn & Leonoff International Ltd. in 1974. This was followed by a Dyregrov & Burgess geotechnical study for the existing plant which was undertaken in 1988 and a subsequent review by Dyregrov Consultants in 1990. The reports of the two geotechnical investigations and the review are attached as Appendices B, C and D.

3.0 PROPOSED EXPANSION

The proposed expansion is to include the two 16 metre diameter primary sludge fermenters and pump room, one secondary clarifier with a preferred floor elevation 235.2 metres, a DAF

building and a U/V disinfection building with a lower floor elevation of 231.89 metres. The locations of these units are illustrated on Figure 1 and 1A.

It is anticipated that the type of construction will be similar to that of the 1991 development. Of particular interest is the depth of excavations being considered for the secondary clarifier and the U/V building.

4.0 FIELD INVESTIGATION

On the basis of the existing information and a recent site inspection, the field investigation program consisted of two test holes at the berms where the primary sludge fermenters and secondary clarifier were proposed and an alternate site for the primary sludge fermenters, a single test hole at the DAF building and a single test hole for the U/V building and one on the proposed access road.

The test holes for the U/V building and access road were drilled at locations which were originally staked but are some 150 metres south of the present location. It will be necessary to drill a test hole at its present location to confirm that the geotechnical conditions are similar and that the following discussions on the U/V building are appropriate.

Due to access conditions (soft ground and onto the berms) the test drilling had to be undertaken by track-mounted drills except for the test hole at the DAF building which was drilled with a piling rig which advanced a 400 mm diameter test hole. The other test holes were 125 mm in diameter. Other than the test hole for the U/V access road which was 3.05 metres, the test holes were carried to auger refusal depths in the underlying glacial till. Both disturbed off-auger samples and undisturbed thin walled Shelby tube samples were recovered as the drilling progressed. Standpipe piezometers were installed in six of the test holes.

The laboratory testing included moisture content determinations on all of the undisturbed samples and undrained shear strengths and densities of selected undisturbed samples. The samples which were not tested were waxed and saved for further testing, if required.

The logs of the test holes are attached as Figures 2 to 10. The logs include the soil stratigraphy at each test hole location, the results of the laboratory testing which was undertaken and the results of the groundwater measurements which were taken at the piezometers.

5.0 SOIL PROFILE

5.1 General

On the basis of this investigation and previous studies, the soil profile at various locations consists of fill over the usual Lake Agassiz lacustrine silty clay which in turn overlies a glacial silt till deposit.

5.2 Fill

Extensive amounts of fill have been placed around the plant as a berm which is about 4 to 5 metres in height. The fill thickness in the berms ranged from 6.25 to 8.28 metres (TH 4, 5 and 7) and 4.57 metres at TH 9. The fill thickness was larger than the berm height which is likely indicative of the backfill of the excavations from the original construction. The fill was primarily a medium to high plastic silty clay with some layers of granular materials and granular within the clay fill. The condition of the fill varied from stiff to firm and soft to medium soft, however, it was visually evident that the fill had not been well compacted. The unit weight of some of the backfill samples was in the order of 18.2 kN/m^3 which is considerably less than a typical density of a well compacted clay.

5.3 Lake Agassiz Lacustrine Clay

The Lake Agassiz lacustrine clay at the plant site was found beneath the clay fill at elevations (some of which were at a former excavation level) between 234.52 and 237.96 metres. The clay extended to the glacial till surface between 230.39 and 231.93 metres. The thickness of the clay ranged from 3.66 metres at TH 5 to 7.27 metres at TH 3. The moisture contents are generally in the 40 to 60 percent range. The consistency of the clay is firm to stiff with some soft to medium soft conditions. The undrained shear strengths of a limited number of tests are generally in the 40 to 60 kPa range.

The foregoing conditions are generally consistent with the data from the 1988 Geotechnical Report.

At the location of the U/V building under a 0.61 metre layer of clay fill, the Lake Agassiz lacustrine clay was at elevation 237.27 metres and extended to the glacial silt till at elevation 232.85 metres for a thickness of 4.42 metres. It was firm in consistency with moisture contents in the 35 to 45 percent range.

5.4 Glacial Silt Till

The glacial silt till is known to be a heterogeneous mixture of sand, gravel, cobble and boulder-size materials within a predominately silt matrix. It has moisture contents in excess of 10 percent and is as high as 18 percent. It is classified as loose to medium dense. The glacial till at the U/V building location had moisture contents in the 10 percent range which are consistent with it being classified as soft.

5.5 Groundwater Conditions

As noted earlier, standpipe piezometers were installed in six of the test holes and water elevations obtained shortly after installation and several weeks later. The last set of readings was obtained on July 4, 2005 and ranged from elevation 235.21 to 235.28 metres at the plant site and 235.52 metres at the U/V building location.

The hydrograph from a Province of Manitoba groundwater monitoring well, which is located at the grain elevator on the north side of Wilkes Avenue west of the west Perimeter Highway, is attached in Appendix A. The water levels which were obtained from the piezometers are believed to be consistent with the hydrograph.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

The major items which are envisaged for the additional works which are proposed are associated with the relatively thin thickness of clay which will underlay the proposed excavations and the relatively high groundwater levels which are present.

The deepest general excavation will be for the secondary clarifier which is presently being considered at elevation 233.7 metres with the primary sludge fermenters, somewhat higher, near elevation 237.00 metres and the U/V building at 231.29 metres. This excavation will be into the glacial till. The excavations for the 1991 secondary clarifiers were apparently near the same elevation as that proposed for the new secondary clarifier, namely 233.7 metres.

The piezometric conditions in the bedrock are shown on the hydrograph from the monitoring well at the north side of Wilkes Avenue which is included in Appendix A. From 1960 to about 1990, the piezometric conditions decreased from 235.2 to 233.6 metres and since then

they have been increasing to a high of 235.25 metres this past winter. Since about 1995, the piezometric conditions have been above elevation 234.25 and since 2000 above elevation 234.5 metres.

With these piezometric conditions and the depths of excavations as proposed for the secondary clarifier at elevation 233.7 metres, there is a risk that if a connection was made (or exists) between the bedrock aquifer (or the glacial till) and the excavation, it could be flooded in the short term and could exert uplift forces on the bottom of the clarifier in the long term. Also, analyses have shown that there is a potential for heave of the base of the excavation under high piezometric conditions and/or the factors of safety against base heave could be unacceptably low. This would be the case for the piezometric conditions prevalent since 1995.

Control of the piezometric conditions by pumping or some other means may be possible to permit the construction of the clarifier tank, however, it would not be desirable to consider long term pumping to manage the piezometric conditions. If pumping is to be considered, it will be necessary to undertake some field pumping tests and monitoring to determine whether, in fact, pumping would be effective. Also, the disposal of the discharge would have to be addressed as the water is expected to be saline.

The excavation for the primary fermenter will be to elevation 237.00 metres which will be above the piezometric conditions in the bedrock. As such, there is no concern with the piezometric conditions on the design and construction of the fermenters.

The excavation for the U/V building will be to elevation 231.29 metres into the glacial till at elevation 232.85 metres and below the bottom of the test hole which met refusal at 231.48. The depth of the excavation is below the observed groundwater level of 235.52 metres (which is

consistent with the piezometric conditions in the monitoring well). These conditions will require special consideration of groundwater control during construction and the design for long term conditions.

6.2 Foundations

6.2.1 General

The foundations for the existing plant are driven end bearing precast prestressed concrete piles. These piles are suitable for the proposed facilities at the plant site but not at the U/V building location.

6.2.2 Driven Precast Piles

The driven precast piles can be assigned conventional capacities of 445, 625 and 800 kN respectively for 305, 356 and 406 mm diameter pile sizes respectively. The piles must be driven to practical refusal with heavy diesel hammers with rated energies of at least 40,000 Joules. With the use of a Link Belt 520 diesel hammer, final sets of 5, 8 and 12 blows/25 mm or less can be used for the final three sets of pile penetration for the 305, 356 and 406 sizes respectively. If other hammers are used, the refusal blow counts should be reassessed.

Preboring should be done at all pile locations to minimize heave and vibrations and to enhance pile verticality. The depth of prebore should not be deeper than 2.1 metres at the secondary clarifier in an effort to reduce the likelihood of a connection between the underlying piezometric source and the excavation. The prebore should be backfilled with a bentonite clay slurry prior to driving with the intent of developing a seal between the pile and the prebore hole.

All piles in groups should be restruck to counter the effects of pile heave and pile spacing should not be closer than 2.5 pile diameters, centre to centre. In view of the large number of piles

which will be required to support the various tanks and the potential for heave under these circumstances, heave should be monitored, at least at the start of construction, to determine that this behaviour is counteracted. The sequence of driving should be reviewed to minimize the effects of pile installation on previously installed piles.

The precast concrete piles driven to practical refusal will derive virtually all of their support from end bearing and no reduction is necessary for reasons related to group action.

The piles should be at least one week old before driving.

6.2.3 Raft Slab

As noted earlier, the excavation for the U/V building will extend into the underlying glacial till. As such, the appropriate support for the structure is a raft slab that would be placed on the glacial till. The excavation surface will encounter some cobbles and boulders which may require removal and replacement. The replacement should be with a lean mix concrete which should also be used as a skin coat over the entire excavated surface. The condition of the glacial till at the subgrade level may be relatively soft to hard (loose to dense) depending on the required depth of excavation. The minimum bearing capacity which would be expected would be in the order of 150 kPa. The slab design could consider a Modulus of Vertical Subgrade Reaction of 47,000 kN/m^3.

The primary design criteria for the building is to guard against buoyancy rather than bearing capacity. In this regard, it is recommended that the design consider the groundwater to be at the ground surface.

6.3 Excavations

Excavations will be required for the secondary clarifier, the fermenters and the U/V building. Control of the piezometric conditions is essential to permit the excavations as presently being considered.

It is anticipated that excavations can be open cut. At the secondary clarifier and the fermenter tanks, it is recommended that the berms be removed and the excavated slopes cut at gradients of 2 horizontal to 1 vertical. Even with these slopes, some instabilities may be encountered. The impact of these excavations on the adjacent tanks and other structures must be determined.

At the U/V building, the excavation will be about 6.7 metres. Temporary slopes of 1 horizontal to 1 vertical can be used, however, if sloughing of the upper soft portion of the glacial till is encountered during the excavation, the slope configuration may have to be changed.

If temporary shoring is necessary, it may be designed on the basis of the earth pressure distribution shown on Figure 11.

6.4 Below Grade Walls

Any below grade walls including the tanks and any retaining walls should be designed to resist lateral earth pressures that are derived on the basis of the following relationship which produces a triangular pressure distribution:

$$P = K \gamma D$$

where:

P = lateral earth pressure at depth D (kN/m^2)
K = earth pressure coefficient (0.5)
γ = soil/backfill unit weight (17.4 kN/m^3)
D = depth to surface to point of pressure calculation (m)

The selection of backfill materials should be reviewed during the design and their impact on the foregoing pressures assessed.

The foregoing applies to walls that are drained. Where drainage is not provided, the lateral pressures should be increased by the hydrostatic pressure.

An allowance for surface loads should be included if significant load is applied within a distance from the wall equal to the height of the wall. The lateral pressure due to the wall should be presumed to be equal to 50 percent of the vertical pressure due to the live load.

6.5 Floor Slabs

The floor slabs in the secondary clarifier and the fermenters will be structurally supported. It is recommended that the floor slab in the DAF building should also be structurally supported. We would recommend that a 150 mm void space be provided between the underside of the slab and the soil. Underdrainage below the slabs of the secondary clarifier is not expected to be provided and it would be expected that water could collect in the void. This is conducive to swelling and a generous allowance for the void is recommended, despite the relatively thin layer of clay which would be present below the tank.

6.6 Other

All concrete in contact with the soil at this location should be manufactured with sulphate resistant cement and should be of high quality.

Test Hole 2 was drilled on the access road for the U/V building. The design of the road is being undertaken by the Earth Tech Transportation group.

The installation of the foundations for the proposed facilities should be inspected by experienced geotechnical personnel. The pile installations should be undertaken on a full time basis.

6.7 Recommendation

As noted earlier, control of the piezometric conditions in the bedrock is necessary for the design and construction of the proposed expansion. It is necessary that pumping tests be undertaken to determine that pumping from relief wells is a possible option and whether it would be economical.

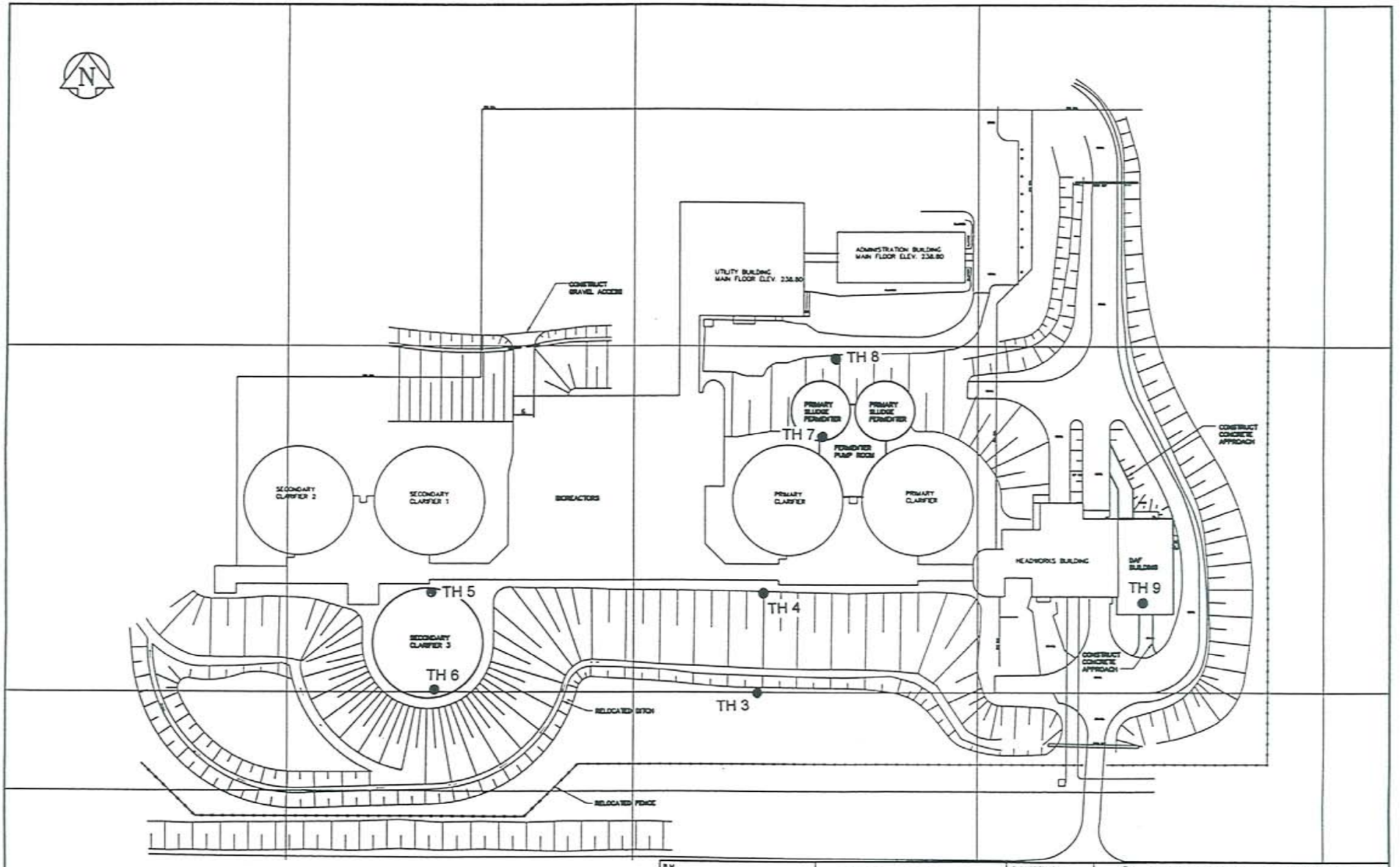
Respectfully submitted,

DYREGROV CONSULTANTS

PROVINCE OF MANITOBA
A. O. DYREGROV
15/07/05
REGISTERED PROFESSIONAL ENGINEER

Per:

A.O. Dyregrov, P.Eng.



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TEST HOLE LOCATION PLAN

SCALE: NTS	DATE: 13-7-05	MAIN: TJH	CHKD: AOD	JOB: 252725	FIGURE: 1B

B.M. ELEV.

NO.	REVISIONS	DATE	BY

EarthTech
A Tyco International Ltd. Company

DESIGNED BY	CHECKED BY
DRAWN BY: PAAP	APPROVED BY
HOR. SCALE: 1:500 VERTICAL SCALE:	RELEASED FOR CONSTRUCTION BY:
DATE: 2005/08/27	DATE

ENGINEER'S SEAL

CONSULTANT DRAWING NO. 8701

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

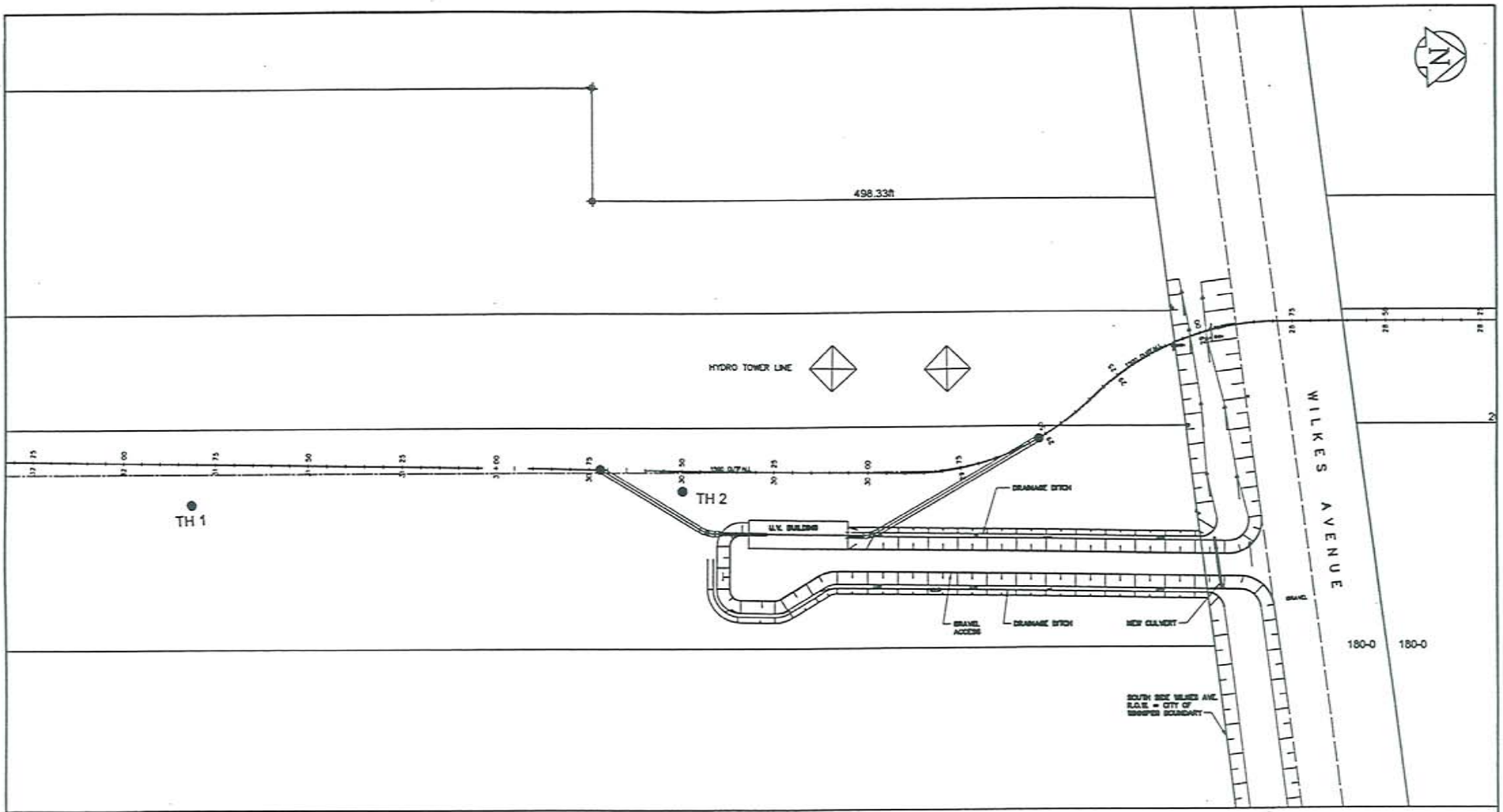
WEST END WATER POLLUTION CONTROL CENTRE
BIOLOGICAL NUTRIENT REMOVAL AND UV DISINFECTION UPGRADE

CITY FILE NUMBER

SHEET OF

SITE PLAN

CITY DRAWING NUMBER



DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

TEST HOLE LOCATION PLAN

SCALE	DATE	MADE	CHKD	JOB	FIGURE
NTS	13-7-05	TJH	AOD	252725	1A

B.M. 89-005
ELEV. 236.330

EarthTech
A Tyco International Ltd. Company

DESIGNED BY
CHECKED BY
DRAWN BY PAAP
APPROVED BY
HOR. SCALE: 1:500
VERTICAL SCALE: NA
RELEASED FOR CONSTRUCTION BY:
DATE 2005/08/24
DATE

ENGINEER'S SEAL

CONSULTANT DRAWING NO. 87012

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

WEST END WATER POLLUTION CONTROL CENTRE
BIOLOGICAL NUTRIENT REMOVAL AND UV DISINFECTION UPGRADE

UV - BUILDING SITE PLAN

CITY FILE NUMBER
SHEET OF
CITY DRAWING NUMBER

NO.	REVISIONS	DATE	BY

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 1	Project No. 252725
PROJECT: WEWPCC, WILKES AVE. CLIENT: EARTH TECT		DATE OF INVEST : JUNE 6, 2005 DRILL : PADDOCK 5 INCH AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	S Y M	SOIL DESCRIPTION
				LOC'N: UV BLDG ADDITION. 3 M N of S END & 8 M E of CENTRE of OUTFALL
	0.00	237.88		
	0.50	237.38		0.00-0.08 ORGANIC SOIL, BLACK 0.08-0.61 FILL, CLAY MATRIX, BROWN, MED SOFT, H PLASTIC
	1.00	236.88		0.61-5.03 CLAY BLACK TO BROWN, ORGANIC, STIFFF, H. PLASTIC
	1.50	236.38		AT 0.62 BROWN, SILTY, FIRM, MEDIUM TO TRACE SILT & FINE SAND INCLUSIONS, SMALL
	2.00	235.88		SLICKENSIDES Pp-258.6 KPA Tv-131.7 KPA W -18.25 KN/M
	2.50	235.38		
	3.00	234.88		SAME, GREY
	3.50	234.38		TRACE SILT AND FINE SAND INCLUSIONS
	4.00	233.88		
	4.50	233.38		
	5.00	232.88		Pp-105 . KPA Tv-52.7 KPA
	5.50	232.38		5.03-6.40 GLACIAL SILT TILL W -17.08 KN/M SILT MATRIX, SOME SAND AND GRAVEL, TAN
	6.00	231.88		SOFT TO MEDIUM SOFT, OCCASSIONAL COBBLES AND BOULDERS, LOW TO VERY LOW PLASTIC,
	6.50	231.38		TRACE OF FREE WATER AT TOP OF GLACIAL TILL LAYER
	7.00	230.88		END OF TEST HOLE AT 6.40 AT AUGER REFUSAL
				STANDPIPE INSTALLED
				WATER LEVEL JUNE 24, 2005 WAS ELEV. 235.19
				WATER LEVEL JULY 4, 2005 WAS ELEV. 235.52

MOISTURE CONTENT (%)

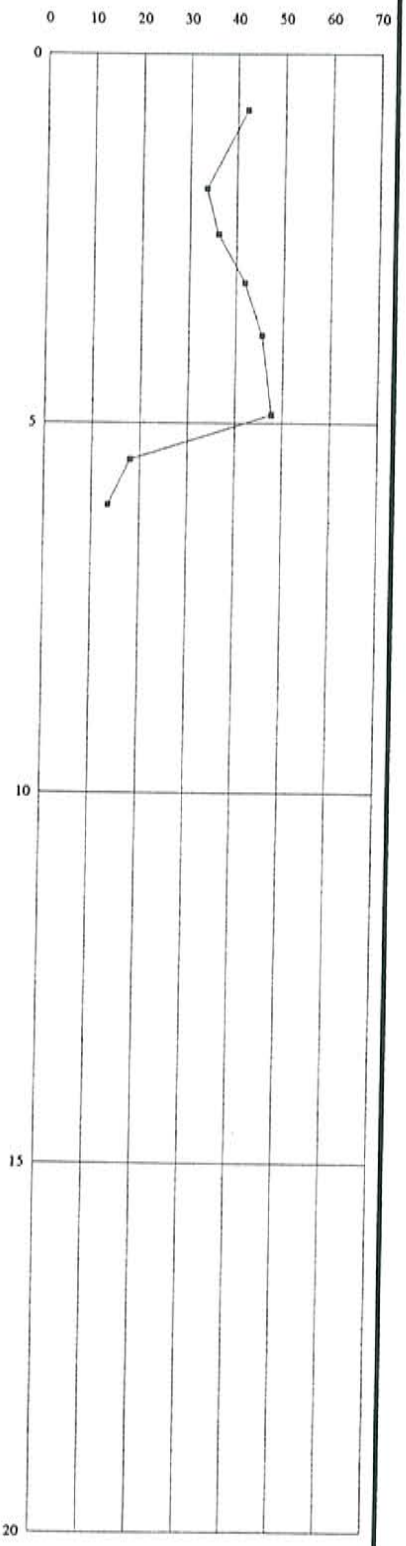


FIGURE 2

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 2	Project No. 252725
PROJECT: WEWPCC, WILKES AVE. CLIENT: EARTH TECT		DATE OF INVEST : JUNE 6, 2005 DRILL : PADDOCK 5 INCH AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
				LOC'N: UV BLDG ACCESS. 4 M E of C/L of OUTFALL & 140 M S of HYDRO LINES on WILKES AVE.
	0.00	237.58		0.00-0.02 TOPSOIL, BLACK
	0.50	237.08		0.02-0.30 FILL - CLAY, BROWN, MED SOFT, HIGH PLASTIC
	1.00	236.58		0.30-3.05 BLACK TO BROWN, FIRM, MEDIUM PLASTIC, AT 0.53 DARK BROWN, MOTTLED, TRACE SILT AND FINE SAND INCLUSIONS, FEW OXIDIZED SEAMS AND
	1.50	236.08		INCLUSIONS,
	2.00	235.58		
	2.50	235.08		AT 2.6 FIRM, LIGHT BROWN, MEDIUM SOFT
	3.00	234.58		HIGH PLASTIC
	3.50	234.08		END OF TEST HOLE AT 3.05 IN BROWN LAY

MOISTURE CONTENT (%)

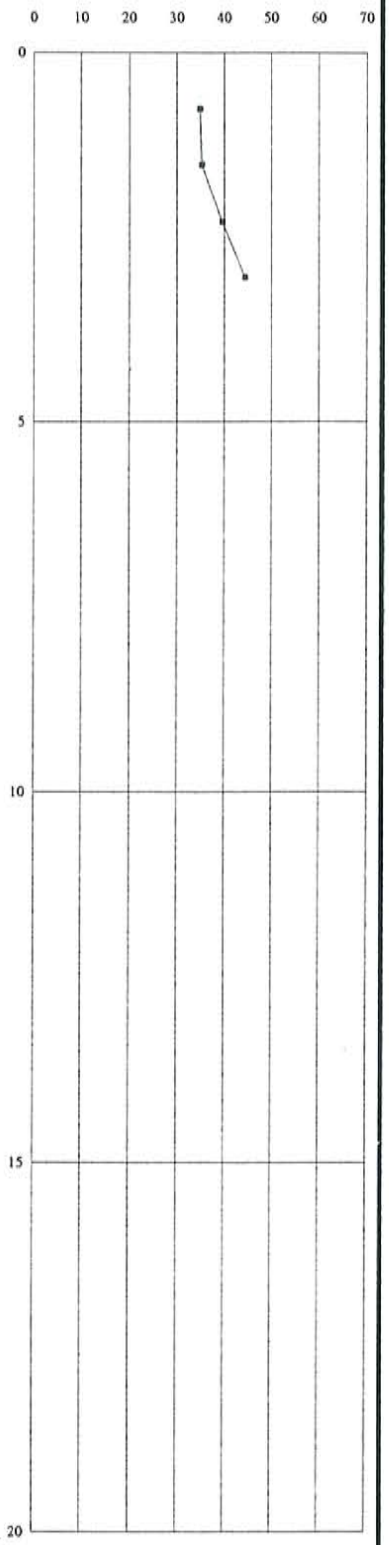


FIGURE 3

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 3	Project No. 252725
PROJECT: WEWPCC, WILKES AVE.		DATE OF INVEST : JUNE 17, 2005	
CLIENT: EARTH TECT		DRILL :SUBTERRANEAN 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
				LOC'N: PRIMARY CLARIFIER ADDITION, LOWER LOCATION	
	0.00	238.01		0.00-0.05TOPSOIL, BLACK	
	0.50	237.51		0.05-0.35 FILL, CLAY MATRIX WITH GRAVEL,FIRM, MOIST, MEDIUM PLASTIC	
	1.00	237.01		0.35-7.62 CLAY BLACK TO BROWN, FIRM TO STIFF, FEW INCLUSIONS MOTTLED	
	1.50	236.51			
	2.00	236.01			
	2.50	235.51		STIFF FEW SILT AND FINE SAND INCLUSIONS,	
	3.00	235.01		TRACE SULPHATE INCLUSIONS AND LENSI	Pp-125.4 KPA
	3.50	234.51		OCCASSIONAL FINE GRAVEL STONES	Tv-79.0 KPA W -17.57 KN/M
	4.00	234.01			
	4.50	233.51		SAME, STIFF	Pp-124.5 KPA
	5.00	233.01			Tv-71.8 KPA W -18.15 KN/M
	5.50	232.51		FIRM TO STIFF AT 5.5, MEDIUM TO HIGH PLASTIC	
	6.00	232.01			
	6.50	231.51			Pp-78.8 KPA
	7.00	231.01		DARK GREY, FIRM	Tv-50.3 KPA W -16.07 KN/M
	7.50	230.51			
	8.00	230.01		7.62-10.06 GLACIAL SILT TILL SILT MATRIX WITH SAND AND GRAVEL, SOFT, TAN BROWN, MORE COBBLES AND BOULDERS BELOW 9.1	
	8.50	229.51			
	9.00	229.01			
	9.50	228.51			
	10.00	228.01			
	10.50	227.51		END OF TEST HOLE AT 10.06 AT AUGER REFUSAL	
				WATER LEVEL AT COMPLETION OF DRILLING WAS 2.44 BELOW GROUND (ELEV. 235.57)	
				WATER LEVEL ON JUNE 24, 2005 WAS ELEV. 235.22	
				WATER LEVEL ON JULY 4, 2005 WAS ELEV. 235.27	

MOISTURE CONTENT (%)

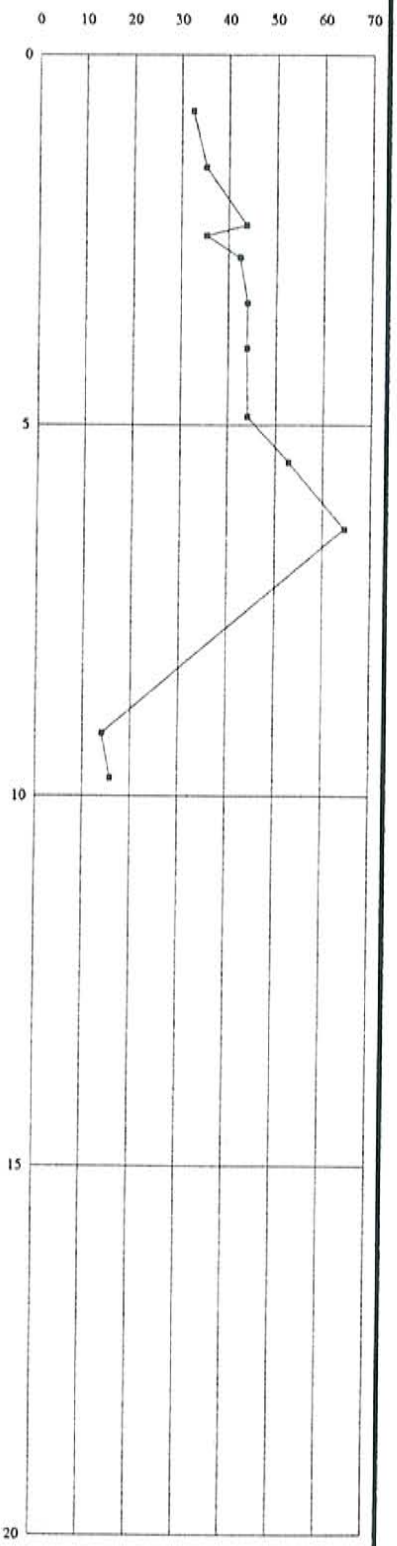


FIGURE 4

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 4	Project No. 252725
PROJECT: WEWPCC, WILKES AVE. CLIENT: EARTH TECT		DATE OF INVEST : JUNE 21, 2005 DRILL : PADDOCK 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	S Y M	SOIL DESCRIPTION
				LOC'N: PRIMARY CLARIFIER UPPER LOCATION
	0.00	242.90		0.00-0.08 TOPSOIL
	0.50	242.40		0.08-8.38 FILL CLAY MATRIX WITH TRACE GRAVEL, FIRM TO STIFF, MEDIUM TO HIGH PLASTIC
	1.00	241.90		
	1.50	241.40		Qu-162.6 KPA Pp-177.2 KPA Tv-117.3 KPA W -18.29 KN/M
	2.00	240.90		
	2.50	240.40		
	3.00	239.90		
	3.50	239.40		3.6 TO 4.4 GRANULAR PITRUN, BROWN, WELL GRADED
	4.00	238.90		
	4.50	238.40		4.5- 5.0 CLAY AND PITRUN MATRIX
	5.00	237.90		
	5.50	237.40		5.0-7.7 GRANULAR PITRUN, WELL GRADED, BROWN
	6.00	236.90		
	6.50	236.40		
	7.00	235.90		
	7.50	235.40		
	8.00	234.90		
	8.50	234.40		8.38-12.50 CLAY BROWN, SILTY, MOTTLED, TRACE SILT AND FINE SAND INCLUSIONS, OCCASSIONAL PEBBLE FEW OXIDIZED LAYERS AND INCLUSIONS FIRM
	9.00	233.90		
	9.50	233.40		
	10.00	232.90		
	10.50	232.40		DARK GREY, FIRM MEDIUM TO HIGH PLASTIC Qu-84.4 KPA Pp-76.6 KPA Tv-46.0 KPA W -16.2 KN/M
	11.00	231.90		
	11.50	231.40		
	12.00	230.90		
	12.50	230.40		12.50-14.33 GLACIAL SILT TILL SILT MATRIX WITH SAND AND GRAVEL, LIGHT GREY, SOFT, CLAYEY, LOW TO MEDIUM PLASTIC AT 13.1 DENSE, LOW PLASTIC, MORE COBBLES AND BOULDERS BELOW 13.7
	13.00	229.90		
	13.50	229.40		
	14.00	228.90		
	14.50	228.40		END OF TEST HOLE AT 14.33 AT AUGER REFUSAL WATER LEVEL ON JUNE 24, 2005 WAS ELEV. 235.23 WATER LEVEL ON JULY 4, 2005 WAS ELEV 235.28

MOISTURE CONTENT (%)

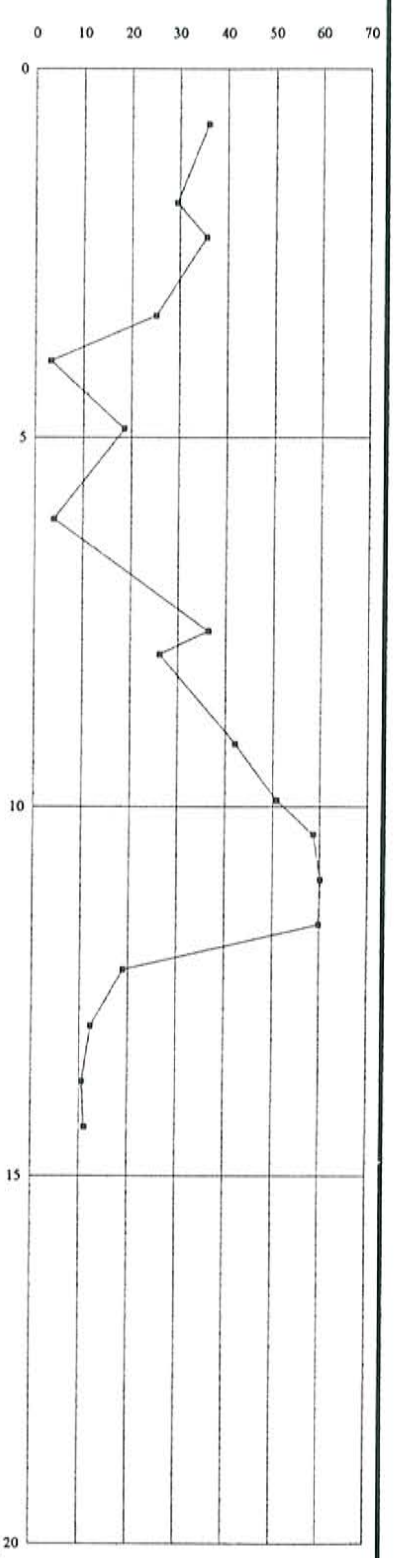


FIGURE 5

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 5	Project No. 252725
PROJECT: WEWPCC, WILKES AVE.		DATE OF INVEST : JUNE 21, 2005	
CLIENT: EARTH TECT		DRILL : PADDOCK 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
				LOC'N: SECONDARY CLARIFIER UPPER LOCATION
	0.00	241.59		0.00-0.08 TOPSOIL
	0.50	241.09		0.08-6.71 FILL BROWN, CLAY MATRIX, STIFF,
	1.00	240.59		
	1.50	240.09		
	2.00	239.59		Qu-193.7 KPA Pp-287.3 KPA Tv-138.9 KPA W -18.31 KN/M
	2.50	239.09		
	3.00	238.59		
	3.50	238.09		Qu-83.9 KPA Pp-191.5 KPA Tv-107.7 KPA W -17.64 KN/M
	4.00	237.59		OCCASSIONAL GRAVEL LAYER
	4.50	237.09		
	5.00	236.59		
	5.50	236.09		5.5 TO 6.4 GRANULAR PITRUN, BROWN, ODD CLAY INCLUSIONS
	6.00	235.59		
	6.50	235.09		6.71-10.37 CLAY BROWN, MOTTLED, TRACE SILT AND FINE SAND INCLUSIONS, TRACE OXIDIZED INCLUSIONS FIRM TO STIFF
	7.00	234.59		
	7.50	234.09		
	8.00	233.59		Qu-190.6 KPA Pp-201.1 KPA Tv-102.9 KPA W - 17.83 KN/M
	8.50	233.09		
	9.00	232.59		
	9.50	232.09		9.7 DARK GREY, TRACE (+) SILT AND FINE SAND INCLUSIONS
	10.00	231.59		
	10.50	231.09		10.37- 13.72 GLACIAL SILT TILL SILT MATRIX, LIGHT GREY, TRACE CLAY, WITH SAND AND GRAVEL,
	11.00	230.59		
	11.50	230.09		
	12.00	229.59		
	12.50	229.09		AT 12.5 TAN BROWN, MORE COBBLES AND BOULDERS, MORE DENSE, LESS CLAY
	13.00	228.59		
	13.50	228.09		
	14.00	227.59		END OF TEST HOLE AT 13.72 AT AUGER REFUSAL
				WATER LEVEL JUNE 24, 2005 WAS ELEV. 235.19
				WATER LEVEL JULY 4, 2005 WAS ELEV. 235.21

MOISTURE CONTENT (%)

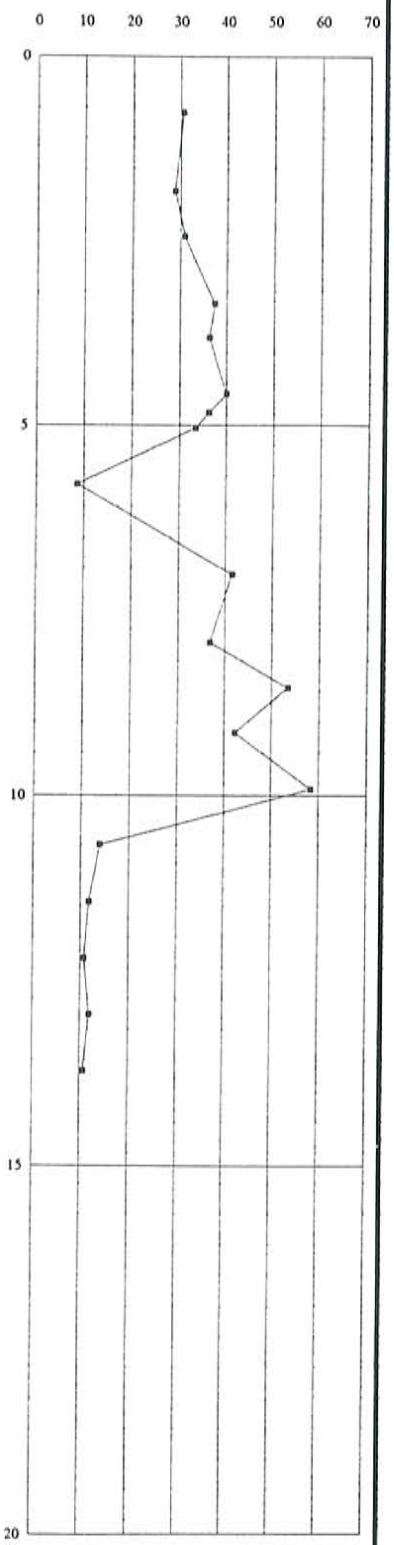


FIGURE 6

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 6	Project No. 252725
PROJECT: WEWPCC, WILKES AVE. CLIENT: EARTH TECT		JUNE 21, 2005 DRILL : PADDOCK 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
				LOC'N: SECONDARY CLARIFIER LOWER LOCATION
	0.00	238.03		
	0.50	237.53		0.00-0.08 TOPSOIL 0.08-0.53 FILL - CLAY MATRIX, BROWN, TRACE BLACK LAYERINGS FIRM TO STIFF
	1.00	237.03		0.53-7.47 CLAY BLACK TO DARK BROWN, SILTY, FEW SILT AND
	1.50	236.53		FINE SAND INCLUSIONS, STIFF, MEDIUM PLASTIC,
	2.00	236.03		MOTTLED, Pp-145.6 KPA Tv-91.0 KPA W -17.30 KN/M
	2.50	235.53		FEW OXIDIZED INCLUSIONS AND SEAMS
	3.00	235.03		
	3.50	234.53		FIRM TO STIFF Pp-162.8 KPA Tv-83.8 KPA W -17.66 KN/N
	4.00	234.03		
	4.50	233.53		
	5.00	233.03		
	5.50	232.53		DARK GREY, MEDIUM TO HIGH PLASTIC
	6.00	232.03		
	6.50	231.53		Pp-67.0 KPA Tv-47.9 KPA FIRM BELOW 6.7 W -16.27 KN/M
	7.00	231.03		
	7.50	230.53		7.47-10.06 GLACIAL SILT TILL
	8.00	230.03		SILT MATRIX LIGHT GREY, TRACE CLAY, SOME SAND AND GRAVEL,
	8.50	229.53		
	9.00	229.03		AT 9.1 DENSE, VERY LOW PLASTIC
	9.50	228.53		SOME COBBLES AND BOULDERS
	10.00	228.03		
				END OF TEST HOLE AT 10.06 AT AUGER REFUSAL
				NOTE: WATER LEVEL 10 MINUTES PAST DRILLING WAS 3.0 BELOW GROUND AND STILL RISING SLOWLY

MOISTURE CONTENT (%)

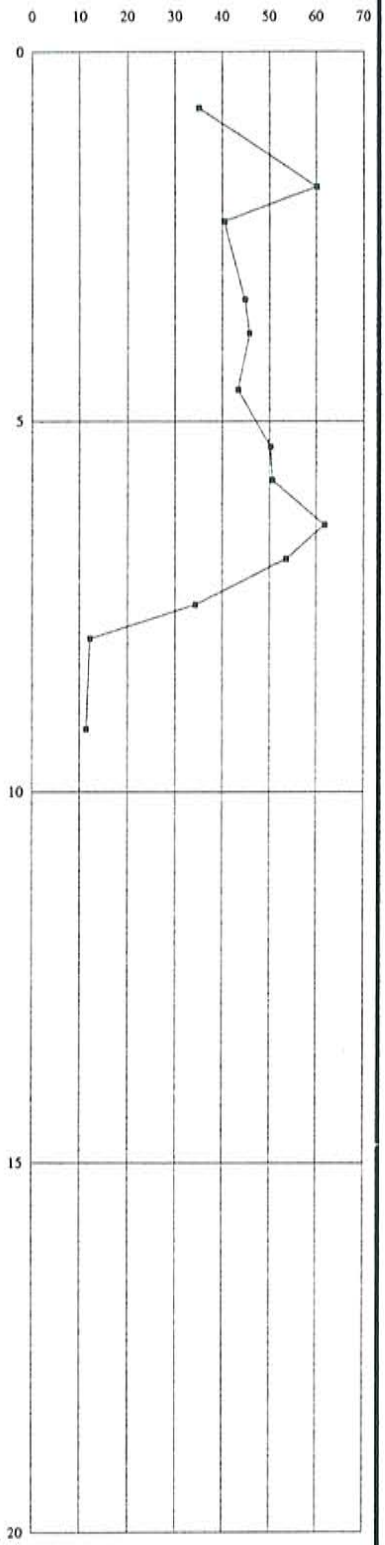


FIGURE 7

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 7	Project No. 252725
PROJECT: WEWPCC, WILKES AVE.		DATE OF INVEST : JUNE 21, 2005	
CLIENT: EARTH TECT		DRILL : PADDOCK 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
				LOC'N: SLUDGE FERMENTATION TANKS UPPER LOCATION
	0.00	242.95		
	0.50	242.45		0.00-0.15 TOPSOIL 0.15-6.25 FILL CLAY MATRIX, BROWN, TRACE BLACK CLAY, STIFF, OCCASSIONAL PEBBLE/GRAVEL, MEDIUM TO HIGH PLASTIC
	1.00	241.95		
	1.50	241.45		Qu-126.6 KPA Pp-229.9 KPA Tv-158.0 KPA W -18.39 KN/M
	2.00	240.95		
	2.50	240.45		
	3.00	239.95		Qu-102.2 KPA SAME, LAYER CONCRETE SAND, 150 mm + Pp-153.2 KPA Tv-100.5 KPA W -18.21 KN/M
	3.50	239.45		
	4.00	238.95		
	4.50	238.45		
	5.00	237.95		
	5.50	237.45		
	6.00	236.95		
	6.50	236.45		6.25-11.43 CLAY BROWN, FIRM TO STIFF, SILTY, TRACE SILT AND FINE SAND INCLUSIONS
	7.00	235.95		
	7.50	235.45		
	8.00	234.95		BROWN, HIGH PLASTIC, TRACE SULPHATE INCLUSIONS, TRACE SILT AND FINE SAND INCLUSIONS,SILTY, STIFF, Qu-79.2 KPA Pp-119.7 KPA Tv-67.0 KPA W -16.93 KN/M
	8.50	234.45		
	9.00	233.95		
	9.50	233.45		
	10.00	232.95		
	10.50	232.45		AT 10.8 DARK GREY
	11.00	231.95		
	11.50	231.45		11.43-14.63 GLACIAL SILT TILL SILT MATRIX WITH AND AND GRAVEL LIGHT GREY, SOFT, LOW PLASTIC
	12.00	230.95		
	12.50	230.45		
	13.00	229.95		
	13.50	229.45		
	14.00	228.95		AT 14.0 MORE DENSE, COBBLES AND BOULDERS
	14.50	228.45		
	15.00	227.95		END OF TEST HOLE AT 14.63 AT AUGER REFUSAL
				WATER LEVEL JUNE 24, 2005 WAS ELEV. 235.18
				WATER LEVEL JULY 4, 2005 WAS ELEV. 235.21

MOISTURE CONTENT (%)

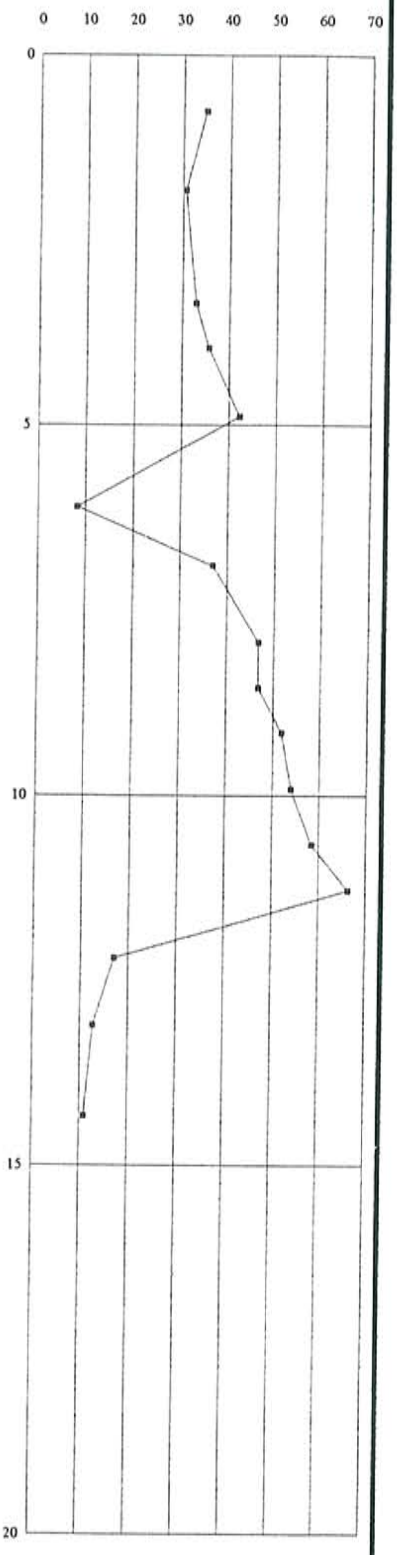


FIGURE 8

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 8	Project No. 252725
PROJECT: WEWPCC, WILKES AVE.		DATE OF INVEST : JUNE 21, 2005	
CLIENT: EARTH TECT		DRILL : PADDOCK 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
				LOC'N: SLUDGE FERMENTATION TANKS, LOWER LOCATION	
	0.00	238.11		0.00-0.15 TOPSOIL	
	0.50	237.61		0.15-6.40 CLAY BLACK TO DARK BROWN, STIFF, MEDIUM PLASTIC, FEW SILT AND FINE SAND INCLUSIONS, FEW OXIDIZED SEAMS AND INCLUSIONS, SILTY	
	1.00	237.11			
	1.50	236.61		AT 1.6 STIFF,	Pp-191.5 KPA
	2.00	236.11		MEDIUM TO HIGH PLASTIC	Tv-107.7 KPA W -17.88 KN/M
	2.50	235.61			
	3.00	235.11			Pp-119.7 KPA
	3.50	234.61			Tv-71.8 KPA W -17.68 KN/M
	4.00	234.11			
	4.50	233.61			
	5.00	233.11		AT 4.8 DARK GREY,	Pp-191.5 KPA Tv-107.7 KPA W -18.17 KN/M
	5.50	232.61			
	6.00	232.11			Pp-91.0 KPA Tv-52.7 KPA
	6.50	231.61		6.40-9.30 GLACIAL SILT TILL	W -16.67
	7.00	231.11		SILT MATRIX, WITH SAND AND GRAVEL SOME COBBLES AND BOULDERS, MEDIUM SOFT TRACE CLAY	
	7.50	230.61		DENSE AT 7.62 (+)	
	8.00	230.11			
	8.50	229.61			
	9.00	229.11			
	9.50	228.61			
	10.00	228.11		END OF TEST HOLE AT 9.30 AT AUGER REFUSAL	

NOTE: TRACE OF FREE WATER FROM SEAM AT APPROX. 2.74

WATER LEVEL JUNE 24, 2005 WAS ELEV 235.16

WATER LEVEL JULY 4, 2005 WAS ELEV 235.23

MOISTURE CONTENT (%)

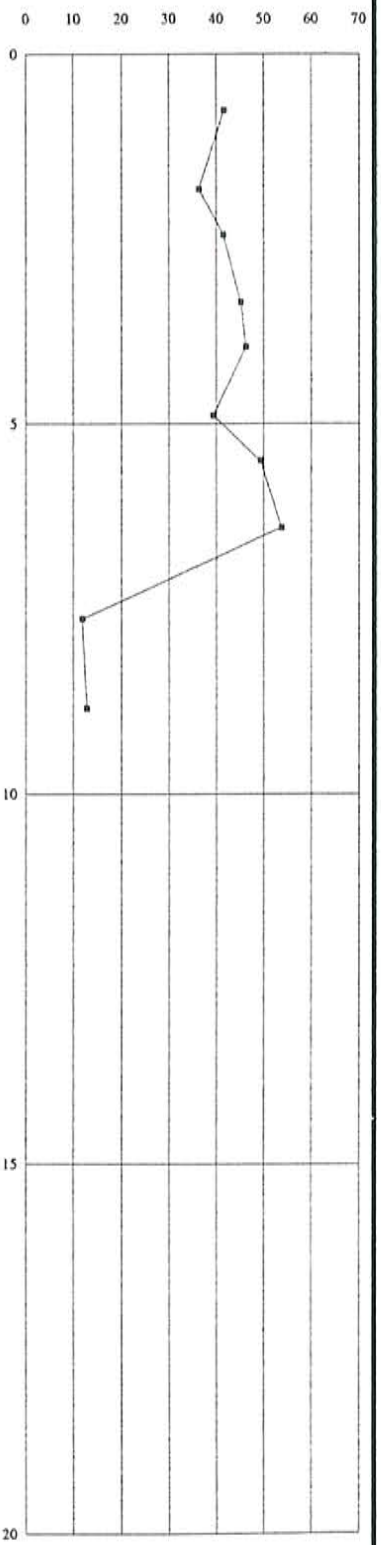


FIGURE 9

DYREGROV CONSULTANTS	Logged/Dwn.: RB/TH Checked: AOD	Test Hole No. 9	Project No. 252725
PROJECT: WEWPCC, WILKES AVE. CLIENT: EARTH TECT		DATE OF INVEST : JUNE 23, 2005 DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
				LOC'N: FERRIC DOSING FACILITY. 2 M S & 4 M E of S/E CORNER OF EXISTING HEADWORKS PLANT
	0.00	241.08		0.00-4.57 FILL CLAY AND GRAVEL MATRIX, MOIST, TIGHT, LOW PLASTIC, MAXIMUM 40 mm AGGREGATE
	0.50	240.58		
	1.00	240.08		AT 0.5 CLAY FILL BROWN, TRACE BLACK, FEW FINE GRAVEL STONES, FIRM, MEDIUM TO HIGH PLASTIC
	1.50	239.58		
	2.00	239.08		
	2.50	238.58		
	3.00	238.08		
	3.50	237.58		
	4.00	237.08		
	4.50	236.58		4.57-9.15 CLAY BROWN, STIFF, MOTTLED, TRACE (+) SILT AND FINE SAND INCLUSIONS,
	5.00	236.08		
	5.50	235.58		
	6.00	235.08		
	6.50	234.58		
	7.00	234.08		
	7.50	233.58		
	8.00	233.08		
	8.50	232.58		
	9.00	232.08		
	9.50	231.58		9.15-12.65 GLACIAL SILT TILL SILT MATRIX, WITH SAND AND GRAVEL, SOFT LIGHT GREY, TRACE CLAY, TRACE WATER AT 10.0 VERY LOW PLASTIC
	10.00	231.08		
	10.50	230.58		
	11.00	230.08		
	11.50	229.58		
	12.00	229.08		
	12.50	228.58		
	13.00	228.08		END OF TEST HOLE AT 12.65 AT AUGER REFUSAL
				NOTE: WATER STANILIZED AT 6.40 BELOW GROUND IN FIVE MINUTES OF COMPLETION OF DRILLING (ELEV. 234.68)

MOISTURE CONTENT (%)

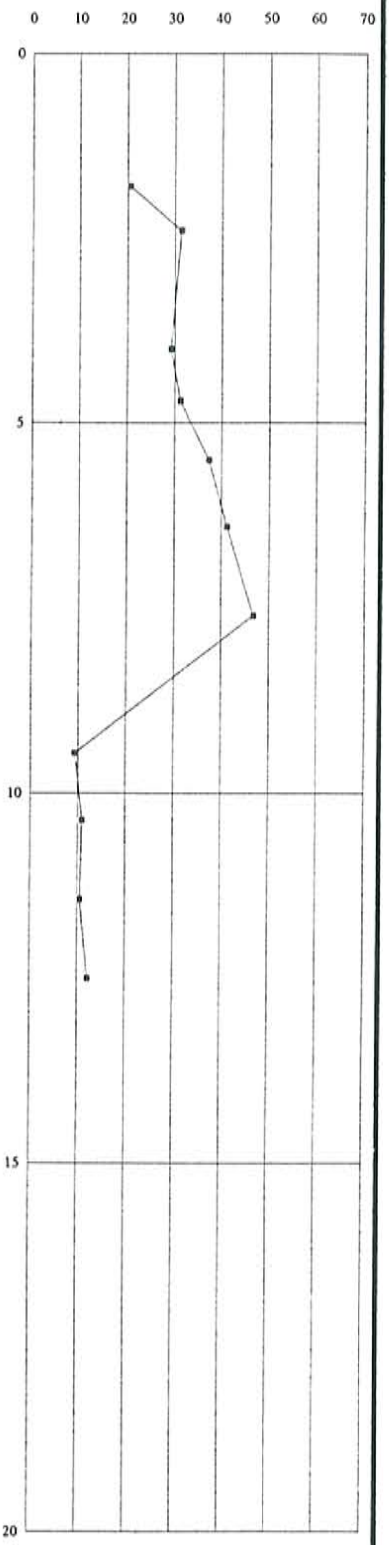
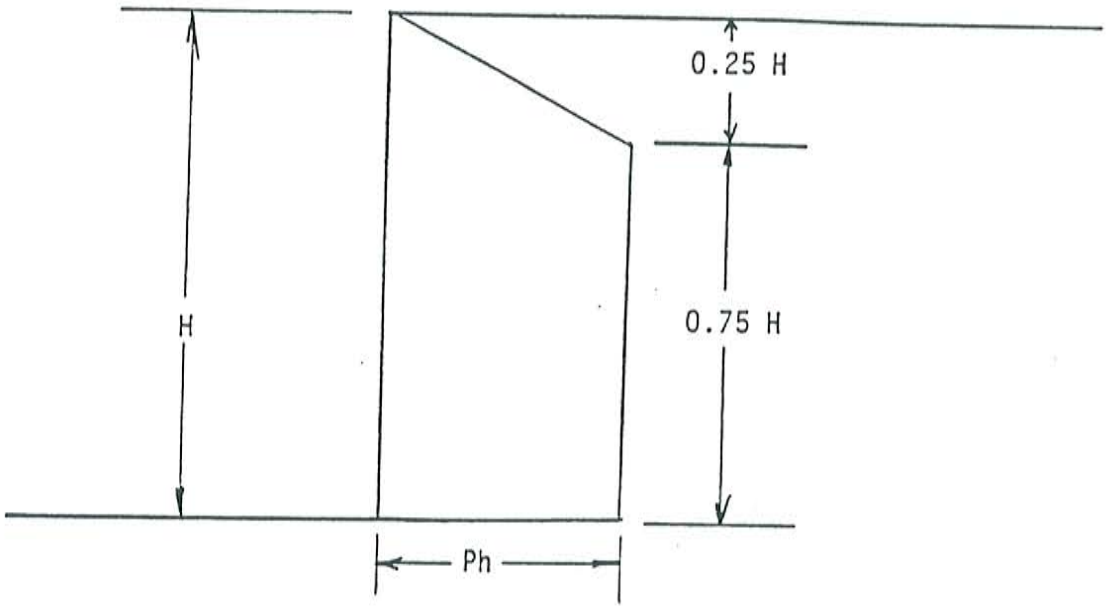


FIGURE 10



$Ph = 0.4 \gamma H$

Where: Ph = Lateral earth pressure on shoring (kPa)

γ = Soil unit weight (17.28 KN/M^3)

H = Wall height (M)

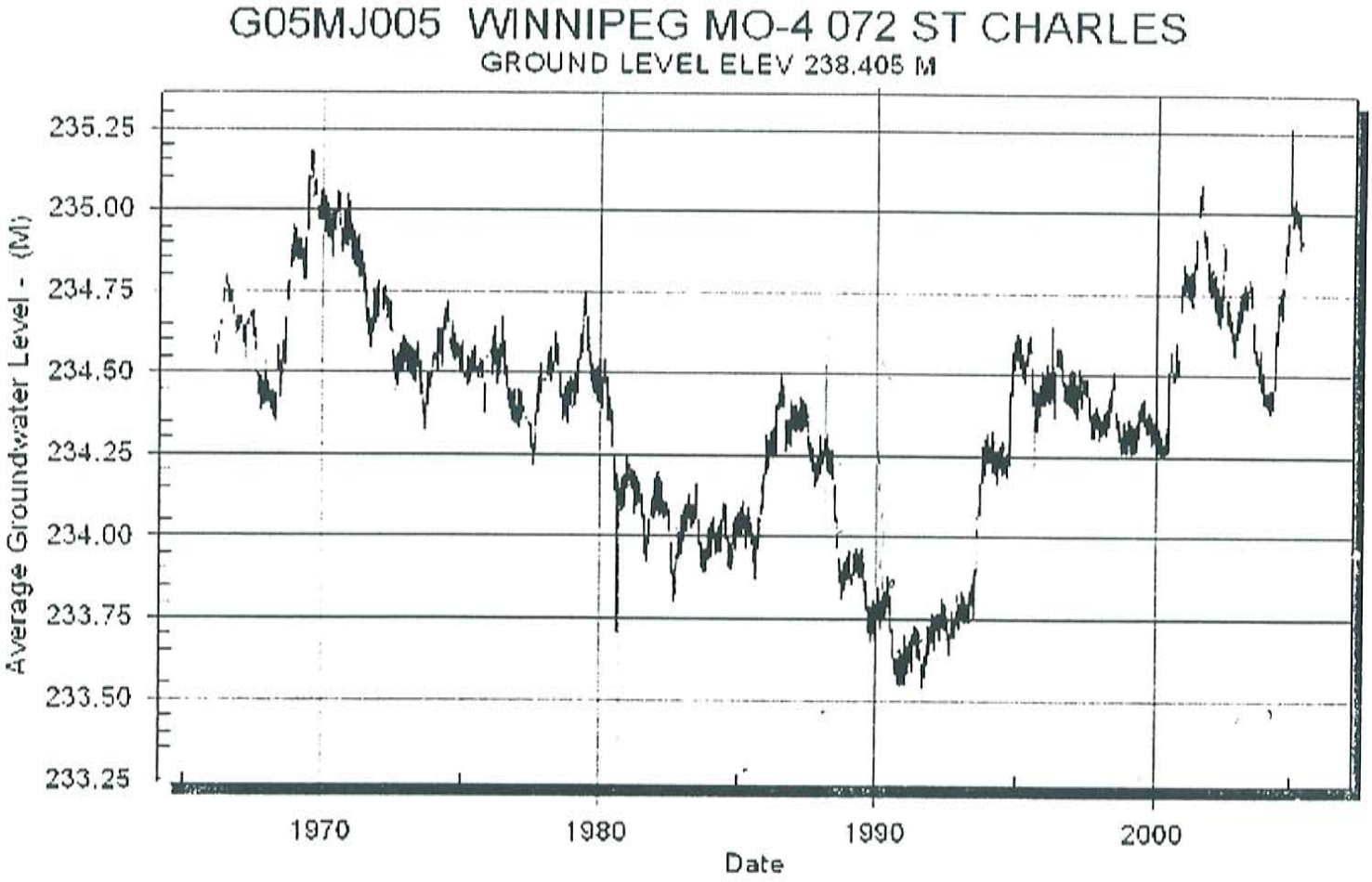
Note: Add surface load surcharge where applicable

DYREGROV CONSULTANTS CONSULTING GEOTECHNICAL ENGINEERS			EARTH PRESSURE DISTRIBUTION TEMPORARY SHORING WEST END WATER POLLUTION CONTROL CENTRE		
SCALE NTS	DATE JULY, 05	MADE TJH	CHKD AOD	JOB 252725	FIGURE 11

APPENDIX A

MO - 4 072 St. Charles

Monitoring Well Hydrograph


G05MJ005 WINNIPEG MO-4 072 ST CHARLES
GROUND LEVEL ELEV 238.405 M
Average Groundwater Level - (M)
235.25
235.00
234.75
234.50
234.25
234.00
233.75
233.50
233.25
1970
1980
1990
2000
Date

APPENDIX B

Report on Sub-Soil Investigation

for Proposed Treatment Plant

West End Water Pollution Control Centre

December 9, 1974

Ripley Klohn & Leonoff International

Project W - 922

TITLE: REPORT ON SUB-SOIL INVESTIGATION FOR PROPOSED TREATMENT PLANT

LOCATION: WEST END WATER POLLUTION CONTROL CENTRE - CHARLESWOOD, MANITOBA

CLIENT: THE CITY OF WINNIPEG

PROJECT: W-922 DATE: December 9, 1974

Ripley, Klohn & Leonoff International Ltd.

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DRAWINGS

December 9, 1974

J. Klohn
. Leonoff
M. Davison
. Olsen
. Speer
S Hunter
Douglass
rt J. Melling
ntant

Klohn Leonoff Consultants Ltd.

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Yves G. Bajard
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Robert C. Lo
Bob Maartman
K. Ian Morrison
Robert J. Rennie
Neil H. Wade

December 9, 1974

Our File W-922

REPORT ON
SUB-SOIL INVESTIGATION
FOR
PROPOSED TREATMENT PLANT
AT
WEST END WATER POLLUTION CONTROL CENTRE
CHARLESWOOD, MANITOBA
FOR
THE CITY OF WINNIPEG
WATERWORKS, WASTE & DISPOSAL DIVISION
BY
KLOHN LEONOFF CONSULTANTS LTD.
CIVIL & GEOTECHNICAL ENGINEERS
WINNIPEG, MANITOBA

1. INTRODUCTION

It is proposed to construct aeration and clarifier tankage at the West End Water Pollution Control Centre. This report contains the results of a sub-soil investigation carried out at the site of the proposed plant, and makes recommendations with regards to the foundations.

The investigation was authorized by Mr. A. Penman, P. Eng., Director, in a letter dated November 18, 1974.

2. CONCLUSIONS & RECOMMENDATIONS

2.1. The investigation revealed that the sub-soil at the site consisted of approximately 22 feet of Lake Agassiz Clay overlying a stiff glacial till. All the test holes terminated with refusal on either boulders or bedrock.

Groundwater was encountered in the glacial till close to refusal depth. The water rose to within 11 feet of the existing surface.

2.2. Because of the groundwater conditions, driven precast concrete piles are recommended as the foundation support system.

If driven according to the Winnipeg Building By-laws, the piles will have the following capacity.

PILE SIZE	PILE CAPACITY (kips)
12"	100
14"	140
16"	180

2.3. All test holes terminated with refusal on what is assumed to be boulders or bedrock. Experience has shown that precast concrete piles are susceptable to breaking when boulders are encountered near refusal depth. We recommend that there is full-time inspection by an experienced soils technician during the installation of the piles to ensure that the broken piles can be recognized.

2.4. The groundwater, which was first encountered at around 35 feet in the glacial till, was under a slight artesian pressure and rose to a depth of 11 feet below the existing grade, which is elevation 769.0, approximately. ~ 734.4

2.5. The excavation for the proposed tankage should be kept to an elevation about 769.0, to lessen the possibility of water seepage into the excavation.

2.6. Excavations for the tankage will require to be supported by shoring. Where space is not a problem, as an alternative, the cut can be sloped at 1 vertical to 2 horizontal.

Depending on the location and depth of the excavations closest to the existing dyke, the stability of the dyke may be affected.

We should be given the opportunity to check the stability when the final design drawings are available.

2.7. Backfilling the excavations around the structure should be carried out with compacted granular material.

A drain with a positive permanent connection to an outfall drain should be laid at the base of the granular fill.

2.8. Type V Sulphate Resistant Cement must be used in all concrete in contact with the native soil.

3. DESCRIPTION OF SITE

The site of the proposed construction is immediately north of the northern dyke of the Charleswood Lagoon.

The structure is to be located just north of the toe of the dyke.

The land north of the dyke is flat and has been cultivated.

4. FIELD AND LABORATORY INVESTIGATION

Five test holes were put down at the locations shown on Drawing No. A-W-922-1 by a truck-mounted 16-inch diameter power auger.

All the test holes were taken to refusal on what is presumed to be either boulders or bedrock.

Disturbed and undisturbed samples were recovered from each test hole.

The samples were returned to our laboratory where they were visually examined and classified. The natural moisture content was determined and estimates made of the unconfined strength, using a pocket penetrometer.

5. SUB-SOIL CONDITIONS

A similar soil stratigraphy was encountered in every test hole.

Under a thin layer of organic topsoil, there was a highly plastic clay. The clay was mottled brown close to the surface and became grey with depth. The clay was stiff to very stiff near the surface but the material became softer with depth.

The glacial till was encountered at depths between 20 and 24 feet. The till contains many pieces of limestone and igneous cobbles. The material was softer near the interface with the clay but became harder with depth.

Refusal was reached at depths between 30 and 35 feet and was presumed to be on boulders and/or bedrock.

Groundwater under slight artesian pressure, was encountered in the till in all test holes. The water level stabilized at depth between 11 and 15 feet below the existing grade.

6. DISCUSSION

The investigation revealed that normal Winnipeg soil conditions exist at this site. The till, however, is at a higher elevation than is found in most Winnipeg locations.

Because of the shallowness of the till, and the artesian conditions it contains, it will be necessary to use a driven pile foundation.

Either timber or concrete piles could be used, but because of the hard driving that could occur in the till stratum, concrete piles appear the more suitable.

As only very general data is known regarding the proposed structure, we have not carried out any stability calculations with regard to the relationship between the existing dyke and the proposed excavation. This must be done before the design has been finalized.

From the soil stratigraphy encountered, it appears very unlikely that any seepage from the lagoons will occur during the excavations for the proposed structure.

While we believe that this report is complete within our terms of reference, we will be pleased to answer any questions you may have.

Yours very truly,
KLOHN LEONOFF CONSULTANTS LTD.

JAMES HUNTER, P. ENG.
MANAGER

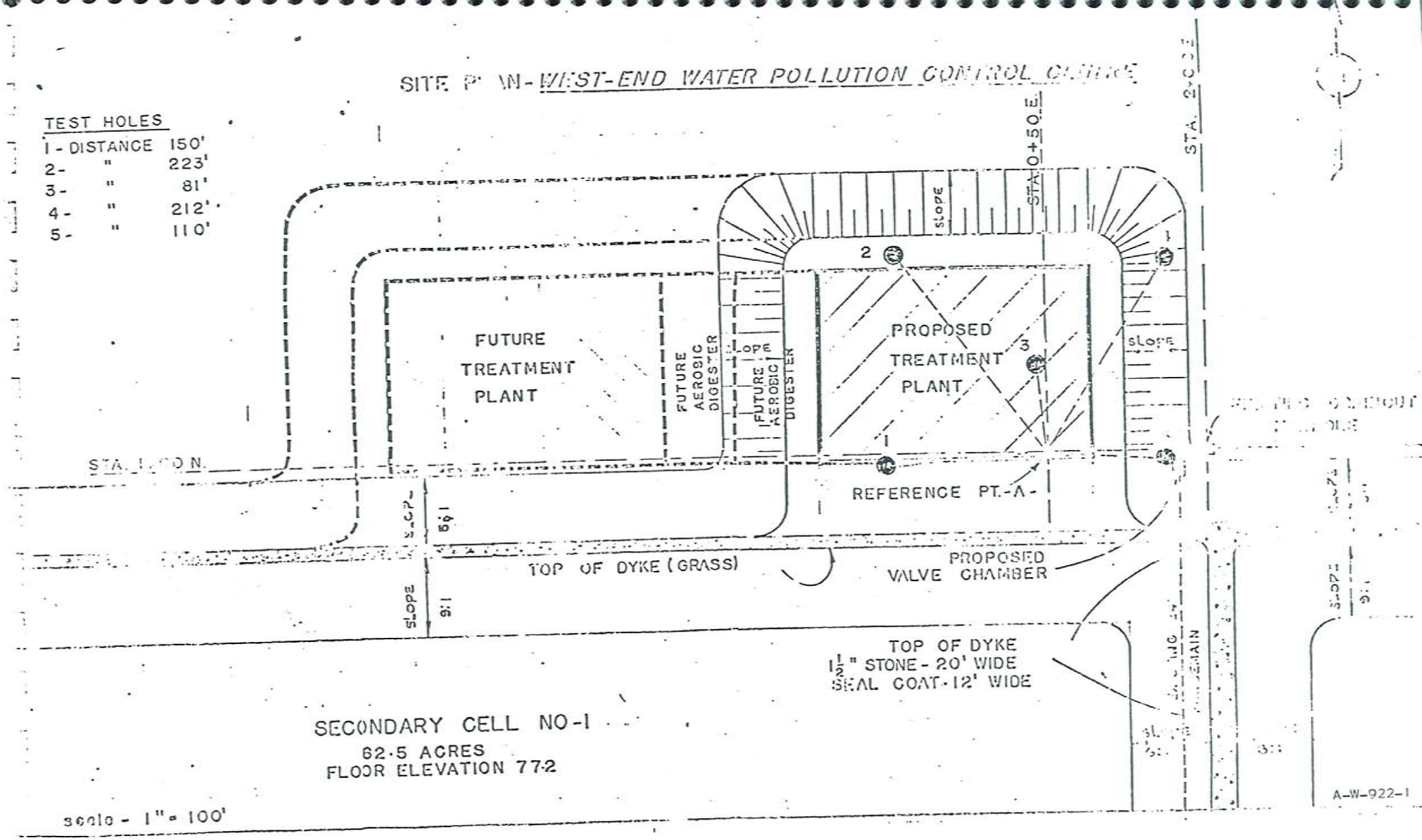
JH/el
4 ccs.

DRAWINGS

SITE PLAN - WEST END WATER POLLUTION CONTROL PLANT

TEST HOLES

1 - DISTANCE		150'
2 -	"	223'
3 -	"	81'
4 -	"	212'
5 -	"	110'



TEST HOLE LOG

Date: November 20, 1974

HOLE NO. 1

SAMPLE DATA	ELEV. COLLAR	Tech: L. King
WT. OF HAMMER	ELEV. GROUND	781
HEIGHT DROP	CO-ORD. LOCATION	

DEPTH FT.	O.D. I.D.	BLOWS FT.	NO.	SYMBOL	DESCRIPTION OF MATERIAL
					1 CLAY – black, organic
					CLAY – brown, organic
5	3"Sy		1		4 CLAY – highly plastic – mottled brown – massive structure – pockets of silt >½" – very stiff to stiff
10	3"Sy		2		
15	3"Sy		3		13 CLAY – highly plastic – grey – massive structure – pieces of limestone and igneous rock >1½" – stiff
20					20 GLACIAL TILL – silt, sand, pieces of limestone and igneous rock >1½" – tan – stiff to hard
25	Bag		4		
30					
35					31 NOTES: 1. Auger refusal on boulders at 31'. 2. Heavy seepage from 31'. Water rose to 13'. 3. No samples from 25' to 31' because of water saturation.

6'4" 231.7'

Unconfined Compressive Strength, tons per sq. ft.: 1 2 3 4

● FIELD VANE ○ LAB VANE ■ POCKET PEN.

PLASTIC LIMIT × — WATER CONTENT ○ — LIQUID LIMIT ×

10 30 50 70 90

○ Moisture Content

□ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.

CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: CHARLESWOOD LAGOON

LOCATION: WINNIPEG, MANITOBA

TEST HOLE LOG

DATE November 20, 1974 HOLE NO. 2

SAMPLE DATA				SYMBOL	ELEV. COLLAR	Tech: L. King	Unconfined Compression Tons per sq. ft.
WEIGHT HAMMER					ELEV. GROUND	780	1 2 3 4 ● FIELD VANE △ LAB. VANE
WEIGHT DROP					CO-ORD. LOCATION		PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT X — — — C — — — X
DEPTH	O.D. I.D.	BLOWS FT.	NO.		DESCRIPTION OF MATERIAL		10 30 50 70 90
5	Bag		1		1 CLAY – black, organic		
					CLAY – highly plastic – mottled brown – massive structure – pockets of silt 7¼" – very stiff to stiff		
10	Bag		2		12		
					CLAY – highly plastic – grey – massive structure – pockets of silt and black organic matter – stiff to soft		
15	Bag		3				
20	Bag		4		21		
					GLACIAL TILL – silt, sand, pieces of limestone and igneous rock 7 1½" – tan – stiff to hard		
25	Bag		5				
30					30		
					NOTES: 1. Refusal on boulders at 30'. 2. Heavy seepage of water. Water rose to 13'.		○ Moisture Content □ Pocket Penetrometer
35							

Ripley, Klohn & Leonoff International Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT CHARLESWOOD LAGOON

LOCATION WINNIPEG, MANITOBA

A-1-0.1-4

PLATE No.

TEST HOLE LOG

DATE November 20, 1974 HOLE NO. 3

SAMPLE DATA				SYMBOL	ELEV. COLLAR Tech: L. King	Unconfined Compression Tons per sq. ft.
WEIGHT HAMMER					ELEV. GROUND 781	1 2 3 4 ● FIELD VANE ▲ LAB VANE ■ UNCONF.
HEIGHT DROP					CO-ORD. LOCATION	PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (X — — — — O — — — →) 10 30 50 70 90%
DEPTH (FEET)	O.D. I.D.	BLOWS FT.	NO.		DESCRIPTION OF MATERIAL	
5	Bag		1		1 CLAY – black, organic CLAY – highly plastic – grey – massive structure – stiff	
10	Bag		2		8 CLAY – highly plastic – mottled brown – massive structure – stiff	
15	Bag		3		15 CLAY – highly plastic – grey – massive structure – pockets of silt $> \frac{1}{2}$" – firm	
20	Bag		4			
25	Bag		5		23 GLACIAL TILL – silt, sand, pieces of limestone and igneous rock $> 1\frac{1}{2}$" – tan – stiff to hard	
30	Bag		6		30	
35					NOTES: 1. Auger refusal on boulder at 30'. 2. Heavy seepage of water from 30'. Water rose to 11'. 3. No samples from 29' to 30' because of water saturation.	○ Moisture Content □ Pocket Penetrometer
40						

Ripley, Klohn & Leonoff International Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT CHARLESWOOD LAGOON

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE November 20, 1974 HOLE NO.

SAMPLE DATA | WEIGHT HAMMER | FLIGHT DROP | SYMBOL | ELEV. COLLAR | Tech: L. King | ELEV. GROUND 780 | CO-ORD. LOCATION

Unconfined Compression tons per sq. ft.
1 2 3 4
● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT | WATER CONTENT | LIQUID LIMIT
X — — — — O — — — — X
10 30 50 70 90

DEPTH (FEET)	O.D. I.D.	BLOWS/FT.	NO.	DESCRIPTION OF MATERIAL
			1	CLAY – black, organic
			2	CLAY – brown, organic
5	Bag		1	CLAY – highly plastic – mottled brown – massive structure – stiff
10	Bag		2	
			12	CLAY – highly plastic – grey – massive structure – pockets of silt > ½" – stiff to soft
15	Bag		3	
20	Bag		4	
25	Bag		5	
			24	GLACIAL TILL – silt, sand, pieces of limestone and igneous rock > 1½" – tan – stiff to hard
30				
35			35	
40				

NOTES:
1. Auger refusal on boulders at 35'.
2. Heavy seepage from 35'.
3. No samples from 26' to 35' because of water saturation.
4. Water rose to 15'.

○ Moisture Content
□ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: CHARLESWOOD LAGOON

LOCATION: WINNIPEG, MANITOBA

TEST HOLE LOG

DATE November 20, 1974 HOLE NO. 5

SAMPLE DATA				SYMBOL	ELEV. COLLAR	Tech: L. King	Unconfined Compression tons per sq. ft.
WEIGHT HAMMER					ELEV. GROUND	781	1 2 3 4 ● FIELD VANE △ LAB VANE ■ UNCONF.
HEIGHT DROP					CO-ORD. LOCATION		PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT . X — — — O — — — X 10 30 50 70 90
DEPTH I.D.	O.D. I.D.	BLOWS FT.	NO.		DESCRIPTION OF MATERIAL		

1 CLAY – black, organic

CLAY – highly plastic
– mottled brown
– massive structure
– pockets of silt > ½"
– stiff

5 3"Sy 1

10 3"Sy 2

15 3"Sy 3

15

Colour changed to grey
Stiff – soft

20 3"Sy 4

20½

GLACIAL TILL – silt, sand pieces of limestone and igneous rock > 1½
– tan
– stiff to hard

25 Bag 5

30

35

35

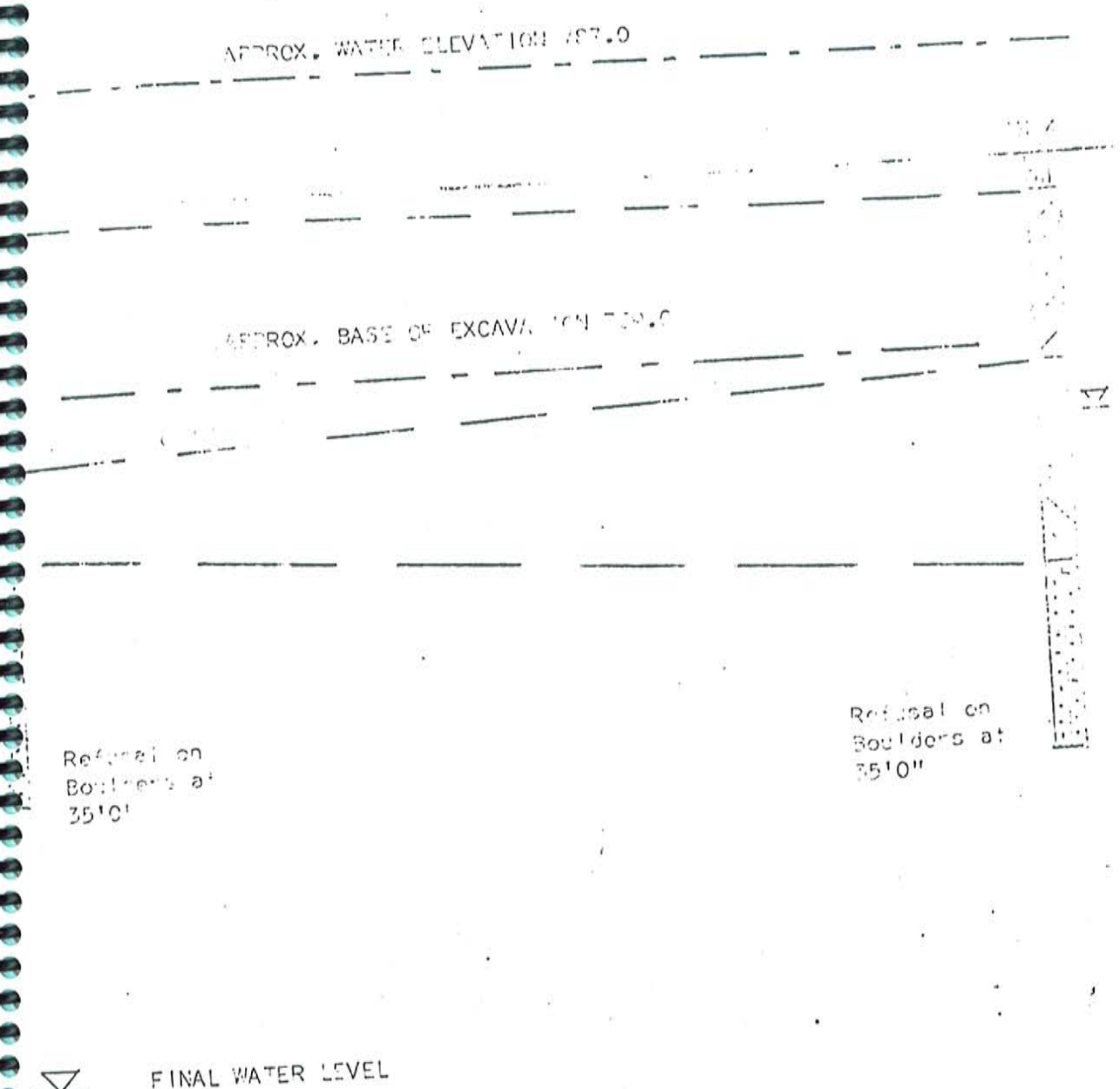
NOTES:
1. Auger refusal on boulders.
2. Heavy seepage from 35'. Water rose to 13'.
3. No samples from 26' to 35' because of water saturation.

○ Moisture Content
□ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: CHARLESWOOD LAGOON

LOCATION: WINNIPEG, MANITOBA



▽ FINAL WATER LEVEL

SCALE Horizontal 1" = 30'
Vertical 1" = 10'

John & Leonoff International Ltd. CONSULTING ENGINEERS EDMONTON — CALGARY — REGINA — WINNIPEG CANADA	ASSUMED SOIL STRATIGRAPHY BETWEEN TEST HOLES [illegible]
CITY OF WINNIPEG	APPROVED [illegible]

APPENDIX C

Geotechnical Report

West End Water Pollution Control Centre

May 1988

Dyregrov & Burgess

Project No. 88570

GEOTECHNICAL REPORT

WEST END WATER POLLUTION CONTROL CENTRE

Prepared For

REID CROWTHER AND PARTNERS Ltd.

on behalf of

THE CITY OF WINNIPEG

May 1988

Project No. 88570

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov and Burgess for the proposed new West End Water Pollution Control Centre. The work was done at the request of Reid Crowther and Partners Ltd. on behalf of the City of Winnipeg and was authorized by letter of April 13, 1988 under the signature of Mr. D.J. Taniguchi, P.Eng.

2.0 SITE

The site for the proposed new facility is presently being used for agricultural purposes. It is flat lying. The location of the new facility will be to the east of the existing treatment plant. A 1500 mm discharge line will be installed in a westerly direction, across agricultural land, to connect to the existing lagoon outfall.

3.0 FIELD INVESTIGATION

On April 19 and 20, 1988 fifteen test holes were put down, nine being in the area of the proposed plant and 6 along the proposed outfall line. The locations of the test holes are shown on Figure 1.

The test holes were advanced using truck mounted drilling equipment which is owned and operated by Subterranean (Manitoba) Ltd. The test holes were 450 mm in diameter and were carried to auger refusal in the glacial till which underlies the site. The soil profile was examined, classified on a continuous basis as drilling progressed and sampled at regular depth intervals. Disturbed samples from auger cuttings and relatively undisturbed 75 mm diameter Shelby tube samples were obtained for laboratory

strength and moisture content testing.

Observations were made during drilling with respect to groundwater, seepage and caving conditions encountered in the test holes. Sealed standpipes were installed within the glacial till in Test Holes 1, 3, 8 and 13.

All test holes were backfilled with excavated materials on completion.

Ground elevations and the locations of the test holes were determined by Reid Crowther and Partners Ltd.

4.0 THE SOIL PROFILE

A deposit of highly plastic Lake Agassiz clay is the major component of the soil profile. It extends from beneath the cultivated topsoil to depths varying from about 5.5 to 7.5 m. The clay is stiff to firm in consistency. Moisture contents are generally in the 40 to 60 percent range, however, there is a tendency to be drier in the upper 1.5 m and wetter in the lower 1.5 m. Plastic and Liquid Limits for the clays are typically 30 and 100 percent, respectively, and liquidity indices are estimated to be in the 0.3 to 0.4 ranges. Specific tests were not performed to evaluate these index properties.

Undrained shear strengths were determined on a number of undisturbed samples by unconfined compression, penetrometer and laboratory vane tests. The results of these tests suggest an average undrained shear strength in the order of 35 kPa.

The clays are underlain by glacial silt till which is a mixture of sand, gravel and boulder size materials within a predominantly silt matrix. The relative density of the till has been described on the basis of its

moisture content and a visual examination of the auger cuttings. Generally the surface of the glacial till is soft grading into a medium dense condition. It was only in Test Hole 12 that the till was described as dense.

The surface elevation of the till at the proposed plant site varies from 230.4 to 231.6 dipping downward from east to west. Along the outfall alignment it is at about elevation 230.8 except at Test Hole 15, the most westerly test hole closest to the existing lagoon outfall line, where it was at elevation 232.1.

A detailed description of the soil profile and the results of the field and laboratory testing are included on the test hole logs, Plates 2 to 16.

5.0 GROUNDWATER CONDITIONS

In the majority of the test holes within the proposed plant area groundwater seepage was noted within the test holes. In some cases water levels at the completion of test drilling were significantly above the bottom of the test holes. Along the outfall alignment groundwater seepage was not as significant during the test drilling.

The four standpipes piezometers which were installed showed the following groundwater elevations some 5 to 6 days after drilling.

Test Hole	Groundwater Elevation
1	234.5
3	233.8
8	234.0
13	234.2

This would suggest a general groundwater level near elevation 234.5 which is probably a reflection of the piezometric condition in the underlying bedrock. The bedrock is suspected to be at a shallow depth below the bottom of the test holes.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

The general arrangement of the proposed plant is shown on Plate 1. The existing ground within the area of the proposed plant is at or very close to elevation 237.8 and it is tentatively proposed that the final grade will be near elevation 240.0. Generally excavations will not be lower than elevation 235 except for those of the secondary clarifiers, which have been proposed near elevation 234, and other smaller works.

It is anticipated that the proposed plant outfall line will have an invert above elevation 233.

6.2 Slabs

The clays at this site are typical of the clays encountered in the Winnipeg area. They are subject to swelling and shrinkage movements and slabs and the like placed on them will undergo similar reflective movements.

The swelling and shrinkage movements are the result of changes in moisture and stress conditions. The movements are often aggravated by environmental conditions which can occur during construction and also during operation. These movements can be quite significant, probably being in excess of several inches and can be largely differential over short distances.

It is for these reasons that it is recommenced that all slabs be structurally supported. It is recognized that there may be circumstances where slabs on soil could be considered. These should be reviewed by the geotechnical consultant during the design stages.

6.3 Foundations

The geotechnical conditions at this site are best suited for the use of high capacity, prestressed, precast concrete piles that are driven to practical refusal in the underlying glacial till or bedrock which may be present. The soft to medium dense condition of the glacial till and the potential for problems related to groundwater seepage and caisson bell instability are the factors which make the site unsuitable for the use of high capacity cast in place concrete belled caissons.

The precast concrete piles can be assigned capacities of 445, 625 and 800 kN for 300, 350 and 400 mm diameter pile sizes respectively. The piles must be driven to practical refusal with heavy diesel hammers such as Link Belt 520 or the Delmag D22 which are routinely used in the Winnipeg area. Preboring should be done at all pile locations to minimize heave and vibration and to enhance pile plumbness. All piles in groups should be restruck to counter the effects of heave and pile spacing should not be closer than 2.5 pile diameters, centre to centre. Monitoring pile heave should be done to ensure that the restriking procedures are satisfactory.

The precast piles will derive nearly all of their capacity due to end bearing and there is no necessity for a reduction in individual pile capacity due to group action.

Cast in place concrete friction piles may be used for support of lightly loaded structures. Their design may be based on an allowable shaft

adhesion of 14 kPa. The upper 2 and 3 m of shaft support should be discounted for interior and exterior piles respectively. A minimum shaft diameter of 400 mm should be specified. Maximum pile penetration should be 1 m above the anticipated glacial till elevation to avoid the seepage problems from the glacial till. A mix of friction and driven piles is not recommended for the support of important elements. Groups of friction piles are also not recommended.

We recommend that full time inspection by qualified geotechnical personnel be provided for the installation of the driven precast concrete piles.

6.4 Excavations

Excavations will be required for the primary clarifiers, aeration tanks, secondary clarifiers, utility blower building and interconnecting tunnel. These excavations are generally not expected to exceed 3 m but could be slightly in excess of 4 m at the secondary clarifiers, near elevation 234.

The groundwater elevation of 234.5 is comparable to published data for April conditions. September conditions could be near elevation 231.5 some 3 m lower. With the groundwater at elevation 234.5 the safety factors against bottom heave are in the order of 2.0 for a 4 m excavation and are greater when the groundwater levels are lower at other times of the year.

It is anticipated that the excavations can be open cut and that the cut slopes can be graded at maximum gradients of 1 horizontal to 1 vertical for short term use. For cuts to be open for extended periods, slope gradients of 1.5 to 1 or even 2 to 1 should be considered.

Temporary shoring may be necessary where ground disturbance is to be

minimized. The shoring can be designed on the basis of the earth pressure distribution shown on Figure 17.

6.5 Other

Below grade walls such as for basements, tanks and rigid retaining walls should be designed to resist lateral earth pressures equivalent to full hydrostatic pressure. This applies to walls that are adequately drained. Where drainage is not provided, the equivalent fluid density should be increased by 50 percent. The water table for undrained walls and for buoyancy/uplift calculations should be assumed to be at the ground surface. Lateral pressures due to any surcharge loads applied within a distance equivalent to the wall height should be presumed to be 50 percent of the surcharge load.

The main components of the plant should have structurally supported floor slabs and these should be isolated from the clay subgrade by a 300 mm void. It is presumed that components such as the aeration tanks and clarifies are not provided by underdrainage and that water can collect beneath them. This is conducive to swelling and a generous void allowance is recommended.

The on site clays are suitable for backfill and site grading purposes. The materials should be free of topsoil and organic materials. The backfill should be compacted in thin lifts to a uniform density of at least 95 percent of Standard Proctor Density and moisture content. Overcompaction of fill adjacent to structural components should be guarded against. Site grading should be at gradients of at least 2 percent for landscaped areas and 1 percent for paved areas.

All concrete in contact with the soil should be made with sulphate

resistant cement and should be of high quality.

6.6 Pavements

Heavy duty pavement designs which can be considered for use at this site include 75 mm of asphaltic concrete on 380 mm of crushed granular base course, or 200 mm of reinforced concrete on 75 mm of crushed granular base course or 200 mm of crushed granular base course on 300 mm of subbase course.

For light duty pavements the designs could include 50 mm of asphaltic concrete on 200 mm of crushed granular base course or 150 mm of reinforced concrete on 75 mm of crushed granular base course or 300 mm of crushed granular base course.

The foregoing should be placed on a prepared subgrade which would include the removal of organic topsoil, and the compaction of the native soil and any fill to a uniform density of at least 95 percent of Standard Proctor Density and moisture content. The granular materials within the pavement structure should be compacted to 100 percent of Standard Proctor Density and moisture content.

Positive drainage should be provided on and around all pavement areas.

It is noteworthy that none of the test holes for this study showed any evidence of silt, which is somewhat unusual. We would suggest that when the location of roads and parking areas are finalized test probes be put down to specifically evaluate the extent of any silt.

6.7 Proposed Outfall

The proposed 1500 mm outfall line is expected to have an invert near elevation 233 some 2 m above the glacial till elevation except near Test Hole 15 where it will be about 1 m above. It is anticipated that with 1 to

2 m of clay cover on the glacial till conventional construction techniques can be employed without encountering serious difficulties with groundwater conditions.

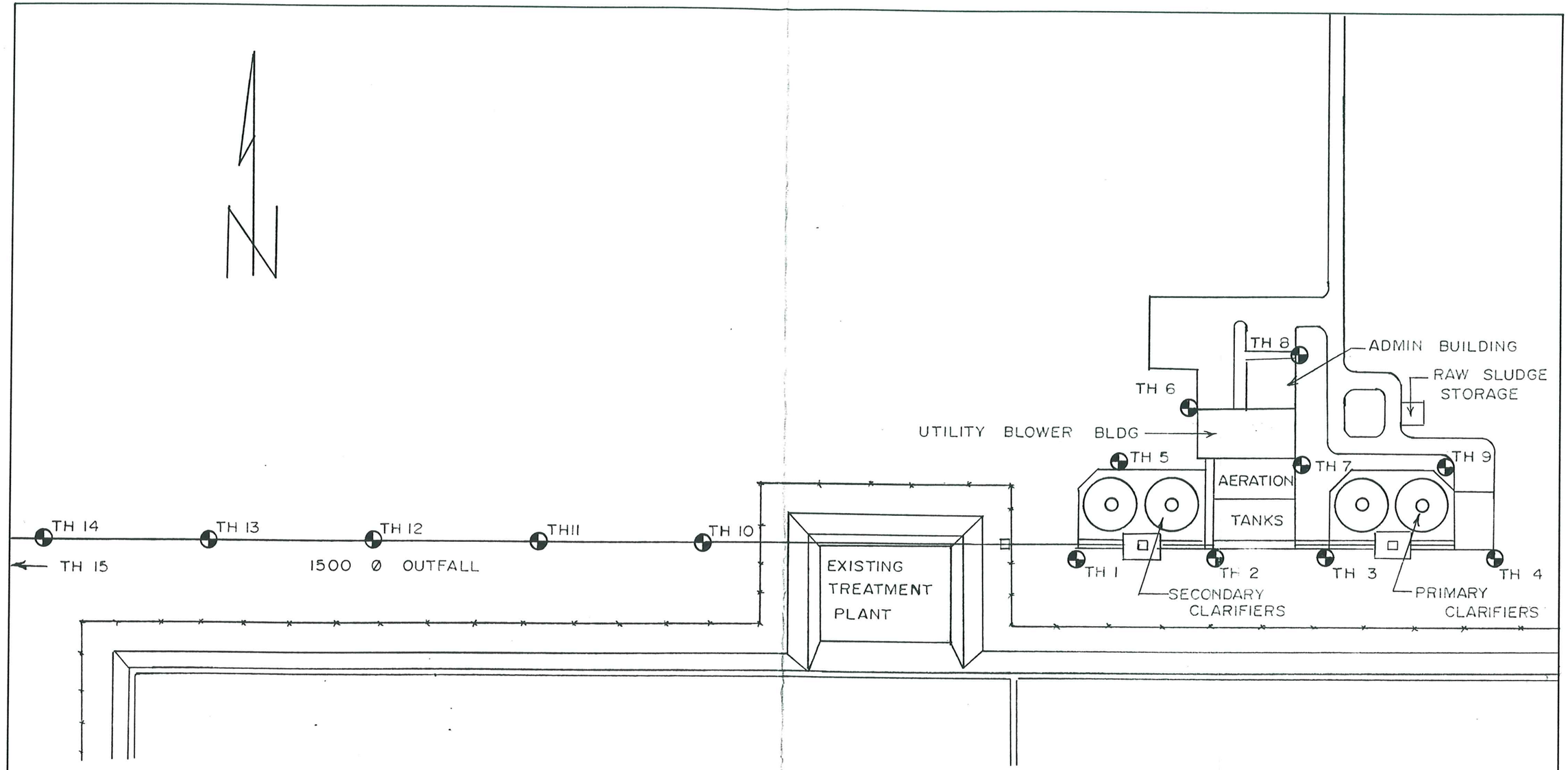
Respectfully submitted,

DYREGROV & BURGESS

Per:

A.O. Dyregrov, P.Eng.

AOD/pf



REV.	DESCRIPTION	DWN	APP.	DATE

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

APP'D:	A O D	DATE	21/04/88
SCALE:	1 : 2500	JOB NO.	88570

TESTHOLE LOCATION PLAN

W E W P C C EXPANSION

DWG. NO. 1

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	1

DRILL TYPE: 450 mm Auger

OTHER TESTS:

WATER CONTENT — W_P - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM: SURFACE ELEVATION 237.765 M)	SOIL SAMPLE: CONDITION	TYPE	PENETRATION RESISTANCE
0		Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
6		---grey			
7					
8		Glacial Till -silty, sandy, gravelly -tan, medium dense -bouldery below 7.6 m			
9					
10					

Notes:
1. Auger refusal at 9.7 m.
2. Fair seepage.
3. Installed sealed standpipe at 7.9 m.
4. Water level at 3.3 m from grade on April 25, 1988.

Plate 2

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	2

WATER CONTENT — W_P - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

SURFACE ELEVATION 237.755 M

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0	SS	Topsoil			
		Clay -mottled brown -highly plastic -stiff to firm			
6		--- grey			
7		Glacial Till -silty, sandy, gravelly -tan, soft, medium dense below 7.6 m -seepage seams throughout -bouldery below 8.8 m			
9		Notes: 1. Auger refusal at 9.1 m. 2. Water level at 3.8 m from grade in about 15 minutes.			
10					

DRILL TYPE: 450 mm Auger

OTHER TESTS

Plate 3

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	3

DRILL TYPE: 450 mm Auger

WATER CONTENT — W_P - □ W - ○ W_L - △, PERCENT %, 10 20 30 40 50 60

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM — SURFACE ELEVATION 237.870 M)	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE	OTHER TESTS
0	SS	Topsoil				
1		Clay -mottled brown -highly plastic -stiff to firm				
2						
3				U		qu=116.5kpa γ_w=17.66kn/m^3 pp=157.0kpa Tv=83.7kpa
4						
5						
6		---grey		U		qu=70.2kpa γ_w=15.96kn/m^3 pp=77.6kpa Tv=33.0kpa
7		Glacial Till -silty, sandy, gravelly -tan, soft to medium dense -seepage seams throughout				
8						
9						
10		Notes: 1.Auger refusal at 9.7 m. 2.Slight seepage upon completion. 3.Placed sealed standpipe at 7.6 m. 4.Water level at 4.1 m from grade on April25, 1988.				

Plate 4

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	4

DRILL TYPE: 450 mm Auger

WATER CONTENT — Wp - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM — SURFACE ELEVATION 237.910 M)	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE	OTHER TESTS
0	SS	Topsoil				
1–5		Clay -mottled brown -highly plastic -stiff to firm		U		qu=53.4kpa γ_w=15.65kn/m^3 pp=71.8kpa Tv=28.7kpa
6–8		Glacial Till -silty, sandy, gravelly -tan, soft -medium dense at 7.6 m -seepageupon drilling to 8.2 m				
9		Notes: 1.Auger refusal at 8.5 m. 2.Some seepage.				

Plate 5

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	5

DRILL TYPE: 450 mm Auger

OTHER TESTS

WATER CONTENT

W_P - □ W - ○ W_L - △

PERCENT %

10 20 30 40 50 60

DATUM

SURFACE ELEVATION 237.740 M

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0		Topsoil			
		Clay -mottled brown -highly plastic -stiff to firm			
1					
2					
3					
4					
5					
6		— — — grey			
7					
8		Glacial Till -silty, sandy, gravelly -tan, soft medium dense below 7.6 m			
9					
10					
		Notes: 1. Auger refusal at 10.0 m. 2. Water level at 6.1 m from grade upon completion of drilling.			

Plate 6

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	6

DRILL TYPE: 450 mm Auger

WATER CONTENT — W_p - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM — SURFACE ELEVATION 237.815 M)	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE	OTHER TESTS
0	SS	Topsoil				
1		Clay -mottled brown -highly plastic -stiff to firm				
2						
3				U		qu=72.7kpa γ_w=17.27kn/m^3 pp=120.5kpa Tv=58.4kpa
4						
5						
6				U		qu=78.1kpa γ_w=16.30kn/m^3 pp=71.8kpa Tv=26.3kpa
7		grey				
8		Glacial Till -silty, sandy, gravelly -tan, saturated, soft -medium dense below 7.9 m -bouldery at 8.5 m				
9						
10		Notes: 1.Auger refusal at 9.4 m. 2.Water level at 5.8 m from grade upon completion of drilling.				

Plate 7

DYREGROV & BURGESS

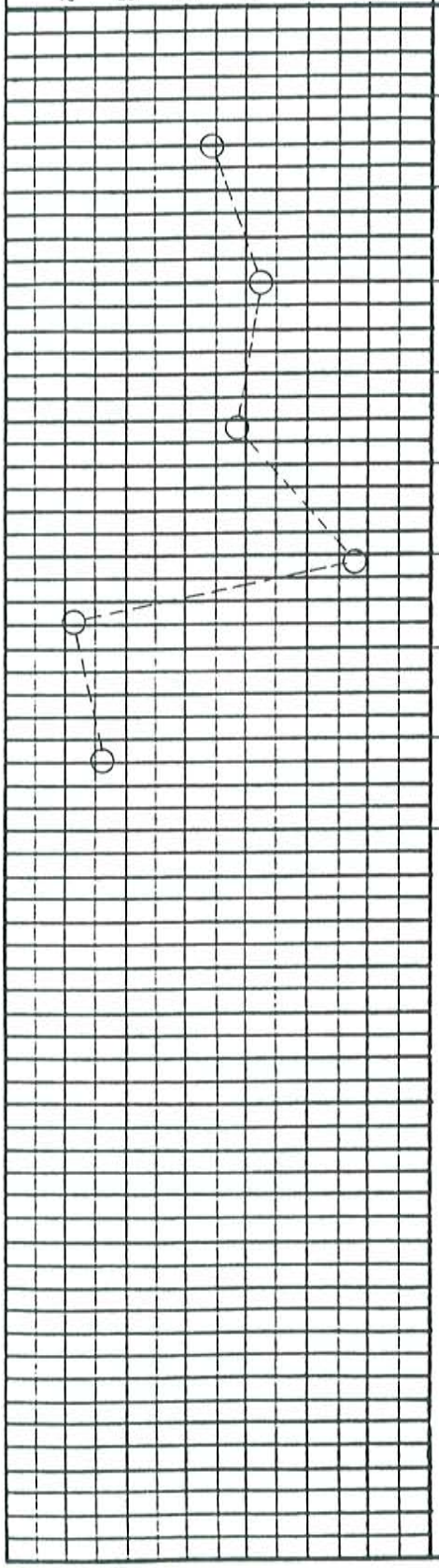
BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	7

DRILL TYPE: 450 mm Auger

OTHER TESTS:



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM / SURFACE ELEVATION 237.760 M)	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0		Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
6		---grey			
7		Glacial Till -silty, sandy, gravelly -tan, saturated, soft -medium dense at 7.6 m			
8					
9		Notes: 1. Auger refusal at 8.8 m. 2. Slight seepage upon completion.			

Plate 8

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	8

DRILL TYPE: 450 mm Auger

WATER CONTENT — W_p - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION (DATUM / SURFACE ELEVATION 237.930 M)	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE	OTHER TESTS
0	SS	Topsoil				
1–4		Clay -mottled brown -highly plastic -stiff to firm				
5		- - - grey		U		qu=68.2kpa γ_w=16.50kn/m^3 pp=91.0kpa Tv=40.2kpa
6–7		Glacial Till -silty, sandy, gravelly -tan, soft				
8–10						

Notes:
1. Auger refusal at 9.0 m.
2. Hole dry on completion of drilling.
3. Placed sealed standpipe at 7.0 m.
4. Water level at 3.9 m from grade on April 25, 1988.

Plate 9

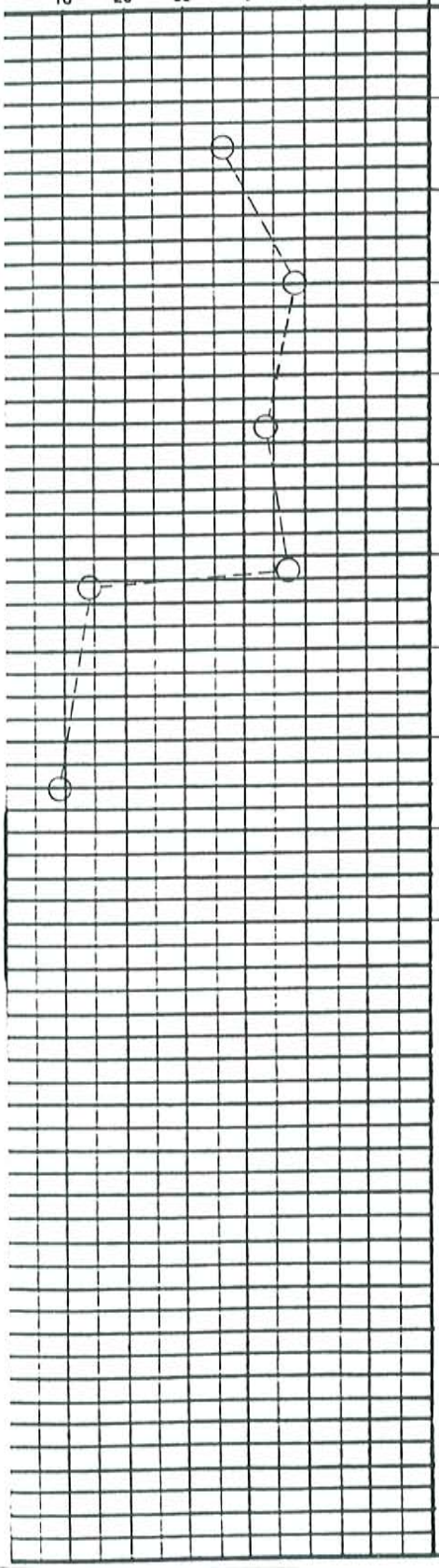
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C.- Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	9

DRILL TYPE: 450 mm Auger



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION DATUM SURFACE ELEVATION 237.975 M	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
0		Topsoil				
1		Clay -mottled brown -highly plastic -stiff to firm				
2						
3				U		qu=91.0kpa γ_w=17.42kn/m^3 pp=134.1kpa Tv=63.2kpa
4						
5		---grey				
6				U		pp=47.9kpa Tv=19.1kpa
7		Glacial Till -silty, sandy, gravelly -tan, soft -medium dense below 8.2 m				
8						
9						
10		Notes: 1.Auger refusal at 9.7 m. 2.Water level at 7.3 m from grade upon completion of drilling.				

Plate 10

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

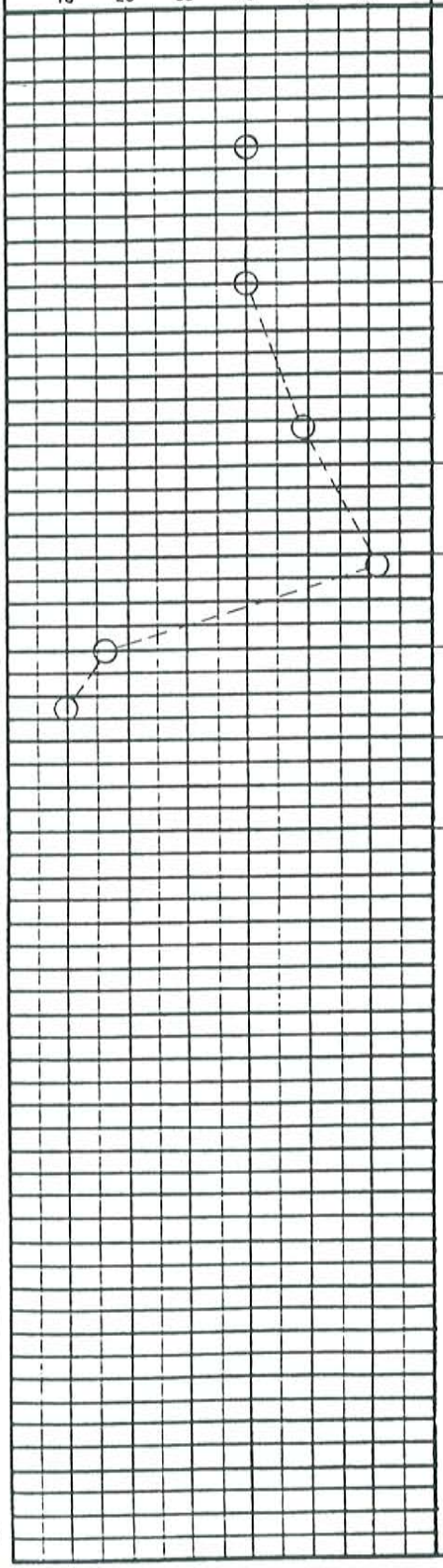
LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	19/04/88	88570	10

WATER CONTENT

W_P - □ W - ○ W_L - △

PERCENT %

10 20 30 40 50 60



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION DATUM SURFACE ELEVATION 237.864 M	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE
0		Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
6		---grey			
7		Glacial Till -silty, sandy, gravelly -tan, clayey, soft -medium dense below 7.3 m			
8					
9		Notes: 1. Auger refusal at 8.5 m. 2. Slight seepage upon completion of drilling.			

DRILL TYPE: 450 mm Auger

OTHER TESTS

Plate 11

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	20/04/88	88570	11

DRILL TYPE: 450 mm Auger

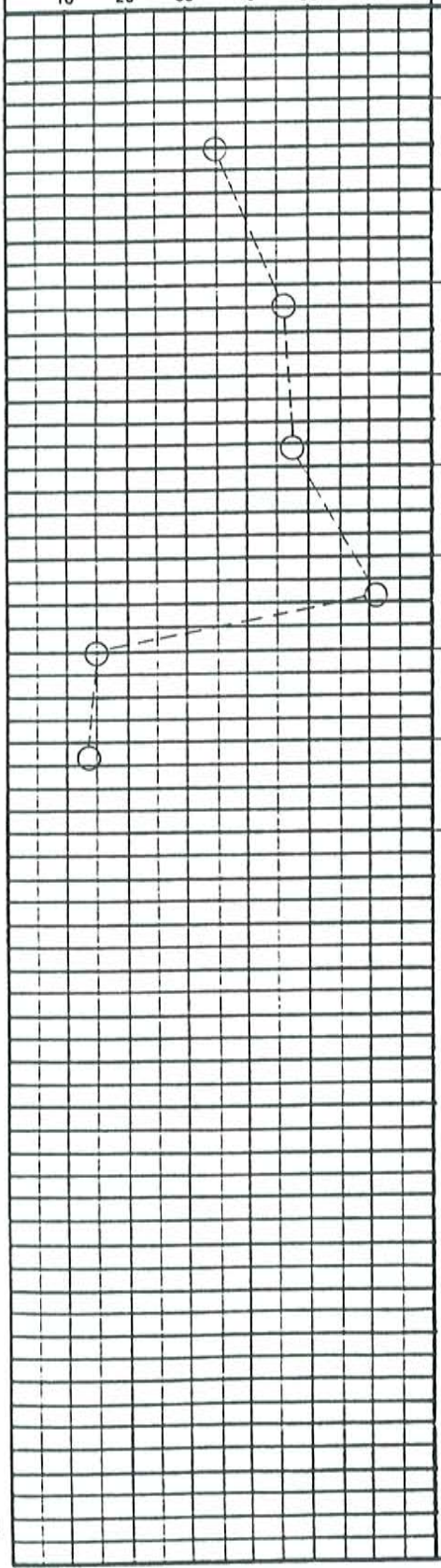
OTHER TESTS:

WATER CONTENT

W_P - □ W - ○ W_L - △

PERCENT %

10 20 30 40 50 60



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION DATUM SURFACE ELEVATION 237.884 M	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE
0		Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
6		---grey			
7		Glacial Till -silty, sandy, gravelly			
8		-tan, soft			
9		Notes: 1. Auger refusal at 8.2 m. 2. Slight seepage upon completion of drilling.			

Plate 12

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	20/04/88	88570	12

DRILL TYPE: 450 mm Auger

OTHER TESTS:

WATER CONTENT — W_p - □ W - ○ W_L - △. PERCENT % (10 20 30 40 50 60)

DATUM

SURFACE ELEVATION 238.004 M

DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0	SS	Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
5		- - - grey			
6					
7					
8		Glacial Till -silty, sandy, gravelly -tan, soft to medium dense -dense at 7.9 m.			
9					

Notes:
1. Auger refusal at 8.5 m.
2. Hole dry on completion.

Plate 13

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	20/04/88	88570	13

DRILL TYPE: 450 mm Auger

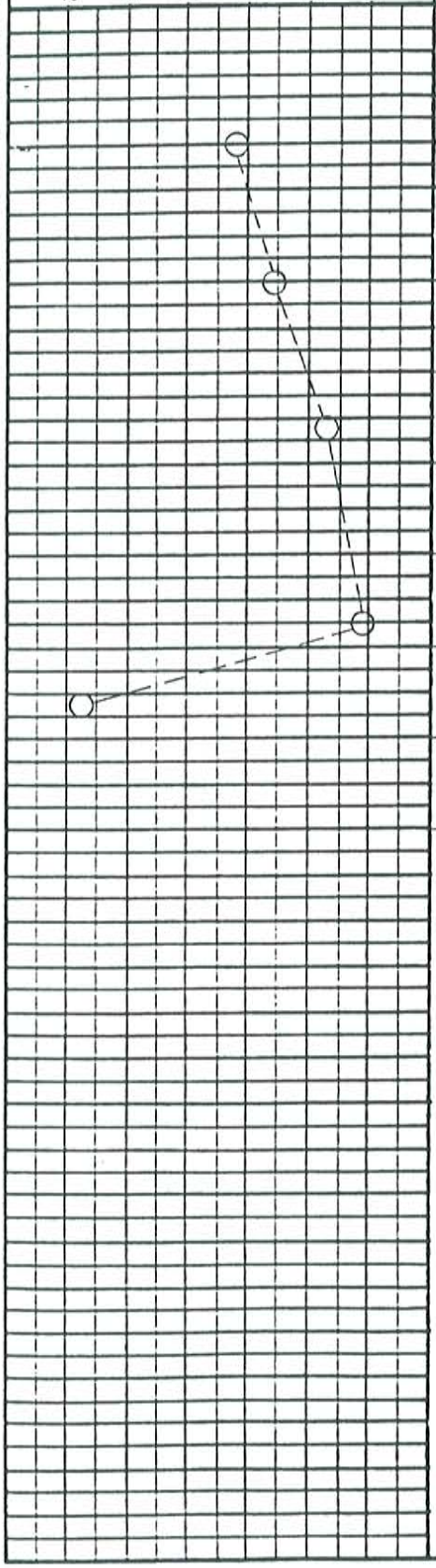
OTHER TESTS:

WATER CONTENT

W_P - □ W - ○ W_L - △

PERCENT %

10 20 30 40 50 60



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
		DATUM SURFACE ELEVATION 237.874 M			
0	SS	Topsoil			
1		Clay -mottled brown -highly plastic -stiff to firm			
2					
3					
4					
5					
6		grey			
7					
8		Glacial Till -silty, sandy, gravelly -tan, medium dense -cobbly and bouldery			
9					

Notes:
1. Auger refusal at 8.2 m.
2. Fair seepage upon completion of drilling.
3. PLaced sealed standpipe at 8.2 m.
4. Water level at 3.7 m from grade on April 25, 1988.

Plate 14

DYREGROV & BURGESS

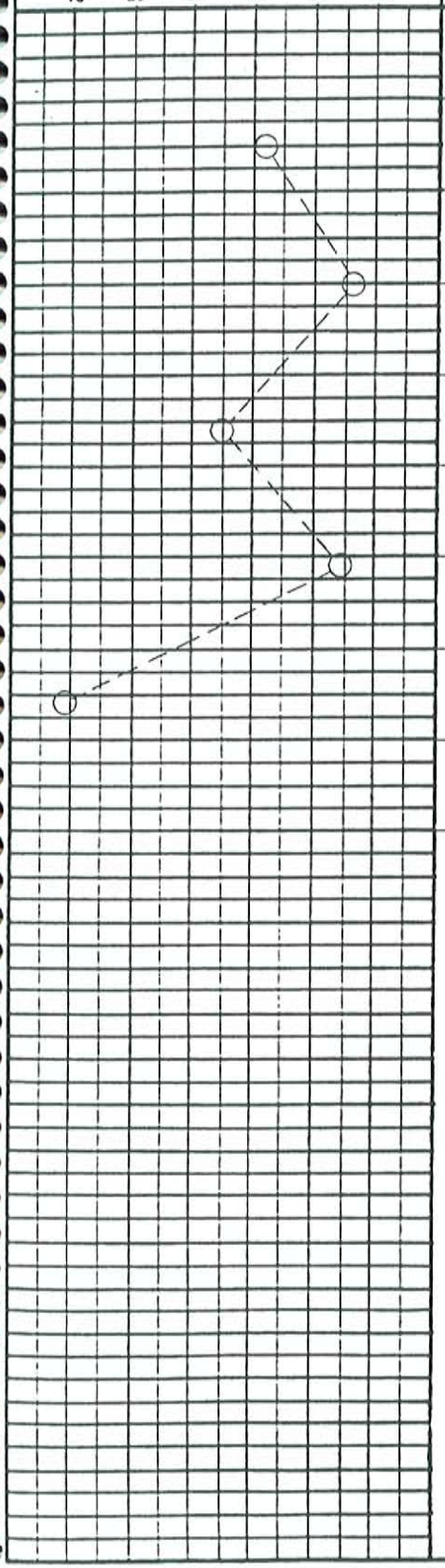
BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	20/04/88	88570	14

DRILL TYPE: 450 mm Auger

OTHER TESTS:



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION DATUM SURFACE ELEVATION 237.844 M	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0	SS	Topsoil			
		Clay -mottled brown -highly plastic -stiff to firm			
1					
2					
3					
4					
5		- - - grey			
6					
7		Glacial Till -silty, sandy, gravelly -tan, medium dense -dense at 7.9 m			
8					
9		Notes: 1. Auger refusal at 8.5 m. 2. Hole dry on completion.			

Plate 15

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: W.E.W.P.C.C. - Expansion

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	AOD	20/04/88	88570	15

DRILL TYPE: 450 mm Auger

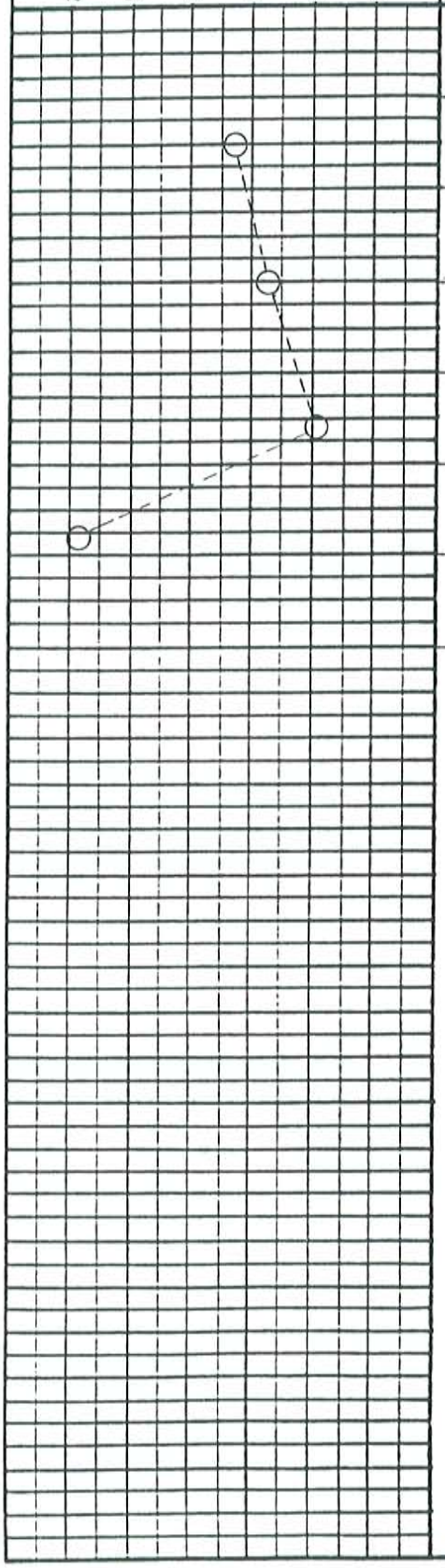
OTHER TESTS:

WATER CONTENT

W_p - □ W - ○ W_L - △

PERCENT %

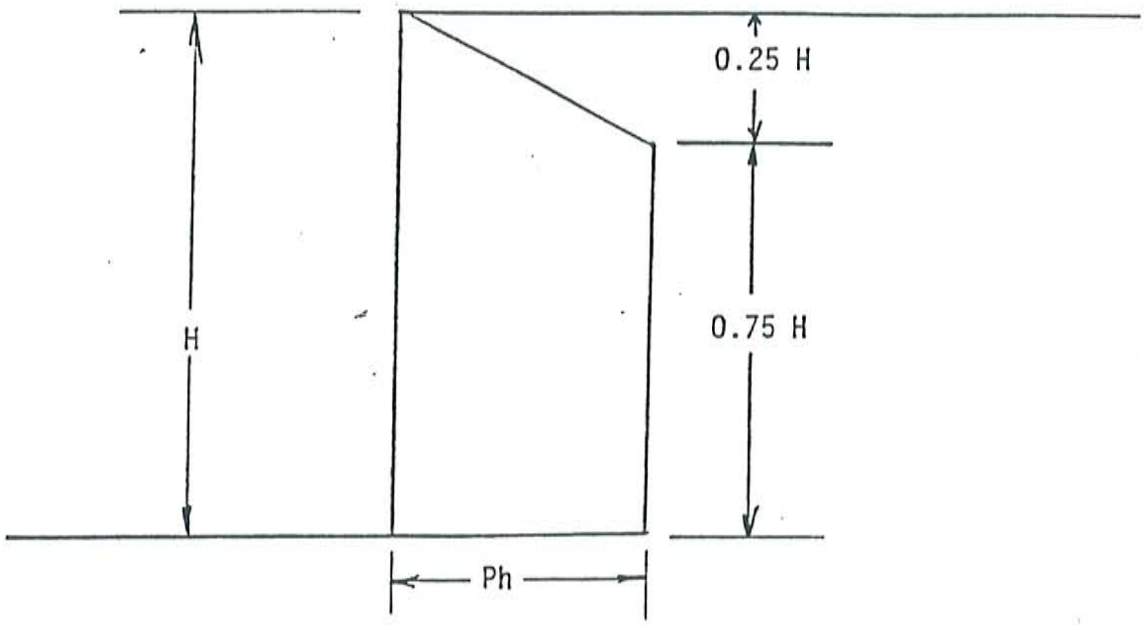
10 20 30 40 50 60



DEPTH (M)	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
		DATUM SURFACE ELEVATION 237.919 M			
0	SS	Topsoil			
1		Clay -mottled brown -highly plastic -stiff			
2					
3					
4					
5					
6		Glacial Till -silty, sandy, gravelly -cobbly and bouldery -tan, soft to medium dense			
7					

Notes:
1. Auger refusal at 6.5 m.
2. Hole dry on completion.

Plate 16



$Ph = 0.4 \gamma H$

Where: Ph = Lateral earth pressure on shoring (kPa)

γ = Soil unit weight (17.6 kN/m^3)

H = Wall height (m)

Note: Add surface load surcharge where applicable

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

EARTH PRESSURES, TEMPORARY SHORING

SCALE NTS	DATE May/88	MADE	CHKD	JOB 88570	FIGURE 17

APPENDIX D

May 25, 1990 Letter

Dyregrov Consultants to Reid Crowther & Partners Ltd.

"Review of May 1988 Geotechnical Report"

WEWPCC

DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

1666 DUBLIN AVE.
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May 24, 1990

File #90850

Reid Crowther & Partners
1150 Waverley St.
WINNIPEG, MANITOBA
R3T 0P4

Attention: Mr. W. McCulloch, P.Eng.

Dear Sir:

Re: WEWPCC

Introduction

This report will summarize recent discussions which we have had with regard to the WEWPCC. We understand that the hydraulic profile for the plant presented in the Functional Design Report resulted in tank floors being approximately 0.4 meters lower than the preliminary hydraulic profile of 1987. After allowances for tank floor thicknesses, void separation and overexcavation, the anticipated elevation of the deepest major excavations is about elevation 232.2 meters. This elevation is approximately 2 meters below the groundwater elevation. This has raised concern as to potential heave of the excavation floor, major seepages into the excavation, disposal of saline water seepages and foundation selection and installation.

Potential Heave

With major excavations such as for the secondary clarifiers carried to elevation 232.2 the safety factor against bottom heave is in the order of 1.4, which is only marginally acceptable. This is based on an assumed groundwater elevation of 234.5 which is consistent with a nearby hydrograph of a Provincial Government observation well and water levels in standpipes which were installed at the time of the geotechnical investigation and monitored since then.

Potential Seepages

By carrying the excavation below the groundwater level there is the potential for upward seepages from the bedrock through cracks and fissures in the overlying clay (which could be less than 1 meter in thickness) and glacial till. Discussions with Frank Render, P.Eng. of the Manitoba Natural Resources agrees with this possibility. He also suggested that driving piles into the glacial till will result in vibration which would tend to assist the cracks and

fissures opening up. Also, seepages along some of the pile shafts would likely occur. He indicated that there would be a major probability that significant seepages would occur and he postulated that pumping up to 500 to 600 gpm could be required. He also was of the opinion that efforts to control the groundwater, such as by grouting, might have a 50/50 chance of succeeding.

Potential Impacts of Seepages

The groundwater conditions at the WEWPCC site are part of the regional groundwater regime. The groundwater levels are controlled by the piezometric head in the limestone bedrock and are strongly influenced by groundwater withdrawals in the Westwood area of the City for air conditioning purposes. Sustained pumping at the WEWPCC plant site could significantly impact the seasonal "drawdown cone" for the air conditioning users in the Westwood area. Some of these users have Water Rights Licenses which give them legitimate use of the groundwater and they could have recourse if the activities at the plant site impacted on their use.

The water quality of the seepage would be expected to be saline. The disposal of the seepages would have to meet environmental standards and approvals.

Foundations

With the excavation carried to elevation 232.2 the preferred foundation of driven precast prestressed concrete piles would have to be questioned as the pile lengths could be too short, i.e. less than 3 meters.

Alternative foundations would have to consider the problems associated with the groundwater conditions. The problems are considered to be significant.

Recommendations

As a result of our discussions and Reid Crowther's review of the plant hydraulics it is anticipated that major excavations, such as for the secondary clarifiers, can be kept above elevation 233.5 meters except for small facilities such as hoppers. We would therefore strongly recommend that the design restrict the depth of large excavations to this elevation, namely 233.5 meters.

With this excavation depth limitation the problems associated with the groundwater conditions will be minimized, i.e. the potential for bottom heave and potential seepages. It is also anticipated that minimum lengths for the precast concrete piles will be greater than 3 meters, which is satisfactory.

Where deeper excavations are undertaken for smaller facilities and problems are encountered it is anticipated that conventional construction techniques can be used to mitigate the problems. These techniques might include pumping, limited grouting, pump wells, etc.

In view of the limited depth of clay beneath the proposed works the thickness of the voids beneath the slabs can be reduced to 150 mm.

It is recommended that materials excavated and being reused for site filling should be sufficiently removed from the excavation cut so as to have no impact on the stability of the cut slope. In this regard the contractor should submit an excavation and fill plan for review.

This report can be considered as an addendum to the Geotechnical Report on the WEWPCC dated May 1988.

I trust that the foregoing is an adequate summary of the recent review of the geotechnical aspects of the WEWPCC.

Yours truly,

DYREGROV CONSULTANTS

Per: 

A.O. Dyregrov, P.Eng.

AOD/pf