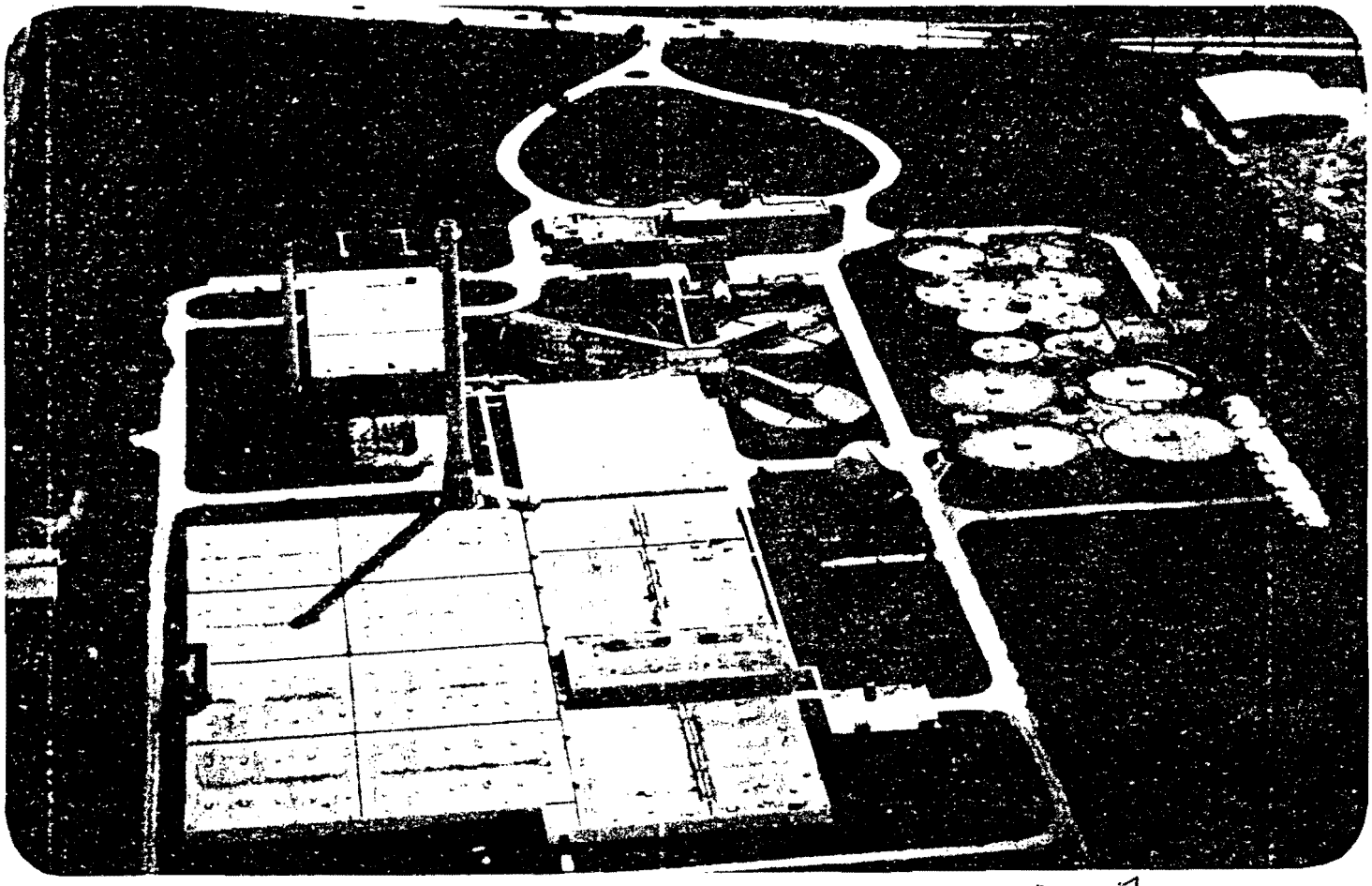
THE CITY OF WINNIPEG

North End Water Pollution Control Centre

T.P.

Sludge Digestion Expansion Geotechnical Report



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Underwood McLellan Ltd.
Consulting Engineers and Planners

the uma group

THE CITY
OF
WINNIPEG

Sludge Digestion Expansion Geotechnical Report

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Our File: 41 06 0265 213 04 02

June 20, 1984

The City of Winnipeg
Waterworks, Waste and Disposal
Department
1500 Plessis Road
Box 178, Transcona P.O.
Winnipeg, Manitoba
R2C 2Z9

ATTENTION: MR. TOM PEARSON, P. ENG.

Dear Sir:

RE: GEOTECHNICAL INVESTIGATION
1985 DIGESTERS AND FUTURE EXPANSION WORKS
NORTH END WATER POLLUTION CONTROL CENTRE

Enclosed is our report of the geotechnical investigation at the North End Water Pollution Control Centre.

In summary, it is recommended that the proposed digesters be founded on end bearing driven precast concrete piles. Practical refusal of such piles is anticipated within the glacial till at approximately 22.0 metres below existing ground surface. This recommendation is based on the nature of subsurface soil conditions found in the area as well as the consideration of consistency between existing and proposed foundation systems. Geotechnical design parameters are also given for general foundation types which may be applicable to other future structures.

In regards to general site development, a shallow continuous layer of saturated silt was encountered within the upper 4.0 metres. Seepage and sloughing from this layer can be expected during the excavation for any subsurface works thus requiring special precautions or, alternatively, total removal and replacement with more suitable materials.

The results obtained in this exploration program agree closely with previous investigations performed elsewhere about the site and with published geological information.

If you have any questions or require clarification of any portion of this report, please contact us at your convenience.

Yours truly,

UNDERWOOD MCLELLAN LTD.

R. Hood, P. Eng.
Vice-President and Manager
Manitoba and Northwestern Ontario

L. D. Keil, P. Eng.
Project Manager

KMS/aek

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Sludge Digestion Expansion Geotechnical Report

1.0 INTRODUCTION

The following report summarizes the results of our field exploration, laboratory testing and geotechnical analyses at the North End Water Pollution Control Center. The study area is located adjacent to (west of) the existing sludge digester tanks No.'s 9 and 11, and is the site of a planned extension of the sludge digestion facilities in 1985 as well as future expansion works after 1985.

The terms of reference for this study were outlined in a letter proposal dated April 19, 1984 to Mr. Tom Pearson, P. Eng., of The City of Winnipeg, Waterworks, Waste and Disposal Department. The program included the following field activities, laboratory testing, and office analyses:

- Subsurface drilling and sampling program.

- Laboratory testing of soils.

- Assessment of alternative foundation systems and general site development considerations.

- Report preparation summarizing our field activities, conclusions and recommendations.

The field program consisted of drilling sixteen boreholes between April 26, 1984 and May 4, 1984 at the locations shown on Drawing No. 1. The holes were advanced to auger refusal within glacial till or on probable limestone bedrock.

Several foundation alternatives for the proposed sludge digester tanks have been outlined in this report. They include both shallow and deep foundations. Problems anticipated with general site development are also addressed.

Conclusions and recommendations given in this report are based on the information collected during our field investigation. Subsurface conditions in the proximity of and between boreholes have been assumed but not verified.

2.0 SITE DESCRIPTION

A general site plan showing the study area and test hole locations is presented on Drawing No. 1. In general, the area is elevated and relatively flat, with ditches along the south and east perimeter of the site. Test holes 1, 7, and 8 are located on slightly less elevated land in the eastern portion of the study area. The site appears to have been originally low lying and possibly swampy. Approximately 2.0 to 3.0 metres of clay fill overlies the site.

3.0 FIELD INVESTIGATION

The field investigation consisted of drilling, soil sampling, and standpipe piezometer installations. Field activities were performed between April 26, 1984 and May 4, 1984. Sixteen test holes were strategically located to reflect possible future site development.

3.1 Drilling

Sixteen test holes were drilled within the perimeter of the study area. All holes were visually logged to determine soil types, thicknesses of various deposits and groundwater conditions. Undisturbed (Shelby tube) and disturbed (bulk) soil samples were secured for laboratory testing. Field soil strength tests were performed on undisturbed samples. The holes were advanced to auger refusal at depths ranging from 20.1 to 23.8 metres below ground surface.

Drilling operations were performed by Subterranean (Wpg.) Ltd. using a truck mounted power auger rig equipped with a 450 mm auger. In some cases the holes were allowed to remain open for periods of up to 1.5 hours in order to identify and record groundwater seepage and sloughing conditions. The holes were then backfilled with native material. General site supervision and borehole logging were provided by Mr. K. Skaftfeld, E.I.T. of Underwood McLellan Ltd.

Undisturbed soil samples were obtained from Shelby tubes taken at regular intervals in holes 8, 10 and 13. Undrained shear strengths were estimated in the field using pocket penetrometer and pocket torvane tests on each Shelby tube sample. Representative disturbed (bulk) samples were secured at regular intervals in all test holes with pocket penetrometer tests performed on auger cuttings from various depths. All holes were advanced to auger refusal. Bedrock coring operations were not performed in any of the holes.

3.2 Piezometer Installations

A standpipe piezometer was installed in hole 16 and is seated in the upper till layer at 20.4 metres below ground surface. A second standpipe was installed adjacent to hole 16 in the brown clay deposit at 7.6 metres below ground surface. The piezometers were subsequently monitored on May 22, 1984.

4.0 LABORATORY TESTING

Laboratory tests were performed on undisturbed samples and included detailed visual soil classifications, Atterberg Limits and moisture content determinations. Undrained shear strength characteristics of the soil were determined from pocket penetrometer, lab vane and unconfined compressive shear strength tests.

Moisture content determinations were performed on all disturbed samples to establish moisture content profiles throughout the soil stratigraphy. All laboratory test results are shown in the composite geotechnical summary chart on Drawing No. 2 and on the individual logs of Appendix A.

5.0 SUBSURFACE CONDITIONS

The following sections identify stratigraphic and groundwater conditions found at the time of our investigation. Individual test hole logs are given in Appendix A.

5.1 Soil Stratigraphy

A general stratigraphic sequence of soil types as determined from our field investigation is approximated as follows:

0 - 2.5 m: Topsoil (150 mm typical) underlain by clay fill material of medium density.

2.5 - 4 m: Saturated silt (ML), seepage and sloughing upon exposure.

4 - 7 m: Brown clay (CH), stiff.

7 - 18 m: Grey clay (CH), stiff to firm, soft near clay-till contact.

18 - 22 m: Glacial till, seepage and sloughing generally within the upper 1.0 m, dense to very dense at auger refusal.

A more detailed description of each soil type is given below:

Topsoil

A layer of topsoil ranging from 75 to 300 mm thick covers the entire test area. Thicker layers consist of black clayey soil with traces of organics while thinner sections are mainly fibrous. The entire area is covered with grass.

Fill

The main component of the fill material is clay with traces of broken brick, stone, gravel, wood, and silt. An organic rich (black) layer, 150 to 500 mm thick, was encountered at approximately 1.8 m depth in test holes 4, 5, 6, and 12. The fill material is of medium density and varies from moist to dry.

Silt (ML)

A layer of saturated silt ranging from 0.7 m to 2.2 m in thickness was found within approximately 4.0 m of the ground surface in all the test holes. The silt is tan colored and often layered with fine sand. Extensive seepage and sloughing emanated upon exposure of the silt layer. It was necessary to sleeve all sixteen test holes to a depth of approximately 4.5 metres to control sloughing for the drilling and sampling operations.

Brown Clay (CH)

The brown clay is stiff, highly plastic, moderate to high compressible, and contains small pockets of sulphates and tan colored silt. This brown clay is typical of the Winnipeg region and is known to be expansive - exhibiting often large volume changes in response to changing moisture contents and stress levels.

Undrained shear strengths of the clay were identified from pocket penetrometer, pocket torvane, lab vane, and unconfined compressive shear strength tests. An envelope of undisturbed shear strengths from sample testing is shown on Drawing No. 2. Shear strengths were mainly confined to the stiff range and were typically in excess of 60 kPa. Representative Atterberg Limit test results of 108% and 32% for the liquid and plastic limits respectively, indicate a highly plastic clay (CH). A soil density of 1.72 g/cc (107.2 pcf) was established from an undisturbed soil sample.

Grey Clay (CH)

The brown clay is underlain by an approximate 11.0 m thick stratum of grey silty clay. The clay is stiff near the upper brown clay and becomes firm with depth. This stratum is similar to the overlying brown clay in that it is expansive, exhibiting volume changes with changes in moisture content or stress level. Occasional silt and fine sand pockets are typically encountered, with the till inclusions becoming prevalent as the clay till transition is approached. An envelope representing the range of undrained shear strengths is shown on Drawing No.2. Undrained shear strengths were typically in excess of 40 kPa. The transition zone with the till is generally very wet and soft with shear strengths in the clay in the order of 30 kPa.

The grey clay is high plastic as confirmed from liquid and plastic limits of 65% and 27% respectively. A soil density of 1.79 g/cc (111.3 pcf) was established from undisturbed soil samples.

Glacial Till

The till layer is generally found at approximately 18.0 m depth. The main soil component is silt. A saturated layer approximately 1.0 m thick overlies a dense to very dense material. Boulders and cobbles were frequently encountered within the entire stratum. Moisture contents vary from 10 to 13% near the upper clay contact to 7 to 9% in the vicinity of probable bedrock.

5.2 Auger Refusal

Probable bedrock as interpreted from auger refusal was encountered in holes 2, 4, 5, 6, 7, 12, and 14 at depths ranging from approximately 22.0 to 24.0 m below existing ground surface. Several large pieces of limestone recovered from holes 5, 6 and 7 suggested that the auger tip had penetrated probable bedrock.

Powdered limestone was found on the auger tip in holes, 2, 4, 12 and 14. The remaining holes (1, 3, 8, 9, 10, 11, 13, 15, and 16) terminated upon either large boulders or very dense till as interpreted from auger resistance and visual observation of the auger tip.

5.3 Groundwater Conditions

Seepage and sloughing within the silt layer were observed during drilling operations. This perched water level is dependent on seasonal variations of climate. Open water observed in ditches on the south and east flanks of the site appear to be connected with this groundwater level. Standpipe piezometer readings taken on May 22, 1984 established the water level at hole 16 to be 1.36 m below the ground surface (elev. 230.81 m).

The static groundwater level within the brown clay unit is typically in the order of three metres below natural prairie elevation.

Groundwater was invariably encountered upon drilling into the upper portion of the glacial till where a good hydraulic connection between the till and underlying Upper Carbonate Aquifer usually exists. A groundwater level of 8.11 metres below ground surface (elev. 224.06 m) was recorded on May 22, 1984 in a standpipe installation located in the till. This level is consistent with potentiometric levels in this area as documented from groundwater mapping of the Winnipeg area (Ref. Baracos et al, 1983). This level would be expected to vary seasonably, depending mainly on local industrial demands.

6.0 DISCUSSION

Site development for 1985 will include the construction of two digesters and associated gallery facilities. It is understood that the digesters will be 35 metre diameter tanks, located in part below prairie grade. The following sections address alternate foundation types considered in our assessment of a suitable foundation system mainly for the proposed digesters. Geotechnical design parameters are also given for general foundation types which may be applicable to future structures such as a sludge dewatering facility and WAS thickening facility.

6.1 Shallow Foundations

Fill material and the underlying layer of saturated silt are located above the brown clay stratum and neither material is considered a competent bearing surface. In consideration of spread footings or raft foundations for the proposed structures located on the brown clay below the fill and silt, we would recommend an allowable bearing capacity of 120 kPa (2500 psf). Corresponding settlements will be commensurate with the net foundation loads imparted on the underlying clay subsoils. In the absence of site specific consolidation data, compressive indices of 0.6 and 0.8 for the brown and grey clays respectively can be used in estimating settlements.

Should the shallow foundations be designed to bear on the underlying clay material, design allowances for hydrostatic uplift pressures would be necessary.

Given the swelling and shrinkage characteristics of Winnipeg clays in general, as well as potential hydrostatic uplift situations for empty and partially filled digester tanks, some movement of the foundations would be anticipated. The existing digesters adjacent to those proposed in 1985 are supported on end

bearing driven precast concrete piles. The existing and proposed digesters will be structurally integrated. As such, a shallow foundation system is not endorsed as tank performance, ie. movements, may unduly cause structural distress on the existing digester works.

6.2 Deep Foundations

Deep foundations, consisting of friction (in clay) or end bearing (in till or on bedrock) piling systems could be considered at this site. In regards to friction type piles, steel, concrete or timber structural members could be considered. Friction piles derive their load carrying capacity from adhesion between the pile and adjoining soil. Adhesion values for timber, steel and concrete friction piles applicable to this site are given as follows:

Depth (metres)*	Adhesion (KPa)			
in native clays	Timber	Steel	Concrete	
			driven	cast-in-place
0 - 3 m	0	0	0	0
3 - 6 m ±	14	9	14	16
6 - 15 m ±	12	9	12	14

*from prairie grade

Of the three structural pile members indicated, cast-in-place concrete piles have probably been used the most extensively in the Winnipeg area.

However, cast-in-place concrete friction piles embedded in the clay would require sleeving for auger hole formation to seal off the saturated silt layer. This will be necessary if the silt stratum is not removed during excavation for subsurface works.

Considering the heavy foundation loads anticipated for the digester tanks, a friction type pile system would not be practical. The existing digesters are supported on end bearing precast concrete piles and as such it is not considered good practice to mix foundation types. In addition, the existing and proposed digesters will be structurally integrated and relative foundation movements may cause inordinate structural distress.

Friction type piles may be applicable to future expansion works. Compacto or Franki piles are not recommended as soil displacements associated with the installation may severely damage existing structures.

End bearing piles, either driven or cast-in-place into the till or bedrock could also be used at this site. Cast-in-place systems could either be straight shaft or mechanically belled. However, for straight shaft piles sleeving of the upper saturated silts and till layer would be necessary. Belled caissons bearing within the till deposit are not considered applicable at this site. Mechanical formation of the bell in the glacial till would be very difficult as seepage and sloughing conditions would prevail.

Hexagonal precast concrete piles, driven to practical refusal in the till, have been extensively used in the Winnipeg area. Applicable design loads of various pile sizes are given as follows:

Nominal Size (mm) (across flats)	Design Capacity (KN)
300	445 (50 ton)
350	625 (70 ton)
400	800 (90 ton)

We would anticipate that practical refusal during pile driving would be achieved within the glacial till at approximately the same depth as auger refusal experienced during our site investigation ie) approximately 22.0 m below existing ground surface. Less than 12 mm of settlement could be expected for precast piles end bearing on the glacial till.

Precast concrete driven piles eliminate the need for sleeving open bore holes and would provide a foundation system consistent with adjacent construction works.

6.3 General Site Development

In regards to site development a shallow continuous layer of saturated silt was encountered within the upper 4.0 metres. Seepage and sloughing from this layer can be expected during the excavation for any subsurface works thus requiring special precautions, or alternatively, total removal and replacement with more suitable materials. Excavations, into the silt will have to be adequately sidesloped if left unsupported. Alternatively, a temporary shoring system could be considered. Other comments relating to general site development follow:

- The digesters should be designed assuming full, ie. at ground surface, hydrostatic uplift pressure. Subsurface drainage systems should be considered where facilities are not structurally designed to resist uplift pressures. A weeping tile system around the perimeter of any subsurface works should be included to control seepage into below grade areas.

- Walls located below ground surface should be designed using an at-rest earth pressure coefficient of 0.6.

- Drainage should slope down and away from all sides of the structures at a minimum of 2% for paved areas and 3% for unpaved areas.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the results of our field investigation and subsequent analyses.

7.1 Conclusions

1) The soil stratigraphy in the test area generally consists of 2.5 metres of dry to moist clayey fill of medium density overlying a layer of saturated silt varying in thickness from 0.7 to 2.2 metres. The underlying clays range from stiff to firm and are highly plastic and expansive. A layer of glacial till 4.0 m ± thick was encountered at approximately 18.0 metres. The upper 0.5 to 1.0 m of the till is saturated and the upper clay contact is very soft and wet.

2) All test holes were advanced to auger refusal upon probable bedrock, boulders, or very dense till. Practical refusal of end bearing driven precast concrete piles would be anticipated within the glacial till at approximately the same depth as auger refusal found during our site investigation ie) approximately 22.0 metres below existing ground surface.

3) A perched water table exists in the saturated silt layer as confirmed by standpipe piezometer readings. The upper portion of the glacial till is also water bearing.

4) In regards to general site development, seepage and sloughing from the saturated silt layer can be expected during the excavation for any subsurface works. This will require special precautions or, alternatively, total removal and replacement with more suitable materials. Excavations in this layer will have to be adequately sidesloped or a temporary shoring system considered.

7.2 Recommendations

1) As mentioned throughout this report, we recommend that a pile foundation system consistent with earlier construction works be adopted. Since the existing digester tanks are founded on end bearing driven precast concrete piles, we recommend that a similar system be employed.

2) Alternative foundation systems were addressed in the report, however, some are not recommended for digester expansion because of the problems associated with the water bearing soils found within the study area. They may, however, be applicable for future expansion works where light to moderate foundation loads are anticipated.

3) In regards to precast hexagonal concrete piles driven to practical refusal in the till the following recommendations are given:

   (a) Traditional design loads be used, namely:

Nominal Size (mm) (across flats)	Design Capacity (KN)
300	445 (50 ton)
350	625 (70 ton)
400	800 (90 ton)

   Load capacities higher than these traditional values are not recommended due to the thick glacial till layer and the existence of boulder size particles within this layer.

   (b) A minimum 150 mm (6") void space should be maintained under pile caps, grade beams and structural floor slabs.

(c) To prevent subsoil disturbance, piles within 10 diameters (minimum) of existing foundations should be prebored to a depth compatible to 3.0 metres below the underside of the pile caps of the existing digesters east of the site. The diameter of the prebore should be 50 mm larger than the nominal diameter of the pile.

(d) Concrete works in direct contact with adjacent subsoils should consist of sulphate resistant cement.

(e) Spacing of individual piles within groups should not be less than three pile diameters centre to centre.

4) The digesters should be designed assuming full, ie. at ground surface, hydrostatic uplift pressure. Subsurface drainage systems should be considered where facilities are not structurally designed to resist uplift pressures. A weeping tile system around the perimeter of any subsurface works should be included to control seepage into below grade areas.

5) Walls located below ground surface should be designed using an at-rest earth pressure coefficient of 0.6.

6) Drainage should slope down and away from all sides of the structures at a minimum of 2% for paved areas and 3% for unpaved areas.

7) Site supervision by a qualified engineer or technician is necessary during pile driving operations. For piles believed to be hung up on boulders in the till the load carrying capacities must be accordingly reduced and additional piles possibly driven.

The recommendations provided have been based on the findings in 16 test holes at selected locations over the site. Should any conditions other than those noted in this report be found during future stages of site development, we should be notified in order that our recommendations can be re-evaluated.

Respectfully Submitted,

D. Kingerski, P. Eng.
Project Engineer
Earth Sciences Division

K. M. Skaftfeld, E.I.T.
Earth Sciences Division

PROVINCE OF MANITOBA
D. E. KINGERSKI
REGISTERED ENGINEER

8.0 REFERENCES

Baracos, Shields, Kjartanson, Geological Engineering Maps and Report for Urban Development of Winnipeg, Department of Geological Engineering, University of Manitoba, Winnipeg, Manitoba, 1983.

APPENDIX A

APPENDIX

EXPLANATION OF FIELD & LABORATORY TEST DATA

The field and laboratory test results as shown for a particular test boring by the Test Hole Log Data Sheet are briefly described below:

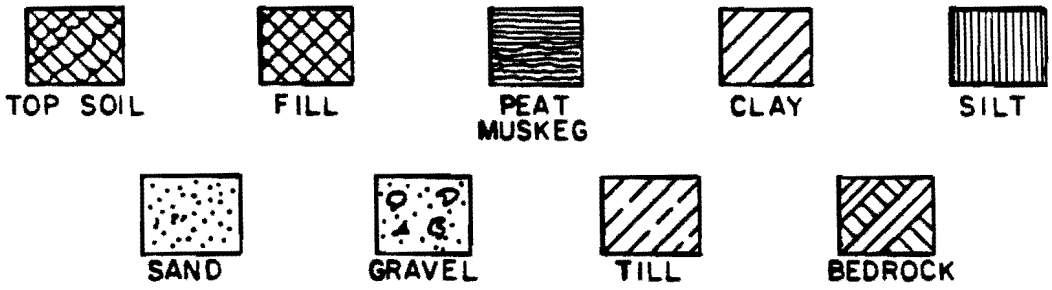
NATURAL MOISTURE CONDITIONS & ATTERBERG LIMITS

The relation between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits should be compared to the Natural Moisture Content of the subsurface soil as well as plotted on the Plasticity Chart.

SOIL PROFILE & DESCRIPTION

Each soil strata is classified and described noting any special conditions. The unified classification system is used, and the soil profile refers to the existing ground elevation. When available the ground elevation is shown.

The soil symbols used are briefly shown below but are indicated in more detail in the Soil Classification Chart.



TESTS ON SOIL SAMPLES

Laboratory and field tests are identified by the following symbols:

- q_u - unconfined compressive strength usually expressed in tons per square foot. This value is used in determining the allowable bearing capacity of the soil.
- γd - dry unit weight expressed in pounds per cubic foot. This value indicates the density or consistency of the in-situ soil.
- C - consolidation test. These test results are separately enclosed and provide information on the consolidation or settlement properties of the soil strata.
- T_v - undrained shear strength using a Torvane.
- pp - undrained shear strength derived from pocket penetrometer testing.
- L_v - undrained shear strength using a lab vane.

UNDERWOOD MCLELLAN LTD.
EARTH SCIENCES DIVISION
GENERAL STATEMENT
NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations represented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general ground water levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions different from those encountered in the exploratory borings and excavations are observed or encountered during construction or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

M.A. - grain size analysis. These test results are separately enclosed and indicate the gradation properties of the material tested.

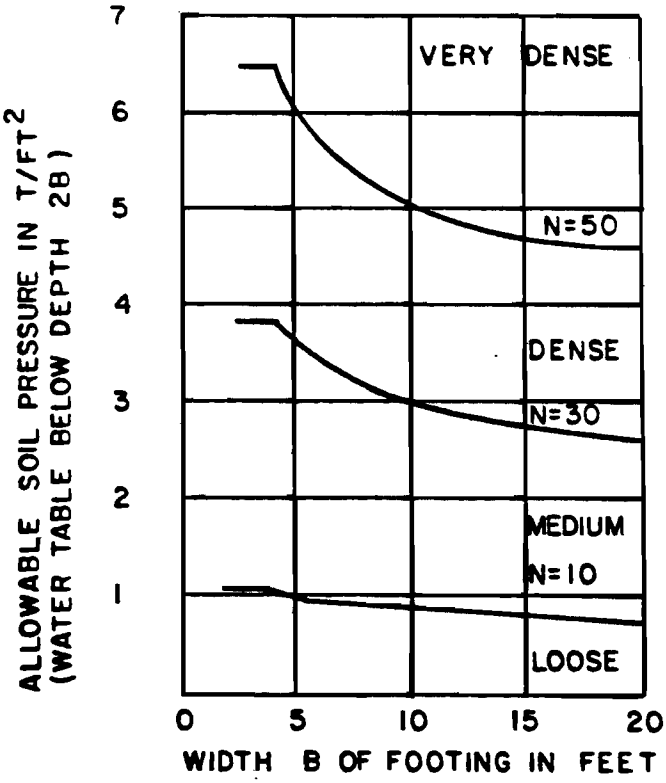
SO_4 - water soluble sulphate content is conducted primarily to determine whether sulphate resistant cement is required for the foundation structure.

N - standard penetration field test. This test is conducted in the field to determine the in-situ consistency of a soil strata. The "N" value recorded is the number of blows from a 140 lb. hammer dropped 30 inches (free fall) which are required to drive a 2" O.D. Raymond type sampler 12 inches into the soil.

The resistance and unconfined compressive strength of a cohesive soil can be related to its consistency as follows:

N - BLOWS/Ft.	QU - $T/Ft.^2$	CONSISTENCY
2	0.25	very soft
2-4	0.25-0.50	soft
4-8	0.50-1.00	medium or firm
8-15	1.00-2.00	stiff
15-30	2.00-4.00	very stiff
30	4.00	hard

The resistance of a non-cohesive soil (sand) can be related to its consistency as follows:



SAMPLE TYPE

A: Split Spoon
B: Shelby Tube
C: Piston Sampler
D: Core Barrel
E: Auger
F: Wash
G: Bulk Sample
H: Block Sample

CLASSIFICATION CODE

Clay	< 0.005 mm
Silt	0.005 mm - #200 Sieve
Sand	#200 - #4 Sieve
Gravel	#4 Sieve - 3 inch
Cobbles	3 - 12 inch
Boulders	> 12 inch

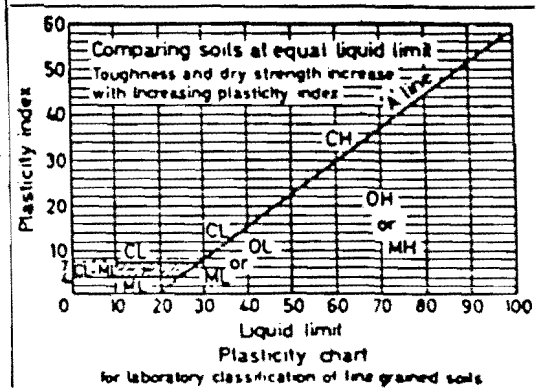
GRADATION DESCRIPTIVE TERMS

And	40 - 50%
with	30 - 40%
some	20 - 30%
little	10 - 20%
trace	0 - 10%

TABLE 1

Unified soil classification (including identification and description)

Field identification procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)				Group symbols	Typical names	Information required for describing soils	Laboratory classification criteria
Coarse grained soils: More than half of material is larger than No. 200 sieve size[a]	Gravels: More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics *Example:* *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% — GW, GP, SW, SP More than 12% — GM, GC, SM, SC 5% to 12% — Borderline cases requiring use of dual symbols $Cu = \frac{D_{60}}{D_{10}}$ Greater than 4 $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for GW Atterberg limits below 'A' line, or PI less than 4 — Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits above 'A' line, with PI greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see CL below)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines		
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Non-plastic fines (for identification procedures, see ML below)	SM	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see CL below)	SC	Clayey sands, poorly graded sand-clay mixtures		
Fine grained soils: More than half of material is smaller than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification procedures on fraction smaller than No. 40 sieve size						Atterberg limits above 'A' line with PI greater than 7 — Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols
		Dry strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Cu = $\frac{D_{60}}{D_{10}}$ Greater than 6 Cc = $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for SW Atterberg limits below 'A' line or PI less than 4 — Above 'A' line with PI between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits above 'A' line with PI greater than 7
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions *Example:* *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity	
Highly organic soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils	



Plasticity chart for laboratory classification of fine grained soils

(from A.A.Wagner, 4th Int. Conf. SMFE, London 1957, Vol 1, pp125 - 134)

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the UMA group

PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE APRIL 26, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **1**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 230.98 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
		TOPSOIL (75 mm) - clayey - black - trace of organics					
1		FILL - clay - some silt - medium density - moist	G-8				1
2		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-1				2
		CLAY (CH)	G-2				
3		- brown - stiff - trace of silt pockets					3
4							4
5							5
6			G-3				6
		CLAY (CH)					
7		- grey - stiff - trace of silt pockets					7
8							8
9			G-4				9

0 20 40 60 80%

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CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	APRIL 26, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **1**

0 20 40 60 80 %

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 230.98 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11		CLAY (CH) - grey - trace of silt pockets - becoming firm with depth					11
12		- trace of 20 mm Ø stone	G-5				12
13							13
14							14
15							15
16			G-6				16
		CLAY/TILL TRANSITION - very wet - soft					
17			G-7				17
		TILL - silty - upper 0.7 m saturated - logging of till very difficult due to extensive seepage and sloughing from silt and upper till matrix					
18							18

0 20 40 60 80 %

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TEST BORING No **1**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 230.98 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19							19
20		End of borehole at 19.5 m on probable boulders (auger refusal).					20
21							21
22		NOTES:					22
23		- Extensive seepage and sloughing in silt layer during drilling operations.					23
24		- Further seepage and sloughing appears to be from upper till layer.					24
25							25

0 20 40 60 80%

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TEST BORING No **2**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 231.89 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
0		TOPSOIL (300 mm) - clayey - black - dry - trace of organics				
1		FILL - clay - occasional stone and gravel size particles - medium density - dry	G-9			
2			G-10			
3		SILT (ML) - tan - saturated - seepage and sloughing upon exposure				
4		CLAY (CH) - brown - stiff	G-11			
5		SILT (ML) - tan - wet - laminated with grey clay	G-12			pp = 59.8
6		CLAY (CH) - brown - stiff				
7		CLAY (CH) - grey - stiff - trace of silt pockets	G-13			pp = 71.7
8						
9						

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
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JOB No	0265-213-04-02
DRILLING DATE	APRIL 26, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **2**

SURFACE ELEVATION 231.89 m
CO-ORDINATES

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

0 20 40 60 80 %

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
			G-14			pp = 47.9	
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of fine sand pockets - trace of 20 mm Ø stone					12
13			G-15			pp = 23.8	13
14							14
15							15
16			G-16				16
17							17
18		CLAY/TILL TRANSITION - very wet - soft	G-17				18

0 20 40 60 80 %

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	APRIL 26, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **2**

SURFACE ELEVATION 231.89 m
CO-ORDINATES

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 0.9 m saturated - becoming dense to very dense below 18.9 m - 300 m Ø boulders at 18.3 and 20.1 m	G-18				19
			G-19				
20			G-20				20
21			G-21				21
22		End of borehole at 21.9 m on probable limestone bedrock (auger refusal).					22
23							23
24		NOTES: - Upper 4.5 m of borehole sleeved to eliminate seepage and sloughing from silt layer.					24
25		- Extensive seepage and sloughing from upper 0.9 m of till matrix.					25

0 20 40 60 80%

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DRILLING DATE APRIL 26, 1984
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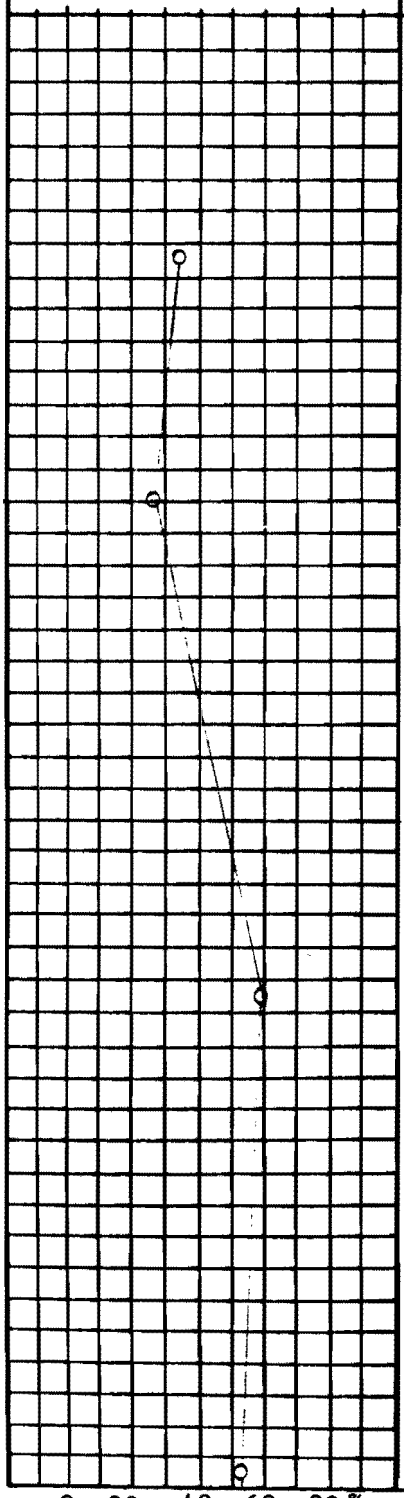
TEST BORING No **3**

SURFACE ELEVATION 232.12 m
CO-ORDINATES SEE SITE PLAN

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

0 20 40 60 80%



DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		**TOPSOIL** - clayey - black - dry - trace of organics					0
1		**FILL** - clay - occasional broken brick and gravel - dry - loose	G-23				1
2							2
3		**SILT** (ML) - tan - saturated - seepage and sloughing upon exposure	G-22				3
4							4
5		**CLAY** (CH) - brown - stiff - trace of silt pockets					5
6		- trace of 20 mm Ø stone	G-24			pp = 59.8	6
7							7
8		**CLAY** (CH) - grey - stiff - trace of silt pockets					8
9			G-25			pp = 59.8	9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No	0265-213-04-02
DRILLING DATE	APRIL 26, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **3**

SURFACE ELEVATION 232.12 m
CO-ORDINATES

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

0 20 40 60 80 %

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of 20 mm Ø stone	G-26			pp = 36.0	12
13							13
14							14
15							15
16			G-27			pp = 36.0	16
17							17
18							18

0 20 40 60 80 %

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TEST BORING No **3**

SURFACE ELEVATION 232.12 m
CO-ORDINATES

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		CLAY/TILL TRANSITION - wet - soft					19
			G-28				
20		TILL - silty - moist - dense becoming very dense below 23 metres					20
21							21
			G-29				
22							22
23			G-30				23
24		End of borehole at 23.2 m on very dense till (auger refusal).					24
25		NOTES: - Upper 4.5 m of borehole sleeved. - Seepage at clay/till transition.					25

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
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JOB No	0265-213-04-02
DRILLING DATE	APRIL 26, 1984
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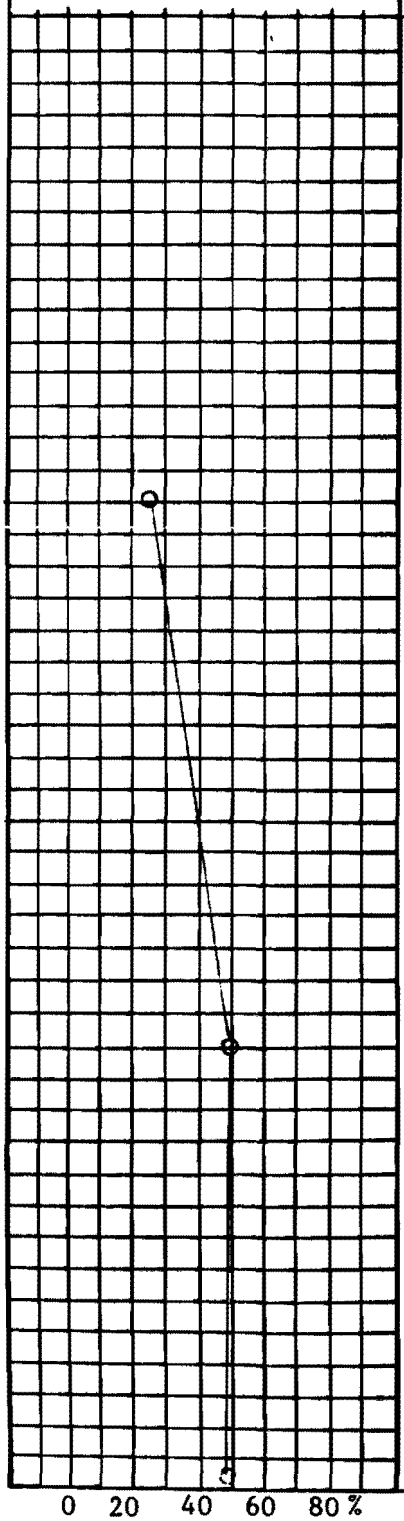
TEST BORING No **4**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △



SURFACE ELEVATION 232.07 m

CO-ORDINATES
SEE SITE PLAN

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
0	TOPSOIL (75 mm) - clayey - dry - trace of organics				
1	FILL - clay - occasional stone and brick pieces (100 mm typical) - organic rich layer (150 mm thick) at 1.5 m - dry - medium density	G-31			
3	SILT (ML) - tan - wet - seepage and sloughing upon exposure				
4	CLAY (CH) - brown - stiff - trace of silt pockets				
6		G-32			pp = 83.6
7	CLAY (CH) - grey - stiff - trace of silt pockets				
9		G-33			pp = 47.9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No	0265-213-04-02
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TEST BORING No **4**

0 20 40 60 80 %

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.07 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of 20 mm Ø stone at 12 m - trace of fine sand pockets	G-34			pp = 47.9	12
13							13
14							14
15							15
16			G-35			pp = 23.8	16
17							17
18			G-36				18

0 20 40 60 80 %

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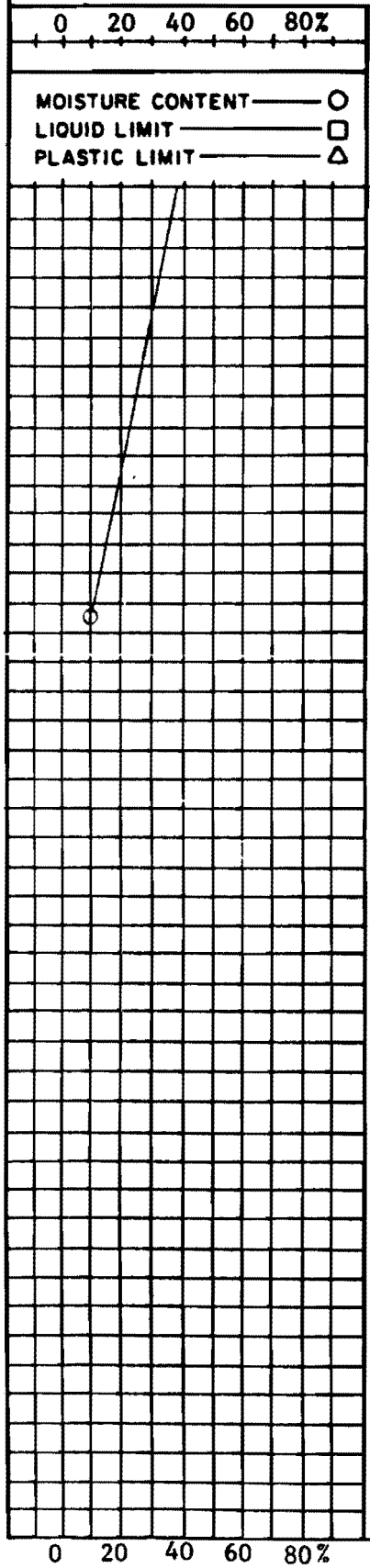
TEST BORING No **4**

SURFACE ELEVATION 232.07
CO-ORDINATES



DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		CLAY/TILL TRANSITION - soft - very wet TILL - silty - upper 0.8 m saturated - becoming dense to very dense below 19.3 m					19
20							20
21			G-37				21
22		End of borehole at 21.9 m on probable limestone bedrock (auger refusal).					22
23							23
24		NOTES: - Hole sloughed to 20.5 m 2 - 3 minutes after hole left open.					24
25		- After 15 minutes water in borehole had risen to 17 m depth. - Upper 4.5 m of hole sleeved.					25

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DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **5**

SURFACE ELEVATION _____
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (75 mm) - clayey - black - trace of organics					0
1		FILL - clay - organic rich layer from 1.8 - 2.1 m - dry - medium density	G-38				1
2							2
3		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-39				3
4		CLAY (CH) - brown - stiff - trace of sulphates - trace of silt pockets	G-40			pp = 71.7	4
5							5
6			G-41			pp = 71.7	6
7		CLAY (CH) - grey - stiff - trace of silt pockets					7
8							8
9			G-42			pp = 71.7	9

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

0 20 40 60 80%

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TEST BORING No **5**

0 20 40 60 80 %

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.12 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of 20 mm Ø stone	G-43			pp = 47.9	12
13							13
14							14
15			G-44			pp = 36.0	15
16							16
17							17
18		CLAY/TILL TRANSITION - soft - wet	G-45			pp = 23.8	18

0 20 40 60 80 %

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TEST BORING No **5**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.12 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 0.6 m saturated - becoming dense to very dense below 18.9 m	G-46				19
20							20
21							21
22			G-47				22
		SAND (SP) - fine to medium - clean - saturated					
23		TILL - very dense					23
24		End of borehole at 23.8 m on probable limestone bedrock (auger refusal).					24
25		NOTES: - Upper 4.5 m sleeved. - Seepage and sloughing from upper till layer. - Seepage from sand layer. - 300 mm piece of limestone recovered from auger tip at 23.8 m. - Water level at 22.7 m 30 minutes ater hole left open.					25

0 20 40 60 80%

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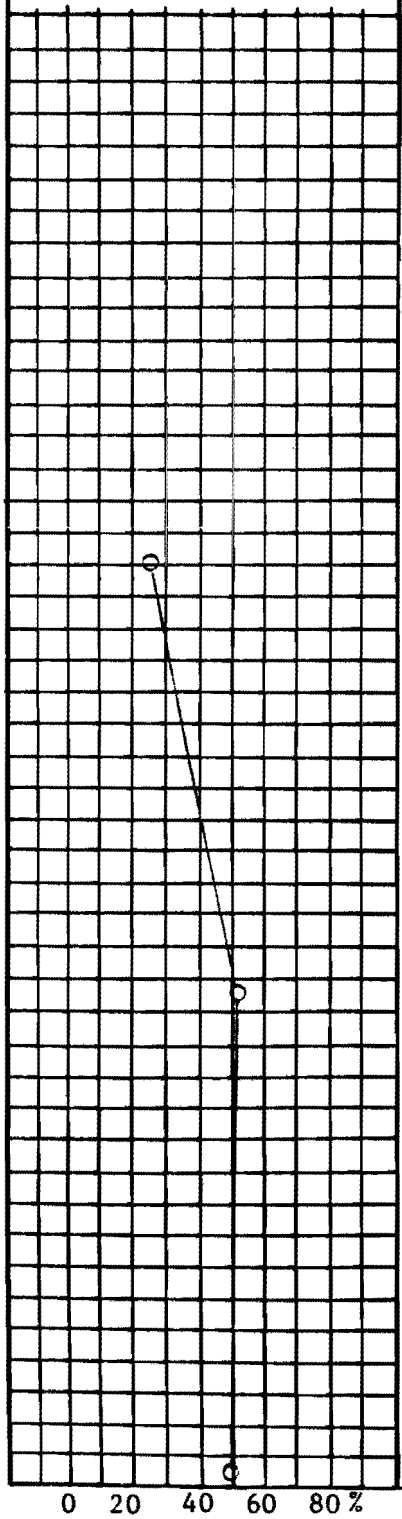
TEST BORING No **6**

SURFACE ELEVATION 231.89 m
CO-ORDINATES SEE SITE PLAN

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△



DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
		TOPSOIL (100 mm) - black - fiberous					
1		FILL - clay - trace of gravel and stone - dry - medium density					1
2		- organic rich layer from 1.2 - 1.4 m depth					2
3		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-48				3
4							4
5		CLAY (CH) - brown - stiff - trace of silt pockets - trace of sulphates					5
6			G-49			pp = 71.7	6
7							7
8		CLAY (CH) - grey - stiff					8
9			G-50			pp = 47.9	9

0 20 40 60 80%

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TEST BORING No **6**

SURFACE ELEVATION 231.89 m
CO-ORDINATES

0 20 40 60 80 %
MOISTURE CONTENT —○—
LIQUID LIMIT —□—
PLASTIC LIMIT —△—

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11		CLAY (CH) - grey - becoming firm with depth - trace of silt inclusions at 12.2 m					11
12			G-51			pp = 35.9	12
13							13
14							14
			G-52				
15							15
16							16
17							17
		CLAY/TILL TRANSITION - soft - very wet	G-53			pp = 23.8	
18							18

0 20 40 60 80 %

Underwood McLellan Ltd.
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Telephone (204) 284-0580

the UMA group

PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE APRIL 30, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **6**

SURFACE ELEVATION 231.89 m
CO-ORDINATES

0 20 40 60 80%	DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
MOISTURE CONTENT ○	19		TILL - silty - upper 0.6 m saturated - becoming dense to very dense below 18.9 m	G-54				19
LIQUID LIMIT □	20							20
PLASTIC LIMIT △	21							21
	22			G-55				22
	23							23
	24		End of borehole at 23.4 m on probable limestone bedrock (auger refusal).					24
	25		NOTES: - Upper 4.5 m sleeved. - Water level at 16.5 m after 1.5 hours (hole drilled to 18.3 m and left open). - 150 mm piece of limestone recovered from auger tip at 22.9 m. - Extensive seepage and sloughing from upper 0.6 m of till matrix.					25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 1, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **7**

SURFACE ELEVATION 231.22 m
CO-ORDINATES SEE SITE PLAN

MOISTURE CONTENT —○—
LIQUID LIMIT —□—
PLASTIC LIMIT —△—

0 20 40 60 80%

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
0		TOPSOIL (75 mm) - black - organic (fiberous)				
1		FILL - clay - some silt - occasional stone size particles - medium density - moist				
2						
3		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-56			
4		CLAY (CH) - brown - stiff - trace of silt pockets - trace of sulphates	G-57			pp = 71.7
5						
6			G-58			pp = 59.8
7						
8		CLAY (CH) - grey - stiff - trace of silt pockets				
9			G-59			pp = 36.0

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 1, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **7**

0 20 40 60 80 %

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 231.22 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of till inclusions at 15.2 m	G-60			pp = 36.0	12
13							13
14							14
15			G-61			pp = 36.0	15
16							16
17							17
18		CLAY/TILL TRANSITION - soft - moist to wet	G-62			pp = 23.8	18

0 20 40 60 80 %

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 1, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **7**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 231.22 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 1.2 m wet - becoming dense to very dense below 18.9 m - occasional cobbles	G-63				19
20			G-64				20
21		End of hole at 20.9 m on probable limestone bedrock (auger refusal).					21
22							22
23		NOTES: - Upper 4.5 m sleeved. - Seepage and sloughing was not observed during or 15 minutes after drilling. - 100 mm pieces of limestone recovered from auger tip at 20.9 m.					23
24							24
25							25

0 20 40 60 80%

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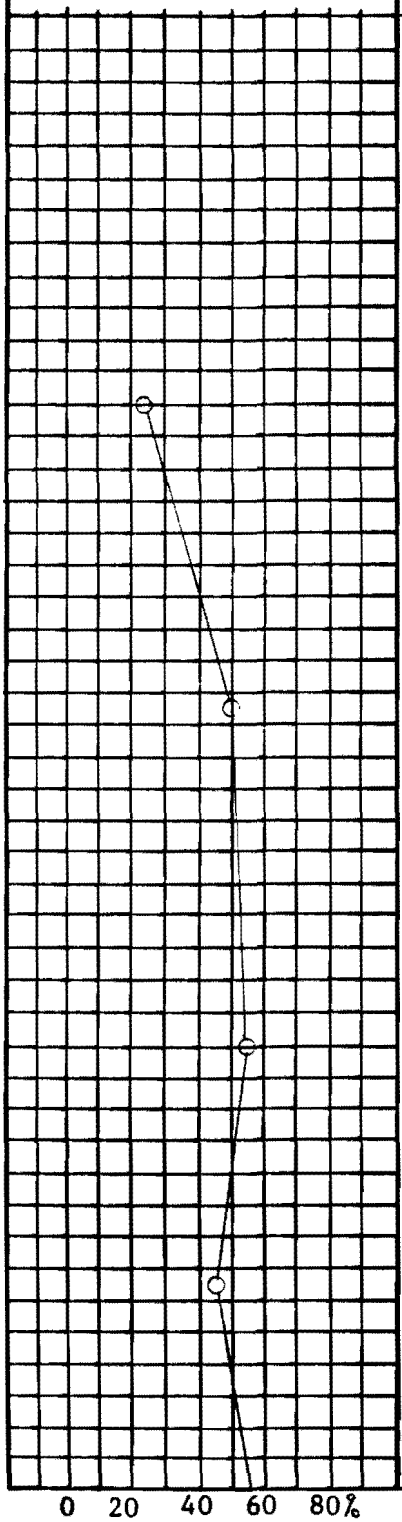
PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 1, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **8**

SURFACE ELEVATION 231.15 m
CO-ORDINATES SEE SITE PLAN

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△



DEPTH (metres)	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
0	TOPSOIL (75 mm) - clayey - organic				
1	FILL - clay - some silt - occasional stone size particles - medium density - moist				
2					
3	SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-65			
4	CLAY (CH) - brown - stiff - trace of silt pockets	B-1			pp = 83.6 T_v = 79.0 L_v = 73.4
5					
6		B-2			pp = 83.6 T_v = 64.6 L_v = 83.8
7	CLAY (CH) - grey - stiff - trace of silt pockets - trace of fine sand inclusions	B-3			pp = 100.5 L_v = 106.0
8					
9					

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 1, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **8**

SURFACE ELEVATION 231.15 m
CO-ORDINATES

0 20 40 60 80 %
MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10			B-4			pp = 59.8 T_v = 50.2 L_v = 61.0	10
11			B-5			pp = 36.0 T_v = 50.2 L_v = 41.4	11
12		CLAY (CH) - grey - becoming firm with depth - trace of fine sand and silt inclusions - trace of till inclusions increasing with depth	B-6	103.0		pp = 43.1 T_v = 59.8 L_v = 57.4	12
13							13
14			B-7			pp = 33.4 T_v = 36.0 L_v = 42.0	14
15			B-8			pp = 36.0 T_v = 38.2 L_v = 41.4	15
16							16
17			B-9			pp = 36.0 L_v = 25.2	17
18		CLAY/TILL TRANSITION - wet - soft	G-66				18

0 20 40 60 80 %

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DRILLING DATE MAY 1, 1984
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TEST BORING No **8**

SURFACE ELEVATION 231.15 m
CO-ORDINATES

0 20 40 60 80%	DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
MOISTURE CONTENT ○	19		TILL - silty - upper 0.9 m wet - becoming dense to very dense below 18.6 m	G-67				19
LIQUID LIMIT □				G-68				
PLASTIC LIMIT △				G-69				
	20			G-70				20
	21			G-71				21
	22		End of borehole at 21.6 m on probable boulders (auger refusal).					22
	23		NOTES: - Upper 4.5 m sleeved.					23
	24		- No seepage or sloughing was evident from upper till layer during drilling.					24
	25		- Extensive sloughing and seepage from silt layer after sleeve removed.					25

0 20 40 60 80%

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JOB No. 0265-213-04-02
DRILLING DATE MAY 1, 1984
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TEST BORING No **9**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 231.70 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (75 mm) - black - fiberous					0
1		FILL - clay - medium density - moist					1
2							2
3		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-72				3
4		CLAY (CH) - brown - stiff - trace of silt pockets					4
5							5
6			G-73			pp = 59.8	6
7							7
8		CLAY (CH) - grey - stiff - trace of silt pockets					8
9							9

0 20 40 60 80 %

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 1, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **9**

0 20 40 60 80 %

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 231.70 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10			G-74			pp = 47.9	10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of till inclusions at 11.9 m (increasing with depth)	G-75			pp = 23.8	12
13							13
14							14
15			G-76			pp = 11.9	15
16							16
17							17
18		CLAY/TILL TRANSITION - very soft - very wet	G-77				18
			G-78				

0 20 40 60 80 %

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 1, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **9**

SURFACE ELEVATION 231.70
CO-ORDINATES

0 20 40 60 80%	DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
MOISTURE CONTENT — ○ LIQUID LIMIT — □ PLASTIC LIMIT — △	19		TILL - silty - upper 0.6 m saturated - becoming dense to very dense below 18.6 m - large boulder at 18.9 m					19
	20		End of borehole at 20.1 m on large boulder (auger drifting to side).					20
	21		NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 0.6 m of till matrix.					21
	22							22
	23							23
	24							24
	25							25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **10**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 232.00 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (75 mm) - black - fiberous					0
1		FILL - clay - trace of small stone - dry to 1.2 m becoming moist with depth from 1.2 to 2.7 m - medium density	G-79				1
2			G-80				2
3		SILT (ML) - tan - wet - seepage upon exposure	G-81				3
4							4
5		CLAY (CH) - brown - stiff - trace of silt pockets - trace of sulphates - nuggety structure	B-10	97		pp = 83.6 T_v = 87.9 L_v = 88.2	5
6							6
7							7
8		CLAY (CH) - grey - stiff - trace of sulphates	B-11			pp = 86.1 T_v = 88.9 L_v = 83.8	8
9							9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 3, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **10**

0 20 40 60 80 %
MOISTURE CONTENT —○
LIQUID LIMIT —□
PLASTIC LIMIT —△

SURFACE ELEVATION 232.00 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
			B-12			pp = 59.8 T_v = 61.1	
11		CLAY (CH) - grey - becoming firm with depth - trace of fine sand pockets - trace of till inclusions				L_v = 54.8	11
12							12
13							13
			B-13			pp = 36.0 T_v = 34.4	
14						L_v = 62.2	14
15							15
16							16
17			B-14			pp = 36.0 T_v = 42.1	17
		CLAY/TILL TRANSITION - soft - wet				L_v = 50.4	
18							18

0 20 40 60 80 %

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **10**

SURFACE ELEVATION 232.00 m
CO-ORDINATES

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 1.2 m saturated - becoming dense to very dense below 19.5 m - occasional cobbles - 300 mm boulder at 21.3 m	G-82				19
			G-83				
20			G-84				20
21			G-85				21
22		End of borehole at 21.6 m on probable boulders (auger refusal).					22
23		NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 1.2 m of till matrix.					23
24							24
25							25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **11**

0 20 40 60 80%
MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.22 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (75 mm) - black - fiberous					0
1		FILL - clay - trace of gravel - medium density - very dry to 1.5 m					1
2		- becoming moist at 1.5 m to 2.4 m					2
3		SILT (ML) - tan - saturated - laminated with fine sand - seepage and sloughing upon exposure	G-87				3
4							4
5		CLAY (CH) - brown - stiff - trace of silt pockets - trace of sulphates	G-88			pp = 83.6	5
6							6
7							7
8		CLAY (CH) - grey - stiff - trace of silt pockets					8
9			G-89			pp = 47.9	9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No	0265-213-04-02
DRILLING DATE	MAY 3, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **11**

SURFACE ELEVATION 232.22 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
10						
11						
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of 10 mm stone at 11.9 m	G-90			
13						
14						
15			G-91			pp = 23.8
16						
17						
18			G-92			pp = 23.8

MOISTURE CONTENT ○
LIQUID LIMIT □
PLASTIC LIMIT △

0 20 40 60 80 %

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 5, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **11**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 232.22 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		CLAY/TILL TRANSITION - soft - very wet					19
20		TILL - silty - upper 0.6 m saturated - becoming dense to very dense below 19.2 m					20
21		End of borehole at 20.4 m on probable boulders (auger refusal). NOTES: - Upper 4.5 m sleeved. - 300 mm Ø boulder recovered from auger tip at 19.5 m. - Extensive seepage and sloughing from upper 0.6 m of till matrix.					21
22							22
23							23
24							24
25							25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **12**

SURFACE ELEVATION 232.05 m
CO-ORDINATES SEE SITE PLAN

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

0 20 40 60 80%

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
		TOPSOIL (50 mm) - black - fiberous					
1		FILL - clay - trace of gravel - medium density - moist					1
2		- black organic layer from 1.7 to 2.4 m	G-94				2
		SILT (ML)					
3		- tan - saturated - seepage and sloughing upon exposure	G-95				3
4			G-96				4
		CLAY (CH)	G-97			pp = 59.8	
5		- brown - stiff - trace of sulphates - trace of silt pockets					5
6							6
7							7
			G-98				
		CLAY (CH)				pp = 47.9	
8		- grey - stiff - trace of silt pockets					8
9							9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 3, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **12**

SURFACE ELEVATION 232.05 m
CO-ORDINATES

MOISTURE CONTENT ○
LIQUID LIMIT □
PLASTIC LIMIT △

0 20 40 60 80 %

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10		CLAY (CH)	G-99			pp = 36.0	10
11		- grey - becoming firm with depth - trace of silt pockets - trace of till inclusions increasing with depth					11
12							12
13			G-100			pp = 23.8	13
14							14
15							15
16							16
17			G-101			pp = 36.0	17
18		CLAY/TILL TRANSIITON - soft - very wet					18

0 20 40 60 80 %

Underwood McLellan Ltd.
1479 Buffalo Pl.
Winnipeg, Manitoba R3T 1L7
Telephone (204) 284-0580
the UMA group

PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **12**

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 232.05 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 0.9 m saturated - becoming dense to very dense below 18.9 m	G-102				19
20			G-103				20
21							21
22			G-104				22
23		End of borehole at 22.9 m on probable limestone bedrock (auger refusal). NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 0.9 m of till matrix.					23
24							24
25							25

0 20 40 60 80%

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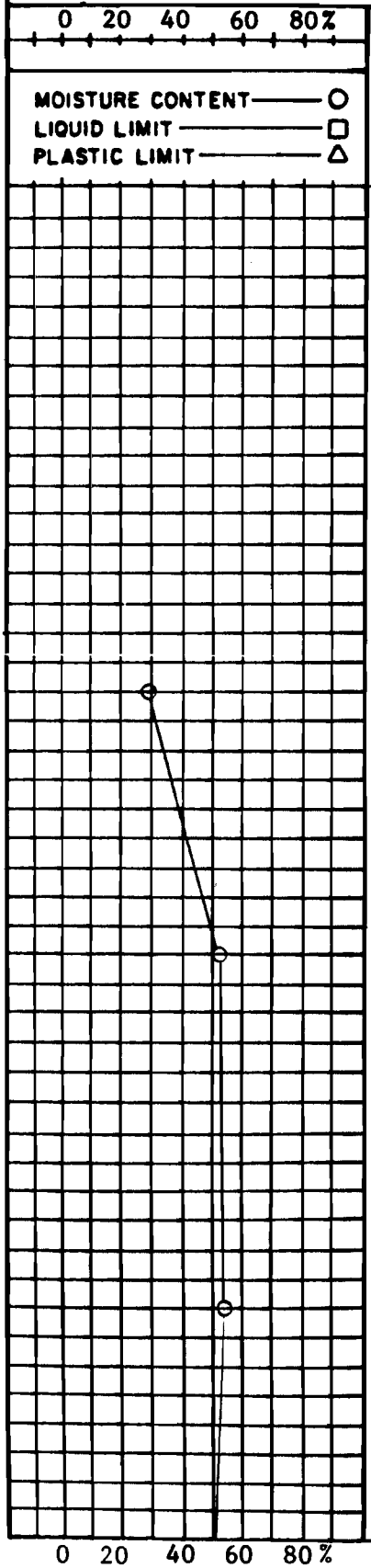
PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 3, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **13**



SURFACE ELEVATION 232.04 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
1		FILL - clay - medium density - dry					1
2		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-105				2
3							3
4		CLAY (CH) - brown - stiff - nuggety structure - trace of sulphates - trace of silt pockets					4
5			B-15			pp = 71.7 T_v = 47.9 L_v = 66.6	5
6							6
7							7
8		CLAY (CH) - grey - stiff - trace of sulphates	B-16			pp = 59.8 T_v = 47.9 L_v = 72.8	8
9							9

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the uma group

PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 3, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **13**

0 20 40 60 80 %

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.04 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11			B-17			pp = 36.0 T_v = 28.9 L_v = 48.6	11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of till inclusions increasing with depth					12
13							13
14			B-18	104.0		pp = 47.9 T_v = 43.1 L_v = 52.6	14
15							15
16							16
17			B-19			pp = 47.9 T_v = 66.9 L_v = 49.4	17
18		CLAY/TILL TRANSITION - soft - wet	G-106				18

0 20 40 60 80 %

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the UMA group

PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 3, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **13**

SURFACE ELEVATION 232.04 m
CO-ORDINATES

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19	TILL - silty - occasional cobble - upper 1.0 m saturated - becoming dense to very dense below 19.0 m - difficult drilling at 20.0 m due to presence of boulders.	G-107				19
20						20
21						21
22	End of borehole at 21.6 m on probable boulders (auger refusal).					22
23						23
24	NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 1.0 m of till matrix.					24
25						25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
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JOB No. 0265-213-04-02
DRILLING DATE MAY 4, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **14**

SURFACE ELEVATION 232.02 m
CO-ORDINATES SEE SITE PLAN

MOISTURE CONTENT —○—
LIQUID LIMIT —□—
PLASTIC LIMIT —△—
0 20 40 60 80%

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS
0		**FILL** - clay - medium density - dry to 1.5 m - moist from 1.5 to 2.4 m - 500 mm Ø granite boulder at 150 mm depth				
3		**SILT** (ML) - tan - saturated - layered with fine sand - seepage and sloughing upon exposure	G-108			
5		**CLAY** (CH) - brown - stiff - trace of silt pockets - trace of 15 mm Ø stone	G-109			pp = 59.8
8		**CLAY** (CH) - grey - stiff - trace of silt pockets	G-110			pp = 47.9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No	0265-213-04-02
DRILLING DATE	MAY 4, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **14**

0 20 40 60 80 %

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 232.02 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of till inclusions increasing with depth	G-111			pp = 36.0	12
13							13
14							14
15							15
16							16
17			G-112			pp = 23.8	17
18		CLAY/TILL TRANSITION - soft - wet					18

0 20 40 60 80 %

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 4, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **14**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.02 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - upper 0.6 m saturated - becoming dense to very dense below 18.9 m.					19
20							20
21							21
22							22
23							23
24		End of borehole at 23.0 m on probable limestone bedrock (auger refusal). NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 0.6 m of till matrix.					24
25							25

0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02
DRILLING DATE MAY 4, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **15**

SURFACE ELEVATION 231.83 m
CO-ORDINATES SEE SITE PLAN

0 20 40 60 80%
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (50 mm) - black - fiberous					0
1		FILL - clay - medium density - dry to moist					1
2							2
3		SILT (ML) - tan - saturated - layered with fine sand - seepage and sloughing upon exposure	G-114				3
4							4
5		CLAY (CH) - brown - stiff - trace of silt pockets					5
6			G-115			pp = 59.8	6
7							7
8		CLAY (CH) - grey - stiff - trace of silt pockets					8
9			G-116				9

0 20 40 60 80%

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the UMA group

PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 4, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **15**

0 20 40 60 80 %
MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 231.83 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of till inclusions increasing with depth	G-117			PP = 36.0	12
13							13
14							14
15			G-118			PP = 36.0	15
16							16
17							17
18		CLAY/TILL TRANSITION - soft - wet					18

0 20 40 60 80 %

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JOB No 0265-213-04-02

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DRILLED BY SUBTERRANEAN (WPG.) LTD.

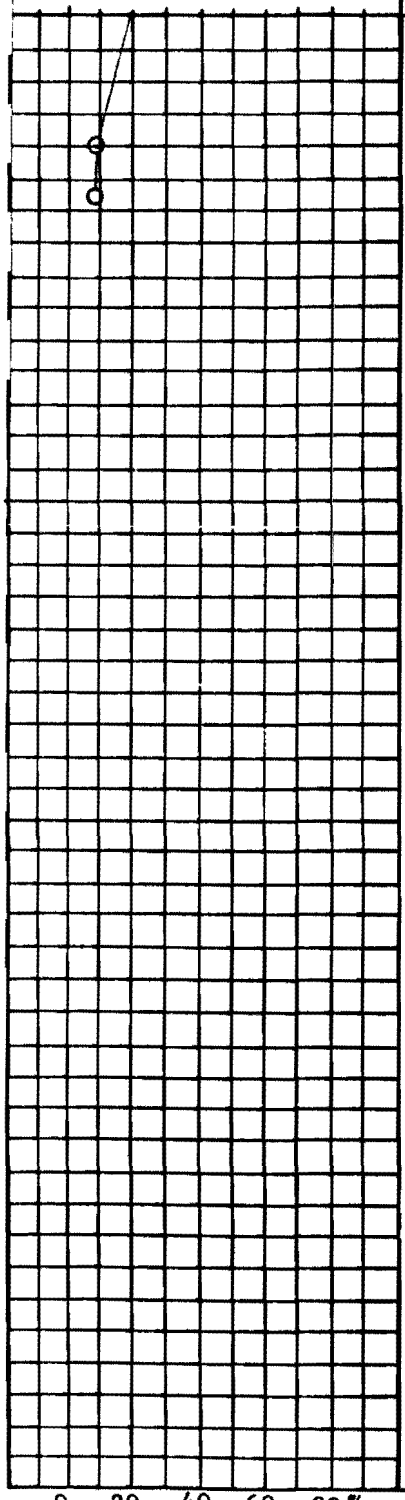
TEST BORING No **15**

SURFACE ELEVATION 231.83 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - boulder at 17.7 m - upper 0.8 m saturated - becoming dense to very dense below 18.5 m	G-119 G-120				19
20							20
21		End of borehole at 20.4 m on very dense till (auger refusal).					21
22							22
23		NOTES: - Upper 4.5 m sleeved. - Seepage and sloughing from upper 0.8 m of till matrix.					23
24							24
25							25

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △



0 20 40 60 80%

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PROJECT N.E.W.P.C.C.
CLIENT CITY OF WINNIPEG
JOB No. 0265-213-04-02

DRILLING DATE MAY 4, 1984
DRILLED BY SUBTERRANEAN (WPG.) LTD.

TEST BORING No **16**

0 20 40 60 80%

MOISTURE CONTENT ——— ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.17 m
CO-ORDINATES SEE SITE PLAN

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
0		TOPSOIL (50 mm) - black - fiberous					0
1		FILL - clay - medium density - dry					1
2							2
3							3
4		SILT (ML) - tan - saturated - seepage and sloughing upon exposure	G-121				4
5		CLAY (CH) - brown - stiff - trace of silt pockets					5
6			G-122			pp = 71.7	6
7							7
8						Standpipe Tip Elev.	8
9		CLAY (CH) - grey - stiff - trace of silt pockets	G-123			pp = 71.7	9

0 20 40 60 80%

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PROJECT	N.E.W.P.C.C.
CLIENT	CITY OF WINNIPEG
JOB No.	0265-213-04-02
DRILLING DATE	MAY 4, 1984
DRILLED BY	SUBTERRANEAN (WPG.) LTD.

TEST BORING No **16**

0 20 40 60 80 %

MOISTURE CONTENT ——○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△

SURFACE ELEVATION 232.17 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (kPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
10							10
11							11
12		CLAY (CH) - grey - becoming firm with depth - trace of silt pockets - trace of till inclusions increasing with depth	G-124			pp = 23.8	12
13							13
14							14
15			G-125			pp = 11.9	15
16							16
17			G-126				17
18		CLAY/TILL TRANSITION - very soft - very wet					18

0 20 40 60 80 %

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TEST BORING No **16**

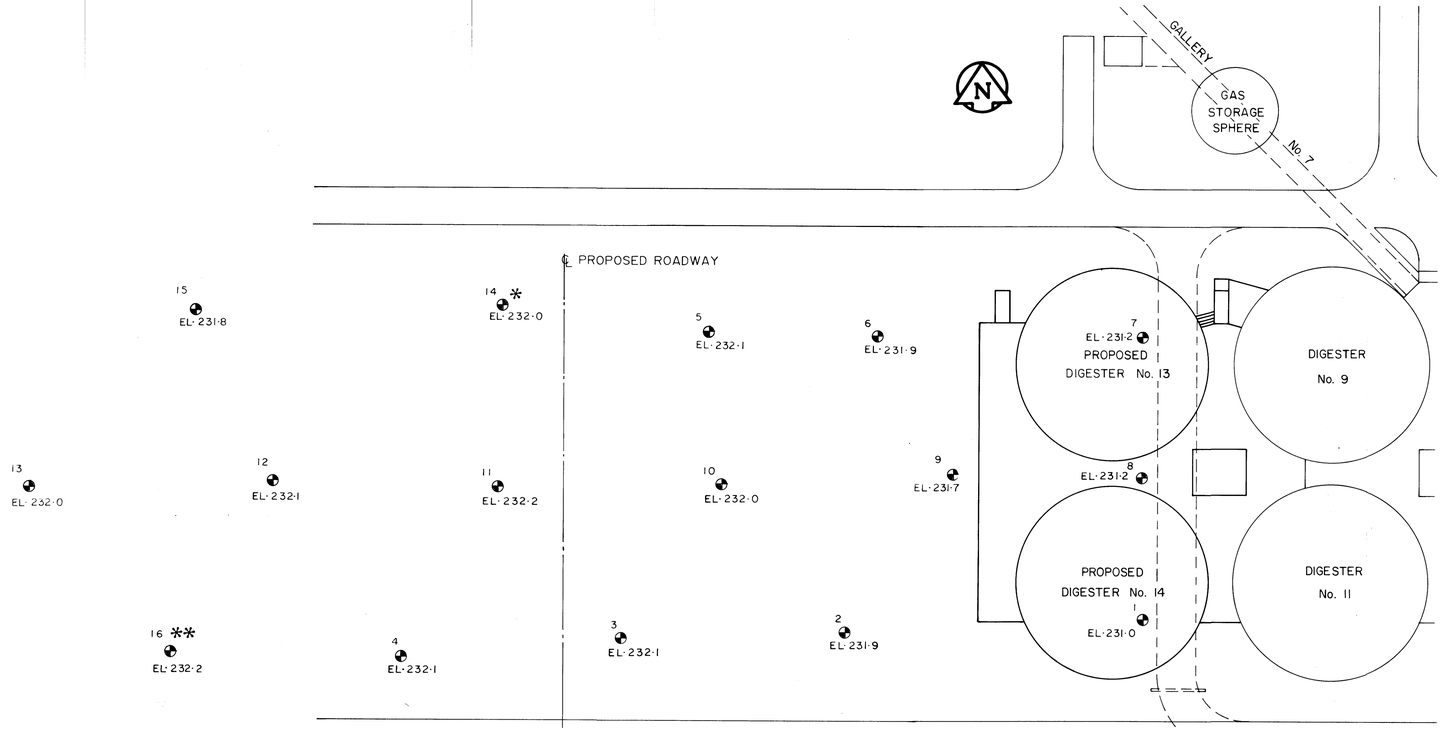
0 20 40 60 80%
MOISTURE CONTENT ——— O
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △

SURFACE ELEVATION 232.17 m
CO-ORDINATES

DEPTH (metres)	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO. & TYPE	COMPRESSIVE STRENGTH (KPa)	STANDARD PENETRATION (BLOWS/0.3 m)	MISC. TESTS & REMARKS	DEPTH (metres)
19		TILL - silty - boulders at 18.8 and 20.7 m - upper 0.5 m saturated - becoming dense to very dense below 18.9 m	G-127 G-128			Standpipe Tip Elev.	19
20							20
21							21
22		End of borehole at 21.3 m on probable boulders (auger refusal).					22
23		NOTES: - Upper 4.5 m sleeved. - Extensive seepage and sloughing from upper 0.5 m of till matrix. - two standpipes installed with tip elevations at 7.6 m (Clay) and 20.4 m (Till).					23
24							24
25							25

0 20 40 60 80%

APPENDIX B



NOTES

TEST HOLES No. 1 TO 3 DRILLED 26/4/84

TEST HOLES No. 4 TO 6 DRILLED 30/4/84

TEST HOLES No. 7 TO 9 DRILLED 1/5/84

TEST HOLES No. 10 TO 13 DRILLED 3/5/84

TEST HOLES No. 14 TO 16 DRILLED 4/5/84

STANDPIPE PIEZOMETERS INSTALLED 4/5/84

* GROUND ELEVATION AT TEST HOLE LOCATION

** STANDPIPE PIEZOMETER LOCATION

LEGEND

AUGER HOLE TO REFUSAL

10 5 0 10 20 30

SCALE IN METRES

THE CITY OF WINNIPEG

WORKS & OPERATIONS DIVISION

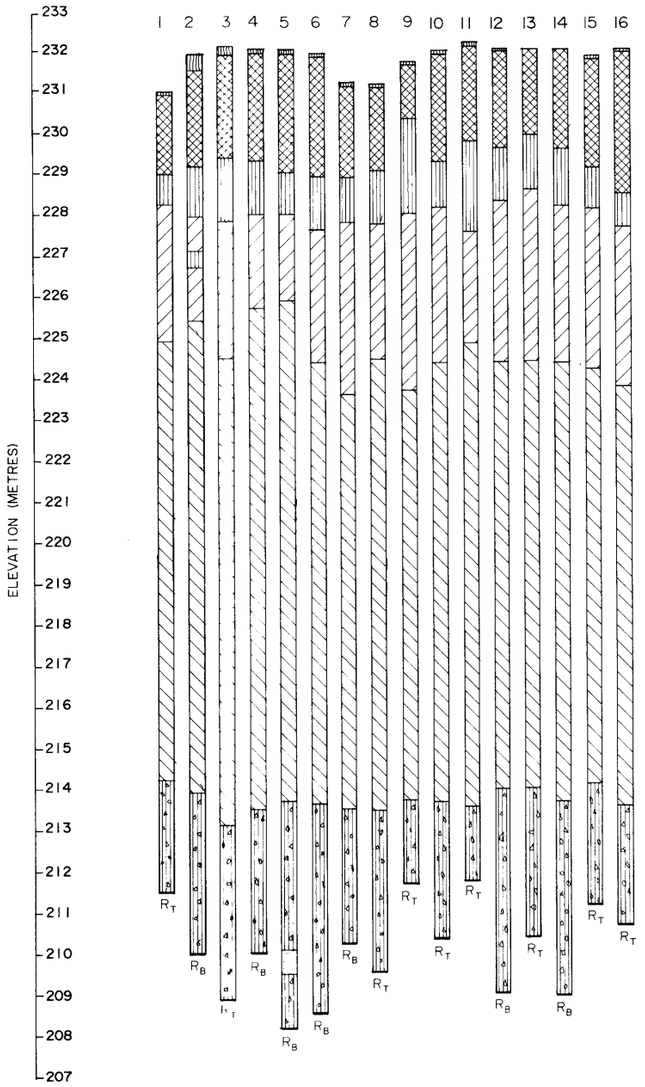
WATERWORKS, WASTE & DISPOSAL DEPARTMENT

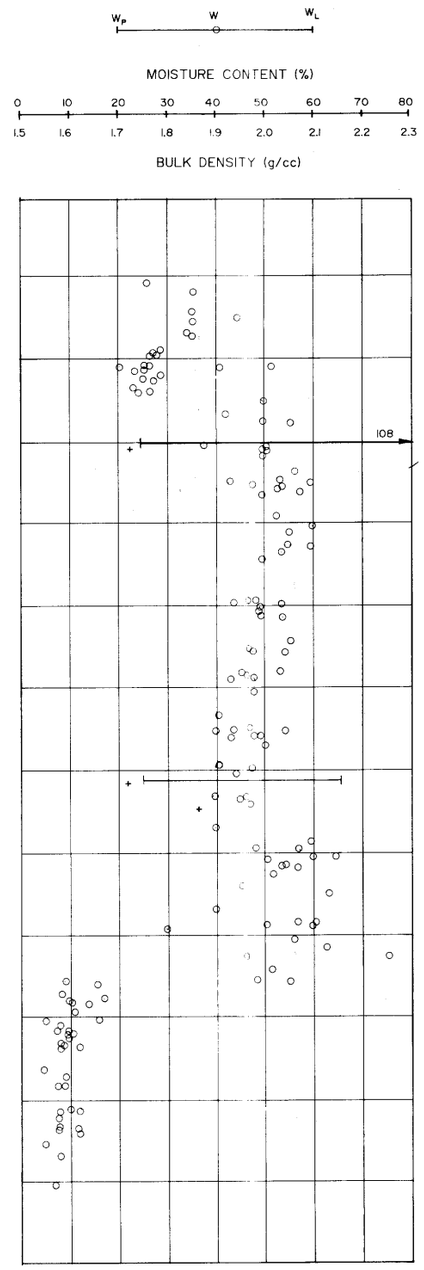
NORTH END WATER POLLUTION CONTROL CENTRE
SLUDGE DIGESTION EXPANSION

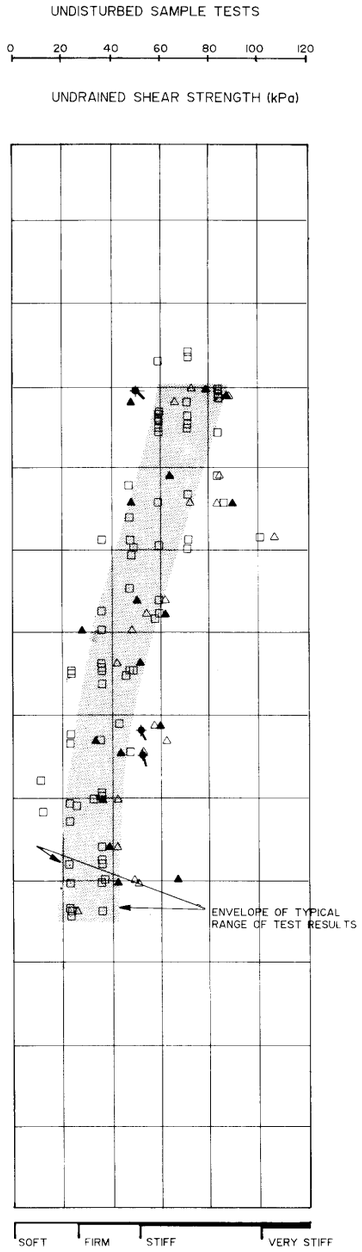
TEST HOLE LOCATION PLAN

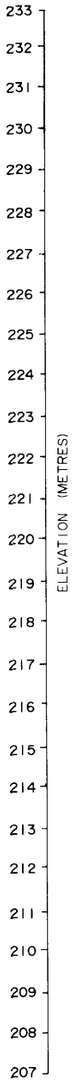
Underwood McLellan Ltd.
Consulting Engineers and Planners

DRAWING 1









LEGEND

- \+ BULK DENSITY
- ○ MOISTURE CONTENT : W natural, W_L liquid limit, W_P plastic limit
- ▲ TORVANE SHEAR STRENGTH
- △ LAB VANE SHEAR STRENGTH
- □ SHEAR STRENGTH FROM POCKET PENETROMETER
- SHEAR STRENGTH FROM UNCONFINED COMPRESSION TEST & % STRAIN AT FAILURE
- TOPSOIL
- FILL
- SILT
- BROWN CLAY
- GREY CLAY
- TILL
- SAND
- R_T REFUSAL WITHIN GLACIAL TILL
- R_B REFUSAL UPON PROBABLE LIMESTONE BEDROCK

NOTES

1) HOLES 1 TO 3 DRILLED 26/04/84.
   HOLES 4 TO 6 DRILLED 30/04/84
   HOLES 7 TO 9 DRILLED 01/05/84
   HOLES 10 TO 13 DRILLED 03/05/84
   HOLES 14 TO 16 DRILLED 04/05/84

2) STANDPIPE PIEZOMETER INSTALLATIONS AT HOLE 16.

NO	REVISIONS	DATE	APP

PROVINCE OF MANITOBA — June 15/84 — D.E. KINGERSKI — REGISTERED ENGINEER
ENGINEER'S SEAL

the uma group — Underwood McLellan Ltd. Consulting Engineers and Planners

DESIGNED BY: K.S.	DRAWN BY: J.R.C.
CHECKED BY: D.K.	DATE: June 15/84
APPROVED BY: L.D.K.	DATE: 20/6/84

THE CITY OF WINNIPEG
WORKS & OPERATIONS DIVISION

NORTH END WATER POLLUTION CONTROL CENTRE
SLUDGE DIGESTION EXPANSION

COMPOSITE GEOTECHNICAL SUMMARY

RELEASED FOR CONSTRUCTION: DATE:

SCALE: AS SHOWN

DRAWING NO: 02