Winnipeg

PLANNING PROPERTY AND DEVELOPMENT DEPARTMENT

PROPOSED FIRE HALL
409 MULVEY AVENUE

RIVERBANK STABILITY STUDY AND FOUNDATION INVESTIGATION

June 2003

JUNE, 2003

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

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June 20, 2003

File No. 03-107-06

The City of Winnipeg
Planning, Property & Development Department
Civic Accommodations Division
3rd Floor, 65 Garry Street
Winnipeg, Manitoba
R3C 4K4

ATTENTION: Mr. Jerry Comeau, P.Eng.
Manager of Civic Accommodations

RE: Riverbank Stability Study and Foundation Investigation
Preliminary Recommendations
409 Mulvey Avenue East
City Project Number 2002-313

Dear Mr. Comeau:

Please find enclosed four (4) copies of our report of the Riverbank Stability Study and Foundation Investigation, Preliminary Recommendations, 409 Mulvey Avenue East.

The scope of this work included the following:

- Site Investigations- perform a subsurface drilling investigation and ground surface survey along three lines from the rear of the existing building, to the river's edge and continuing with bottom soundings from a boat.
- Riverbank Stability Assessment- assess stability of existing riverbank and remedial alternatives by site reconnaissance, air photo review and computer aided stability analysis,
- Foundation Recommendations
- Report- present results of work including preliminary cost estimates for riverbank remedial works.

KGS Group thanks the City of Winnipeg for the opportunity to have provided services on this interesting project. Please contact John McKay or the undersigned if you have questions.

Sincerely,

Rob Kenyon, Ph.D., P.Eng.
Manager, Geotechnical Services

RK/
Enclosure

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1.0 INTRODUCTION

This report presents riverbank stability and foundation recommendations for a proposed fire hall at 409 Mulvey Avenue, Winnipeg, Manitoba.

Authorization to proceed with this work was given in a letter received April 7, 2003 from Mr. Jerry Comeau, P.Eng., City of Winnipeg, Planning, Property and Development Department.

The site is within 107 m (350 ft) horizontal distance from the normal summer water edge of the Red River and in accordance with the City Waterway By-law, a Waterway Permit is required.

The scope of work was described in KGS Group's February 10, 2003 proposal and includes:

- ***Site Investigations*** - perform a subsurface drilling investigation and ground surface survey along three lines from the rear of the existing building, to the river's edge and continuing with bottom soundings from a boat.
- ***Riverbank Stability Assessment*** - assess stability of existing riverbank and remedial alternatives by site reconnaissance, air photo review and computer aided stability analysis,
- ***Foundation Recommendations***
- ***Report*** - present results of work including preliminary cost estimates for riverbank remedial works.

Previous available reports reviewed as part of this project include:

- May 2001, Project Number 00-107-16, Churchill Drive Pathway Slope Stability Assessment, Final Report, KGS Group.
- February 1993, Project Number 91-107-01, Jessie Avenue Flood Pump Station Riverbank Stabilization & Remedial Works, Operational Transfer of Project Information to South-west District & Regional Operations, KGS Group.
- June 1990, Project Number 91-107-01, Jessie Avenue Flood Pumping Station Riverbank Stabilization Study, KGS Group.

2.0 BACKGROUND

2.1 PROJECT DETAILS

The project is understood to comprise the demolition of the existing building and exterior pavement slabs, the design and construction of a city fire hall and possible riverbank remedial works to improve slope stability, if required for long term stability of the property. A potential site plan for the fire station was received from the City of Winnipeg on May 28, 2003. The drawing shows a five bay, stepped footprint reducing the building area nearer to the riverbank. The shown setback is approximately 25 m from the assumed edge of bank to the closest building point.

2.2 SITE DESCRIPTION AND LOCATION

The site is located within the area of Fort Rouge, in the City of Winnipeg, in the Province of Manitoba. The site is approximately 175 m southeast of the Canadian National Railway bridge and Osborne Street intersection. The street address is 409 Mulvey Avenue. The site location and plan are shown on Figure 1 along with a preliminary outline of the proposed new firehall.

There is an existing 2 to 5 story (Brew House is 5 stories) building on site that appears to have been an old brewery and is perhaps approximately 100 years old. The building has a shallow basement. Based on a cursory observation of the existing building exterior, the foundation appears to be in good condition.

Mulvey Avenue East bounds the site on the south, an abandoned parking area bounds the site on the north, a paved alley and building bound the site on the west and the Red River bounds the site on the east.

The site property is approximately 85 m wide along the river and extends back about 55 m from the top of slope to the west property line (towards Osborne Street).

From the toe of slope about 25 m into the river to the top of bank, it is about 65 m in plan and 12 m in height. Overall the gradient is between 5.1 to 5.6:1 (horizontal to vertical).

For slope stability considerations, the site and adjacent river are divided up into five physiographic areas extending parallel to the river as shown in Figure 1:

- **Top of Bank-** The relatively flat top of bank extends away from the top of bank break line towards south Osborne Street at elevations ranging from 232.0 to 232.5 m. The abandoned building occupies most of this area. The ground surface has gravel, and lesser pavement areas. There is a gravel surface path along the crest of the slope.

- **Upper Slope-** The steep upper slope falls toward the river at approximately 2.4:1. The upper slope is approximately 5 to 7 m high extending horizontally about 17 m. The slope face cover includes mature deciduous trees with low grass and bushes. Boulder sized concrete fragments are visible along most of the face of this upper slope.

- **Lower Bench-** A flat lower bench is located below the upper sloe between approximate elevations 226 to 227 m and extending to the ordinary high water mark (O.H.W.M.). The lower bench cover includes deciduous trees, low grass and bushes.

- **Edge of River-** At the river's edge the ground surface drops off nearly vertically up to 1.2 m reflecting the fill and active river erosion. Surface cracks and clods of grass covered soil broken off from the lower bench are visible.

- **River Bottom-** The river bottom slopes away from the shoreline at about 5:1 and becomes flat about 25 m in. On April 24, 2003 the river depth was 0.26 m at the bank and 2.4 m at a distance of 25 m in from the shoreline.

Note that the contours shown in Figure 1 based on aerial photography mapping are not as steep as the upper slope and steeper than the bottom slope as established from the KGS Group field survey and site observations. Figure 1 contours are derived from air photos and can be less accurate with tree, bush and high grass cover.

2.3 WATERWAYS AUTHORITY CONSTRUCTION HISTORY

City of Winnipeg Rivers and Streams Record Summary Report dated February 1993, contains applications for proposed construction along the City's waterways from 1951 to 1992. Only one application is noted at 409 Mulvey Avenue. On September 17, 1970, Permit 42/70 was issued for Lot Number 2, Plan 2939, Dominion Government Surveys River Lots 32 and 33, St. Boniface Parish, Red River Right Bank Coordinate 51.570 km, Location CT883783. The permit was to construct a 14 ft (4.3 m) by 25 ft (7.6 m) cold storage room supported on 20 ft (6.1 m) by 16 inch (406 mm) diameter piles. The piles would likely be in the lacustrine clay.

2.4 1912 HYDROGRAPHIC SURVEY

Manitoba Hydrographic Survey Red River Topographic Sheet No. 1, Scale: 200 ft to One inch, November 1912, includes nearby river lots. The 1912 plan shows the outline of the existing building as well as an additional small building outline on the north end of the site near the top of bank. Slope gradients range from 3:1 to 4.5:1 at the site. The lower bench was not present. Upon comparison of the 1912 river survey versus the present site topographic conditions, it appears that the top of bank in 2003 is closer to the river, probably due to fill placement, whereas the shoreline has moved away from the river at the very north end of the site towards the present Jessie Avenue pump station.

2.5 AIR PHOTOS

Available air photos examined included:

- October 23, 1998, FF98096, Line 2, Numbers 21, 22; Scale 1:5000.
- 1988 AS88012, Numbers 54, 55; Scale 1:5000.
- June 27, 1950, Approximate Scale 1:8500

The gravel pathway was not present on the 1988 photo and also the Jessie Avenue pump station river bank was not remediated. Associated with the remediation and the pathway there was some fill placed behind the old (still in place) parking area north of the site and the river side. There are no other observed differences from 1988 to 1998 (and 2003) at the 409 Mulvey site.

Of note is the Jessie Avenue pump station scarp in the 1988 photo in the upper bench area. This is also described in KGS' June 1990 report.

One air photo from June 27, 1950 (therefore not in stereo) shows the site. On the north side of the site near the top of bank there appears to be a small building. There is no Jessie Avenue pump station but a different building just south (the concrete slab of this building is visible in the 1988 photos). The Red River elevation is high and obscures the lower bench.

2.6 RED RIVER DESIGN ELEVATIONS

Relevant typical river and flood protection levels at the site are presented below.

- Flood Protection Level 230.5 m
- Regulated Summer river level 223.75 m
- Unregulated Winter river level 221.9 m
- 1997 maximum river level 229.5 m
- April 24, 2003 223.6 m

3.0 SITE GEOLOGY

The geologic materials at the site in order of depth from ground surface are as follows:

- **Fill** of variable depth.
- **Postglacial alluvial sediments** - (absent or possibly immediately adjacent to the river at the site, may also be above or within fills) Geologic Survey of Canada unpublished map, Surficial Geology of Southern Manitoba describes the postglacial alluvial sediments as gravelly, sand, sand silt, organic detritus; 1 to 3 m thick; sediments reworked by existing streams and deposited primarily as bars.'
- **Glaciolacustrine sediments -** Geologic Survey of Canada unpublished map, Surficial Geology of Southern Manitoba describes the glaciolacustrine sediments as 'clay, silt; 1 to 20 m thick; massive and laminated distal sediments derived from meltwater discharge and deposited from suspension in offshore, deep water of Lake Agassiz; commonly scoured and at least partially homogenized by icebergs.', approximately 11,600 to 8,700 years before present in age (Teller, 1980, Canadian Journal of Earth Sciences, Volume 13, 1976)
- **Glacial till** - Teller and Fenton (Canadian Journal of Earth Sciences, Volume 17, 1980) present five Late Wisconsinan basal tills in the Winnipeg area as follows:
  - **Marchand Formation -** pebbly silty sand, carbonate-rich, thin and discontinuous, 2 to 6 m thick, approximately 12,000 to 11,600 years before present in age, deposited as the readvancing ice overrode its own sandy outwash.
  - **Intertill sand outwash**
  - **Whitemouth Lake Formation -** silty clay, discontinuous, less than 1 to 18 m thick, approximately 13,100 to 12,700 years before present in age, deposited by glacial readvance over lacustrine intertill clay.
  - **Intertill lacustrine clay**
  - **Roseau Formation -** pebbly sandy-silt, generally continuous, average thickness 4 m but varies from 1 to 16 m, approximately 22,000 to 13,800 years before present in age, deposited by the Keewatin ice sheet advancing from the northeast over Paleozoic carbonate rocks.
  - **Senkiw Formation -** pebbly silty sand, varies greatly in thickness, from 0 to greater than 30 m, approximately 24,000 to 22,000 years before present in age, deposited by the Laurentide ice sheet advancing from the northeast across the Precambrian Shield, sand grains are low in carbonate and high in igneous and metamorphic rock.

- **Bedrock -** Map numbers 1979 DR-2 and DR-1 by Manitoba Mineral Resources Division indicate that at the site, the depth to bedrock is approximately 18 m (from top of slope) and bedrock elevation is approximately 213.4 m (given as 700 ft with 20 ft contour intervals). The bedrock is Ordovician (500 to 435 million years before present) in age, of the Red River Formation and Fort Garry Member. The bedrock is described as dolomite, aphanitic; marker bed of red argillaceous intraformational breccia at top of subunit.'

4.0 INVESTIGATION PROGRAM

4.1 FIELD AND LABORATORY WORK

On April 28, 2003, KGS Group supervised the drilling of three testhole locations (TH1, TH2, TH3) as shown in Figure 1. The holes were drilled with an Acker Soil Sentry rig mounted on a tracked TF60 carrier contracted from Paddock Drilling Ltd. The holes were advanced using 125 mm solid stem augers to depths of between 7.9 and 14.9 m below existing ground surface. Testhole TH1 was drilled at the top of bank near the southeast corner of the existing building, Testhole TH2 was drilled at the lower bench at the base of the visible boulder fill area and Testhole TH3 was drilled at the lower bench near the edge of the river.

Disturbed bulk samples and split-spoon samples were recovered at 1.5 m intervals or changes in stratigraphy. Standard Penetration Tests (SPT's) were performed at approximately 1.5 m intervals. At Testhole TH2 location, a standpipe with a Casagrande tip was installed with response zone in the silt till and a pneumatic piezometer was installed with the response zone in the lacustrine clay. A 70 mm slope indicator casing TH2 (SI) was installed 0.8 m north. Locked steel protective casings were placed over each installation. No instrumentation was installed in Testholes TH1 and TH3. Installation details are presented on the testhole logs. Piezometer response zone depths and readings are presented in Table 1. Testhole logs are presented in Appendix A.

Ground surface elevations at the testhole locations were surveyed by KGS Group and referenced to geodetic. The benchmark used was City of Winnipeg Benchmark 53-011 with elevation 232.057 m. This brass plug is located at the northwest corner of Brandon Avenue and Osborne Street. Site survey horizontal control was referenced to an assumed local coordinate system. Three sections were surveyed by KGS Group and are shown in Figure 2.

Classification and index tests were performed at Eng-Tech Consulting Ltd. laboratories on soil samples collected from the testholes. Laboratory tests included natural moisture content, Atterberg limits and gradation analysis. These results are shown on the testhole logs and in Appendix B.

The slope indicator casing was initialized on May 5, 2003 and read on May 22, 2003. There was no significant movement. Slope indicator results are presented in Appendix C.

5.0 GEOTECHNICAL SITE STRATIGRAPHY

Simplified geotechnical stratigraphy is presented in Table 1 as interpreted from testhole information at 409 Mulvey Avenue, the Jessie Avenue flood pumping station located approximately 150 m north and the Churchill Drive pathway (Togo Avenue) located approximately 400 m south of Mulvey Avenue. Testhole information and site plans from Jessie Avenue flood pumping station and Churchill Drive are included in Appendix D.

5.1 STRATIGRAPHY

The stratigraphy logged at the three testholes drilled at the site is summarized as follows (please refer to the testhole logs for the full description, Table 1 for a summary and Figure 2, Stratigraphic Section C):

- **Clay (Fill)**- Unified Soil Classification System modifier CL, firm, silty, some sand, trace gravel, low plasticity, saturated, light brown to grey, trace organics, occasional glass fragments or other anthropogenic material. Encountered, in Testholes TH2 and TH3 (Testhole TH1 at the top of slope was in native soil except for 100 mm gravel road surface). Fill depths were 2.4 m in Testhole TH2 and 4.6 m in Testhole TH3 at the river's edge. Concrete boulders were not encountered but were visible across the site in the upper slope.

- **Clay (Lacustrine)** - CH, firm to stiff, silty, trace sand, high plasticity, moist to saturated, olive brown to grey, 1 to 2 mm horizontal bedding when visible. The native lacustrine clay was 12.7 m thick in Testhole TH1, 6.6 m thick in Testhole TH2 and 3.2 m thick in Testhole TH3. The clay consistency is generally stiff in the upper 4.6 m at the top of bank (Testhole TH1) and firm below that depth and at the lower bench (Testholes TH2 and TH3).

- **Silt or Sand and Silt (Till)**- ML or SM, stiff to hard or compact to very dense, trace sandy, trace to some subrounded to angular gravel, low to nonplastic, saturated, light grey. Encountered at depths of 12.8 m, 9.0 m and 7.8 m or elevations of 219.5 m, 217.8 and 218.3 m in Testholes TH1, TH2 and TH3 respectively.

5.2 GROUNDWATER CONDITIONS

Table 1 includes groundwater readings at Testhole TH2 located on the lower bench near the base of the upper slope. On May 5, 2003 groundwater was measured at elevation 223.4 m (depth 3.3 m) in the till response zone and at elevation 223.1 (depth 3.7 m) in the clay response

zone. On May 22, 2003 groundwater was measured at elevation 222.5 m (depth 4.2 m) in the till response zone and at elevation 223.2 (depth 3.6 m) in the clay response zone.

Generally groundwater levels measured were low. This may be related to the relatively high uniform till elevations (217 to 219 m) which are very close to measured river bottom elevations of about 219 m, that is the till may be draining into the river.

The river elevation was 223.6 m on April 24, 2003. Groundwater elevations vary seasonally and in response to river levels and precipitation.

6.0 SLOPE STABILITY ASSESSMENT

6.1 ANALYSIS

6.1.1 Definitions and Material Parameters

Bishop modified method of slices was used for stability analyses. The factor of safety is defined as:

- That factor by which the shear strength parameters may be reduced in order to bring the soil mass into a state of limiting equilibrium along a given slip surface.

The calculated factor of safety is a function of the method of analysis, groundwater conditions, material parameters and slope geometry.

The critical groundwater condition assumed was rapid drawdown. Near saturation or hydrostatic water pressures from ground surface were approximated using the pore pressure coefficient $r_u = 0.5$, where

r_u = ratio of pore pressure to the total vertical overburden stress at any point.

The river was set at summer river elevation 223.75 m.
Soil material parameters assumed are:

Material	c' (kPa)	ϕ' (°)	γ (kN/m³)
Clay (Fill and Lacustrine)	5	17	18
Silt Till	hard surface		

Where the resistance of soil to failure in shear is approximated by the Mohr-Coulomb Failure Criterion in terms of effective stress parameters:

c' = Cohesion intercept based on effective stresses

ϕ' = Friction angle based on effective stresses

and γ = Unit weight of soil

These soil strength parameters are consistent with back analysis of the steepest portion of the slope and also are consistent with published strengths for high plastic, soft, saturated lacustrine clay (Freeman and Sutherland, Canadian Geotechnical Journal, 1974, Volume 11, Pages 59 to 71).

6.1.2 Results

Figure 3 presents slope stability analysis results for worst case assumptions with a saturated bank and rapid drawdown. Section B was analyzed. The critical slip surface is in the upper bench with a calculated factor of safety of 1.0. At a setback of 25 m, the factor of safety is 1.3. With a 3 m deep basement the factor of safety for the worst case assumptions increases to 1.4. With allowance for pile support, a slip surface 3 m below the basement, the factor of safety is 1.7. Inclusion of nominal pile resistance further increases the factor of safety to 1.8. (Pile support should only be considered for driven steel or bored cast-in-place concrete piles designed for the lateral resistance).

For the normal range of groundwater levels and regulated summer river levels the factor of safety is greater than 1.5 at the 25 m setback.

Shoreline riprap protection does not significantly increase the factor of safety, but is important to reduce toe erosion and is therefore recommended along with a nonwoven filter fabric to separate the riprap from the fine grained underlying soil.

Other measures that can be used to improve bank stability, if required, include the addition of a toe berm at the base of the slope into the river and the use of rockfill shear keys or rockfill columns to replace weak clay soils with higher strength rockfill at site specific locations to improve critical slip surfaces. There measures are not considered to be necessary at this site.

6.2 RECOMMENDATIONS

The recommended setback grade to the building or critical structures is 9:1 for a minimum factor of safety of 1.4 under near saturated groundwater and rapid drawdown to summer river level conditions. This is feasible with a 3 m deep basement and an approximately 25 m offset from the top of bank break line.

Shoreline riprap protects against river erosion and provides a minor, nominal increase in the factor of stability of the slope. A riprap blanket 0.6 m thick is recommended. The riprap blanket should extend at least 10 m upslope (subexcavated 0.6 m into existing soil) and 5 m downslope into the river (placed on the existing ground surface) from the winter river level.

6.3 RIP RAP AND NONWOVEN FILTER FABRIC SPECIFICATION

The recommended gradation for riprap is as follows:

Size (mm)	Percent Passing by Weight
450	100
350	50-80
300	30-50
200	0-20

Individual riprap pieces should be comprised of good quality rock such as white crystalline dolomite and not be susceptible to degradation. Riprap should be placed with compaction as possible to allow good densities, with an even interlocking surface infilling spaces between the larger riprap.

The recommended specifications for nonwoven filter fabric are as follows:

Test	ASTM Test Designation	Unit	Minimum Requirement
Weight	D5261	Oz/yd²	>8
Grab Tensile	D4632	Lbs	>180
Puncture Resistance	D4833	Lbs	>80
Trapezoidal Tear	D4533	Lbs	>50
Permittivity	D4491	1/sec	>1
UV Resistance	D4355	% strength	>70
Apparent Opening Size	D4751	mm	<0.21

Alternate riprap and nonwoven filter fabric materials may be approved.

6.4 COST ESTIMATE

Shoreline Riprap Protection costs are estimated as follows:

Subexcavation: 100 m length x 0.6 m cut x 10 m x $[redacted]/m³ =	$[redacted]
Riprap:100 m length x 0.6 m thick x 20 m x 2.08 tonnes/m³ x $[redacted]/tonnne =	[redacted]
Nonwoven filter fabric 1000 m² x $[redacted]/m² =	[redacted]
Site access and mob/demob	[redacted]
Subtotal	[redacted]
Engineering and tendering (25%)	[redacted]
DFO submission	[redacted]
Contingency	[redacted]
TOTAL ESTIMATED COST (Excluding GST)	[redacted]

7.0 GENERAL FOUNDATION RECOMMENDATIONS

The site soil conditions are considered good in relation to the proposed development provided the riverbank remains stable. Conditions that can reduce stability and which should be mitigated as possible include:

- Toe erosion by river and ice.
- Surface erosion by water and gravity, assisted by loss of vegetative cover.
- Poor control of surface water runoff being directed towards the slope.
- Irrigation or addition of water to soil near slope.
- Underground water pipes near the slope.
- Net fills on top of bank.

As discussed in the slope stability Section 6.2, a 3 m deep basement is recommended to increase the effective setback distance (measured to the basement floor) to 9:1 and to prevent a net load increase at the top of slope. A basement is unnecessary for stability considerations where the setback already is 9:1. The basement floor elevation should be no more than 229 m and the Flood Protection River Elevation at the site is 230.5 m. The basement will be designed to handle seepage and potential flooding. The basement will also be protected by over 25 m of horizontal width of clay at the top of bank, and a weeping tile and sump system under and around the basement.

Piles driven to refusal in the till are recommended. Spread footings and floor slabs-on-grade are not recommended due to swelling potential and slope stability considerations.

Limited testhole information is available and possibly the top of bank area may have areas of uncontrolled fill. Uncontrolled fill is not a suitable bearing stratum.

The detailed design of dynamically loaded foundations is beyond the scope of this study. Unless noted otherwise, allowable foundation design parameters are for static loadings. Design for dynamic loads may be considered when the type and magnitude of loads are known.

7.1 DRIVEN PRECAST CONCRETE PILES

The allowable capacity of driven precast concrete piles subject to axial compressive loads may be determined from the following static equation:

$$Q = r_s.A_s.D + r_t.A_t$$

Where:

- Q = Allowable load on the pile (kN).
- r_s = Allowable skin friction between the pile and soil (kPa).
- A_s = Perimeter of pile section (m).
- D = Effective length of pile embedment (m) (i.e., total length in native undisturbed soil less allowance for frost, seasonal moisture variations and negative skin friction).
- r_t = Allowable end-bearing (kPa).
- A_t = Gross cross-sectional area of the pile tip (m).

Static design parameters for skin friction and end-bearing are as follows.

Depth Below Existing Grade (m)	Allowable Skin Friction (kPa)	Allowable End-Bearing (kPa)
3 to 13	15	0
Greater than 14 m (in till only below elevation 218 m)	50	250

Precast concrete piles designed on the basis of the above static design parameters should be driven to a minimum depth of 7 m.

In calculating allowable skin friction, the top 2 m below final ground level should be ignored.

When driven to effective refusal in the till, the following precast concrete pile capacities are recommended:

- 300 mm diameter 445 kN
- 360 mm diameter 625 kN
- 410 mm diameter 800 kN

Effective refusal may be taken to be:

Nominal Pile Size (mm)	Approximate Driving Energy (j)	(ft lbs)	Final Set Blows per 25 mm
300	37,000	27,500	15
	55,000	40,000	10
500	55,000	40,000	15

A minimum 200 mm void form should be used below grade beams or pile caps due to the high volume change potential of the lacustrine clay.

7.2 FROST PROTECTION

Frost protection requirements for footings and floor slabs are satisfied for the proposed 3 m deep basement. In areas without a basement, perimeter footings in heated structures should be extended to such depth as to provide a minimum soil cover of 1.6 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation. Interior footings within a heated structure should be provided with at least 0.6 m of soil cover to the top of the floor slab to ensure the design bearing pressure. Grade beams should be provided with the same soil cover as for footings. Grade beams that do not have adequate soil cover for frost protection should have a minimum of 150 mm void space on the underside of the grade beam to reduce the risk of interaction with the underlying soil.

Pipes buried with less than 2 m of soil cover should be protected with insulation to avoid freezing and damage. Rigid insulation placed under areas subject to vehicular wheel loadings should be provided with a minimum thickness of 600 mm of compacted granular base and/or pavement.

7.3 BASEMENT WALL PRESSURES

Basement walls should be designed to resist lateral earth pressures, in the at rest condition using the following expression:

$$P_o = K_o (\gamma H + q)$$

Where:

P_o = Lateral earth pressure at rest condition where no movements of walls occur at a given depth (kPa).

K_o = Coefficient of earth pressure at rest condition; use 0.5 for backfill material such as silts and clays, use 0.45 for sands and gravels.

γ = Bulk unit weight of soil for backfill; for silts and clays, use 19 kN/m, for sands and gravel, use 21.0 kN/m.

H = Depth below final grade (m).

q = Any surcharge pressure at ground level.

The above-noted expression assumes native material or backfill material compacted to approximately 95% of Standard Proctor maximum dry density and horizontal ground behind the basement wall. If the ground surface slopes upwards away from the wall, design wall pressures should be re-evaluated.

Backfill around basements should not begin until the concrete walls have reached a minimum two-thirds of its 28-day strength and first floor framing and basement floor slab are in place. Only hand operated compaction should be used within 600 mm of the concrete basement walls.

7.4 TEMPORARY SHORING

Vertical sided excavations in excess of 1.5 m depth should be supported by some form of shoring. The design and construction of temporary shoring is considered proprietary and the responsibility of the contractor.

Some form of underpinning may be required in conjunction with the shoring system in order to meet the above objectives. This will depend upon such factors as the nature of adjacent structures and the type of shoring system adopted. As a general rule, however, consideration should be given to the need for underpinning if a line drawn from the base of the excavation behind the shoring at an angle of 45° to the horizontal intercepts any below ground part of a structure behind the shoring. Potential movements of any structures within this zone should be monitored by surveying. Survey points should be established prior to construction.

Damage surveys of nearby structures should be carried out prior to excavation and include a photographic record of any existing damage.

7.5 CONSTRUCTION EXCAVATIONS

The composition and consistencies of the lacustrine clay and fill soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials

Construction excavations should be in accordance with good practice and comply with the requirements of the responsible regulatory agencies.

All excavations greater than 1.5 m deep should be sloped or shored for worker protection.

Shallow excavations up to about 3 m depth may use temporary sideslopes of 1:1. A flatter slope of 2:1 should be used if groundwater is encountered. Localized sloughing can be expected from these slopes.

Deep excavations or trenches may require temporary support if space limitations or economic considerations preclude the use of sloped excavations.

For excavations greater than 3 m depth, temporary support should be designed by a qualified geotechnical engineer. The design and proposed installation and construction procedures should be submitted to KGS Group for review.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down, at 45° from the horizontal from the base of foundations of adjacent structures intersects the extent of the proposed excavation, these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless the excavation support system has been designed to accommodate such surcharge.

7.6 CONSTRUCTION DEWATERING

Some seepage may be encountered in excavations during construction. A system of ditches leading to sumps equipped with pumps should be used to dewater excavations, if required.

7.7 PERMANENT DEWATERING

A weeping tile and sump system is recommended under and around the basement. Also, open drain ports should be incorporated in the exterior foundation wall and on the floor slab. In the event of severe flooding and water level rising to above slab elevation, these ports will allow the basement to flood and relieve hydrostatic pressures on the exterior walls.

7.8 STRUCTURAL SLABS

A structurally supported floor slab is recommended. There is a risk of movement of the ground beneath the slab relative to the slab. Utilities beneath structurally supported ground floor slabs should be protected from the effects of such differential movement by placing utilities within boxes suspended from the structural slab. A minimum 300 mm void form is recommended under structural slabs due to the high potential for swelling of the lacustrine clay soil.

7.9 SITE GRADING AND DRAINAGE

It is recommended that final site grading be provided to direct water to areas remote from the proposed structures. Minimum landscape gradients of 1.5% are recommended to reduce the risk of run-off ponding in localized areas. Within approximately 2 m of the exterior perimeter of any structure, the surface should be graded to drain away from the structures at a minimum gradient of 3%.

Roof drains should be positively directed away from buildings or, where possible, into the storm drain system. Roof drains should not be connected to weeping tile systems.

Surface water should not be directed to the slope face due to possible erosion and reduction of slope stability.

7.10 BACKFILL MATERIALS AND COMPACTION

General engineered fill and structural fill materials should comprise clean well-graded granular soils, or inorganic low plastic cohesive soils. Such material should be placed in compacted lifts not exceeding 200 mm and compacted to not less than 98% of standard Proctor maximum dry density, at a moisture content of between 0 to +3% of optimum. The upper 150 mm of pavement subgrades should be compacted to a minimum of 100% of standard Proctor maximum dry density.

Structural fill materials should comprise clean well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 100% of standard Proctor maximum dry density.

Landscape fill materials may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of standard Proctor maximum dry density.

Standard Proctor maximum dry density and optimum moisture content are defined in ASTM Test Method D698.

Backfill comprising cohesive soils or silt should be considered frost susceptible and should not be used in areas where it may become frozen and where frost heaving would be unacceptable.

Pit-run gravel should comprise 200 mm minus, well graded (GW), gravel with less than 5% passing the #200 seive.

7.11 PAVEMENTS

It is understood that trucks with axle loads up to 350 kN will be using the driveway, loading areas and the storage yard. The parking areas are for car and light truck usage. We recommend the following minimum pavement sections.

Material	Recommended Minimum Thickness (mm)		
	Parking Area for Light Vehicles	Driveway and Loading Area Heavy Truck Traffic	Storage Yard
Asphalt Mix "Type 1"*	—	100	-
Asphalt Mix "Type 1A"*	65	50	-
Base Course (25 mm Granular or Crushed Limestone)	75	75	100
Sub-base Course (Pit-Run Gravel)	150	300	500

* City of Winnipeg Standard Specifications

The subgrade should be graded to drain towards catch-basin locations.

All asphaltic concrete paving lifts should be compacted to a minimum of 97% of Marshall design density.

The above design is aimed at acceptable levels of deflection for a 15 year design life and is not for the purpose of mitigating frost heave potential in the subgrade soil.

7.12 GRAVEL ROADWAYS AND PARKING

The subgrade should be brought to required grades by scarifying and recompacting to a depth of not less than 150 mm below the surface. The subgrade should be graded to drain towards catch basin locations. The upper 150 mm of subgrade should be compacted to not less than 100% of maximum standard Proctor dry density. Proof-Rolling of the entire surface area under pavement sections should be carried out to detect any local soft spots. Soft spots detected should be excavated and backfilled with general engineered fill.

For heavy truck roadways and parking areas, a sub-base course not less than 0.3 m thick is recommended. The sub-base course should comprise a layer of "pit-run gravel" placed on top of the prepared subgrade.

The base course placed on the compacted sub-base should comprise not less than 0.3 m of compacted, granular or crushed limestone. This material should have a maximum particle size of 25 mm.

7.13 CONCRETE TYPE

In Winnipeg, the potential degree of sulphate attack on concrete may be considered to be severe. CAN/CSA-A23.1-M90 requires the use of Type 50 cement with a maximum water/cement ratio of 0.45 and a minimum 28-day compressive strength of 32 MPa for concrete with severe exposure to sulphates. Stricter recommendations may be required due to structural or other considerations. Should any imported fill be placed in contact with concrete, that fill should be tested for water soluble content and the above recommendations re-evaluated.

Air entrainment of 4 to 7% by volume is recommended for all concrete exposed to freezing temperatures, native soils, and/or groundwater.

8.0 REVIEW OF DESIGN AND CONSTRUCTION

KGS Group should be given the opportunity to review details of the design and specifications, related to geotechnical aspects of this project, prior to construction. Adequate monitoring during construction will be required. All construction should be carried out by a qualified contractor, experienced in foundation and earthworks construction. Adequate monitoring includes:

- Shallow foundations: Written approval of all bearing surfaces prior to concrete or mud slab placement.
- Deep foundations: Full-time monitoring and design review during construction.
- Earthworks: Full-time monitoring and compaction testing.

All such monitoring should be carried out by qualified persons, independent of the contractor. Failure to provide an adequate level of foundation monitoring may be in contravention of Building Code requirements.

KGS Group is a multi-discipline consulting engineering firm and can provide assistance for the design of any other aspects of this development, as required, including structural, mechanical, electrical and municipal engineering plus project management and site supervision.

9.0 LIMITATIONS

Geotechnical recommendations presented herein are based on findings in three testholes and previous available information. Foundation recommendations are preliminary only and will be revised following additional subsurface investigation within the building footprint, parking areas and roadways. Final 9:1 setback lines with and without the basement can be completed following an accurate topographic survey showing property lines. Periodic observations of the slope by qualified geotechnical personnel are recommended annually and/or after flooding.

If conditions other than those reported are noted, KGS Group should be given the opportunity to review current recommendations. The recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction, or if relevant building code requirements are not met. This report does not include any recommendations related to contaminants in soil or groundwater. Environmental issues are not included in this scope of work.

This report has been prepared for the exclusive use of the City of Winnipeg for specific application to the proposed firehall at 409 Mulvey Avenue. KGS Group makes no representations to any party with whom KGS Group has not entered into a contract. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either expressed or implied.

TABLES

FIGURES

24x36B

N

SHORELINE

TOP OF BANK

UPPER SLOPE

LOWER BENCH

EDGE OF RIVER

RIVER BOTTOM

TOE OF SLOPE

229 231 230 229 228 227 226 225 224 223 222 221 220 220

A 02

233

LIMITS OF ASPHALT

FENCE

PROPOSED NEW FIREHALL

GRAVEL AREA

LOADING DOCK

B 02.03

409 MULVEY

LOADING DOCK

PATH

VISIBLE BOULDER ARMOUR

TH1

TH3

TH2(P)

TH2(SI)

C 02

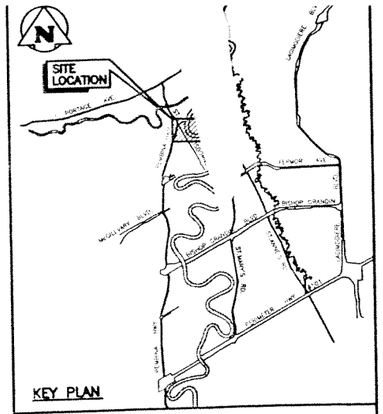
PROPERTY ACCESS

MULVEY AVE.

MH

RED RIVER FLOW

KGS FILE NO.: P:\Projects\2003\03-0107-06\Geo\Dwgs\Revision 0\03-0107-06-01rev0.dwg
24"x36" PLOT SCALE: 250



KEY PLAN

LEGEND:

- CATCH BASIN
- RSRL — REGULATED SUMMER RIVER LEVEL
- UWRL — UNREGULATED WINTER RIVER LEVEL
- 227 — GEODETIC CONTOUR (m)
- PROPERTY LIMIT
- TH1 — DRILL HOLE (KGS GROUP APRIL 2003)
- TH2(P) — PIEZOMETER
- TH2(SI) — INCLINOMETER

NOTES:

1. CONTOURS BASED ON 1999 DIGITAL-ORTHO MAPPING FROM 1998 AIRPHOTOS. RIVER SOUNDINGS AND RIVERBANK SURVEY BY KGS GROUP, APRIL 2003.

0 5 10 15 20 25m

SCALE: 1:250 METRIC 24"x36"
1:500 METRIC 11"x17"

NO.	D / M / Y	DESCRIPTION	BY
0	20/06/03	ISSUED WITH FINAL REPORT	

REVISIONS / ISSUE

A. SECTION LETTER OR DETAIL NUMBER
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
OR
DRAWING WHERE SECTION OR DETAIL WAS INDICATED
— SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP
CONSULTING ENGINEERS & PROJECT MANAGERS
WINNIPEG (204) 896-1209
THUNDER BAY (807) 345-2233

CLIENT: THE CITY OF WINNIPEG
PLANNING, PROPERTY AND DEVELOPMENT DEPARTMENT

PROJECT: RIVER BANK STABILITY ASSESSMENT
409 MULVEY AVENUE

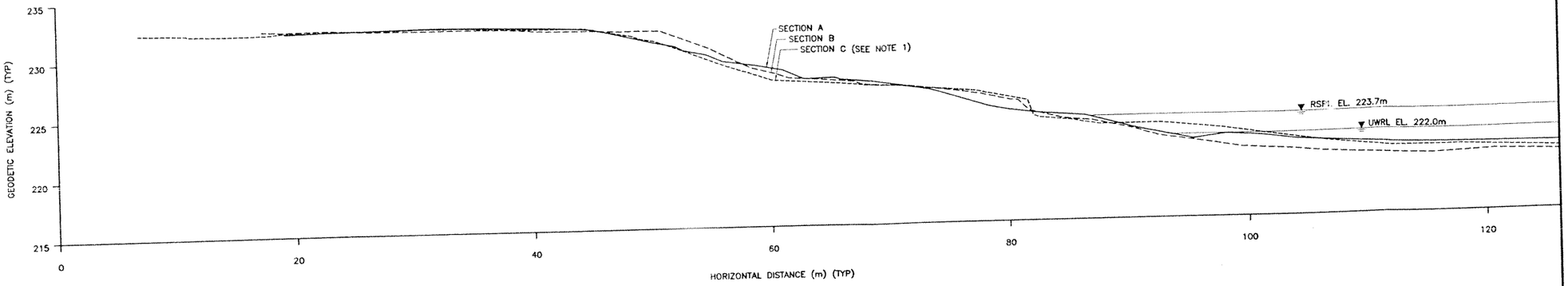
DWG. DESCRIPTION: SITE PLAN
409 MULVEY AVE.

ENG. STAMP

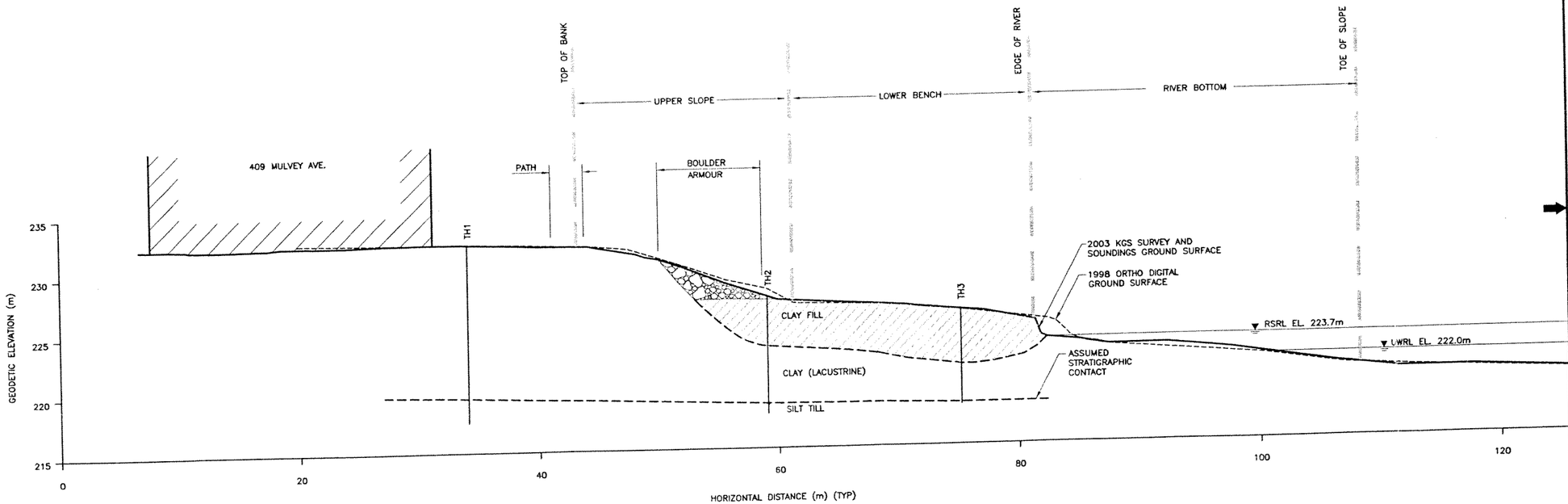
DESIGNED: JMc CHECKED: RKe
DRAWN: PD/PEC CHECKED:
APPROVED:
SCALE: AS NOTED
DATE: MAY 2003
KGS DWG. NO.: 03-0107-06 01
CLIENT DWG. NO.
REV: 0

FIGURE 1

24x36B



A / SK05 COMBINED SECTIONS A, B, AND C
SCALE: 1:400



C / SK05 SECTION
SCALE: 1:400

LEGEND:

- ——— SECTION A
- – – – – SECTION B
- ---------- SECTION C

NOTES:

1. GROUND SURFACE PROFILES BASED ON KGS GROUP BANK SURVEY AND RIVERBED SOUNDINGS, APRIL 2003.

NO.	D / M / Y	DESCRIPTION	BY
0	20/06/03	ISSUED WITH FINAL REPORT	

REVISIONS / ISSUE

A. SECTION LETTER OR DETAIL NUMBER
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
OR
DRAWING WHERE SECTION OR DETAIL WAS INDICATED
— SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP CONSULTING ENGINEERS & PROJECT MANAGERS
WINNIPEG (204) 896-1209
THUNDER BAY (807) 345-2233

CLIENT: THE CITY OF WINNIPEG
PLANNING, PROPERTY AND DEVELOPMENT DEPARTMENT

PROJECT:
RIVER BANK STABILITY ASSESSMENT
409 MULVEY AVENUE

DWG. DESCRIPTION:
SECTION A, B, AND C COMPARISONS AND STRATIGRAPHIC SECTION C

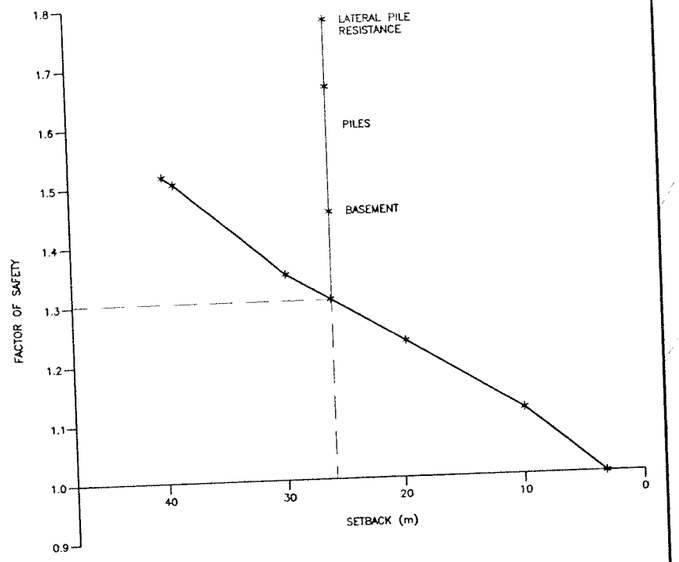
ENG. STAMP

DESIGNED: JMc BY: PEC
CHECKED: RKe CHECKED:
APPROVED:
SCALE: AS NOTED DATE: MAY 2003
KGS DWG. NO: 03-0107-06 02
CLIENT DWG. NO. REV: 0

FIGURE 2

GS FILE NO.: P:\Projects\2003\03-0107-06\Geo\Dwgs\Revision 0\03-0107-02rev0.dwg
4'x36'/PLOT SCALE: 200

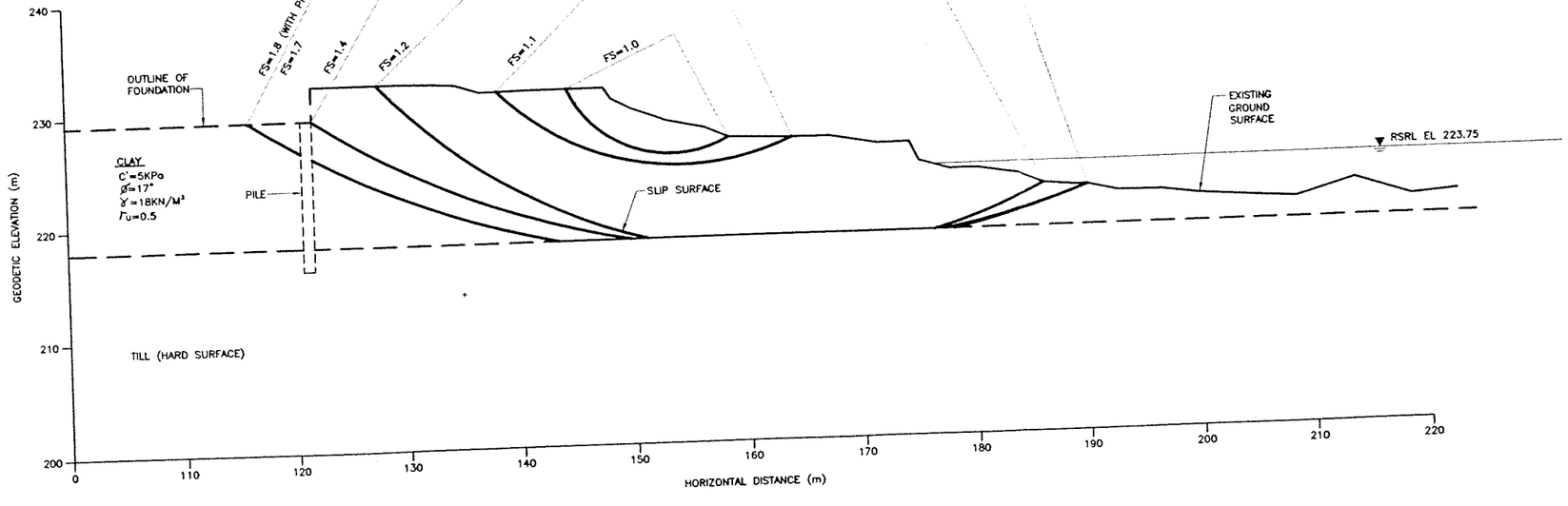
24x36B



NOTES:

1. WORST ANTICIPATED GROUNDWATI... BY r_u=0.5, (RAPID DRAWDOWN ...

...TIONS APPROXIMATED



B/01 SECTION

0 5 10 15 20 25m

SCALE: 1:250 METRIC 24"x36"
1:500 METRIC 11"x17"

NO.	D / M / Y	DESCRIPTION	BY
0	20/06/03	ISSUED WITH FINAL REPORT	

REVISIONS / ISSUE

A. SECTION LETTER OR DETAIL NUMBER
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
OR
DRAWING WHERE SECTION OR DETAIL WAS INDICATED
— SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP CONSULTING ENGINEERS & PROJECT MANAGERS
WINNIPEG (204) 896-1209
THUNDER BAY (807) 345-2333

CLIENT: THE CITY OF WINNIPEG
PLANNING, PROPERTY AND DEVELOPMENT DEPARTMENT

PROJECT:
RIVER BANK STABILITY ASSESSMENT
409 MULVEY AVENUE

DWG. DESCRIPTION:
SLOPE STABILITY ANALYSIS RESULTS

ENG. STAMP

DESIGNED BY: JMc CHECKED: RKe
DRAWN BY: PEC CHECKED:
APPROVED:
SCALE: AS NOTED
DATE: JUNE 2003
KGS DWG. NO.: 03-0107-06 03
CLIENT DWG. NO.:
REV. 0

FIGURE 3

FILE NO.: P:\Projects\2003\03-0107-06\Geo\Dwgs\Revision 0\03-0107-06-03rev0.dwg
24x36"/PLOT SCALE: 250

APPENDICES

APPENDIX A

TESTHOLE LOGS

KGS GROUP

LEGEND FOR SUMMARY LOG

CLIENT CITY OF WINNIPEG

PROJECT 409 MULVEY AVENUE

LOCATION 409 MULVEY AVENUE, WINNIPEG

JOB NO. 03-107-06

DATE DRILLED 28/04/03

GRAPHICS	DESCRIPTION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	Cu from Unconfined Comp. Test (kPa) ◇ / Cu TORVANE (kPa) ◆ PL MC LL % - kPa 20 40 60 80
	SOIL DESCRIPTION					
	CLAY FILL					
	GRAVEL FILL					
	ORGANIC CLAY					
	LACUSTRINE CLAY					
	SILT					
	TOPSOIL					
	PIEZOMETER AND INCLINOMETER LOG					
	One slope inclinometer PVC pipe and two pneumatic piezometer PVC pipes surrounded by auger cuttings.					
	One slope inclinometer PVC pipe surrounded with bentonite chips and two pneumatic piezometer PVC pipes surrounded by auger cuttings.					
	One slope inclinometer PVC pipe surrounded with sand and two pneumatic piezometer PVC pipes surrounded by auger cuttings.					
	One slope inclinometer PVC pipe surrounded with sand and two pneumatic piezometer PVC pipes surrounded by bentonite chips.					
	One slope inclinometer PVC pipe and two pneumatic piezometer PVC pipes surrounded with sand.					
	One slope inclinometer PVC pipe surrounded by bentonite and one pneumatic piezometer PVC pipe surrounded by sand.					
	One slope inclinometer PVC pipe and one pneumatic piezometer PVC pipe surrounded by sand.					
	One slope inclinometer PVC pipe surrounded by sand.					

SAMPLE TYPE AUGER GRAB SHELBY SPLIT SPOON SPLIT BARREL

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR J. MCKAY

APPROVED _____ DATE 17/06/03

KGS GROUP

SUMMARY LOG

HOLE NO. **TH1**

CLIENT CITY OF WINNIPEG

PROJECT 409 MULVEY AVENUE

SITE 409 MULVEY AVENUE, WINNIPEG

LOCATION Top of Bank, 2.4 m from the building

DRILLING METHOD 125 mm dia. Solid Stem Auger, ACKER SS Drill Rig

JOB NO. **03-107-06**

GROUND ELEV. **232.33 m, Geodetic**

WATER ELEV.

DATE DRILLED **28 Apr 03**

ELEVATION m	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ / CONE blows/0.15 m △ (10 20 30)	Cu from Uncon. Comp. Test (kPa) ◇ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
232.23				**GRAVEL FILL**					
232				**CLAY (TOPSOIL)** - Black, silty, organics.					
231.87				**CLAY (LACUSTRINE) (CH)** - Olive brown, moist, stiff, silty, some sand, medium plastic.					
231	1	5		- Olive grey, wet, highly plastic, trace sand below 0.61 m.		1			
230	2			- Sandy, low plastic from 2.13 to 2.29 m. - Approximately 1 mm horizontal bedding at 2.44 m.		2			
229	3	10		- Isolated rootlet, occasional vertical discontinuity, occasional thin white silt layers below 3.05 m.		3	100	▲10	
228	4					4			
227	5	15		- Firm and saturated below 4.57 m.		5	100	▲7	
226	6	20		- Horizontal to sub-horizontal bedding (less than 1 mm), laminated at 6.10 m.		6	100	▲8	
225	7	25		- Isolated rounded to platey gravel, less than 2.54 mm in size below 7.62 m.		7	100	▲6	
224	8					8	77	▲10	
223	9	30				9	100	▲5	
222	10	35				10	117	▲6	
221	11			- Trace angular gravel at 12.19 m.					
220	12	40							
219.53				**SAND AND SILT (TILL) (SM)** - Light grey, saturated, dense, sub rounded to angular, trace to some gravel, trace clay.					
219	13	45				11	56	▲14	
218	14			- Grain Size Distribution: 16.1% gravel, 37.5% sand, 37.4% silt, 9.0% clay at 14.33 m.					
217.39	15	50				12			
217				**AUGER REFUSAL @ 14.94 m**					
216	16	55		Note: 1. Placed one bag of bentonite chips, backfill with the cuttings. No installation.					

SAMPLE TYPE AUGER GRAB SPLIT SPOON

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR J. MCKAY

APPROVED GM DATE 20/06/03

KGS GROUP — **SUMMARY LOG** — HOLE NO. **TH2** — SHEET 1 of 1

CLIENT	CITY OF WINNIPEG
PROJECT	409 MULVEY AVENUE
SITE	409 MULVEY AVENUE, WINNIPEG
LOCATION	Lower Bench next to Upper Slope
DRILLING METHOD	125 mm dia. Solid Stem Auger, ACKER SS Drill Rig

JOB NO.	03-107-06
GROUND ELEV.	226.75 m, Geodetic
TOP OF PVC ELEV.	
WATER ELEV.	223.50 m
DATE DRILLED	28 Apr 03

ELEVATION m	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ / CONE blows/0.15 m △	Cu from Uncon. Comp. Test (kPa) ◇ / Cu TORVANE (kPa) ◆
226	1	5		**CLAY (FILL) (CL)** - Light brown, saturated, low plastic, firm, silty, sandy, trace organics.		0.9					
						1.2		13			
225	2			- Olive grey below 1.52 m.				14	50	▲9	
				- Occasional glass fragments at 2.13 m.							
224.31				TOPSOIL							
224.21				**CLAY (LACUSTRINE) (CH)** - Olive grey, saturated, high plastic, firm, trace sand, trace gravel.		2.7					
224	3	10		- SPT at 3.0 m: 3 blows for the first 150 mm, then refusal on possible wood.				15	100		
223	4	15						16	1.22	▲5	
222	5					5.2					
						5.5					
221	6	20				5.8					
						6.1		17	100	▲4	
220	7	25						18			
219	8							19	100	▲6	
218	9	30		**SILT (TILL) (ML)** - Light brown, saturated, stiff to very stiff, low to non-plastic, trace sand, trace angular gravel (+).		9.1					
217.76						9.3					
						9.6		20	50	▲29	
217	10	35		**AUGER REFUSAL @ 9.75 m**		9.8					
216	11			Notes: 1. Two holes drilled close together. Installed 2.75" slope indicator in the south hole. 2. Installed pneumatic piezometer and one standpipe with a Casagrande tip in the north hole. 3. Two lockable protective steel casings installed at ground surface. 4. Groundwater at 223.5 m in standpipe and 223.1 m in pneumatic on May 5, 2003.							
215	12	40									
214	13										
213		45									

Cu TORVANE (kPa) ◆: 20 40 60 80

PL MC LL

% : 20 40 60 80

SPT (N) blows/0.30 m ▲ / CONE blows/0.15 m △: 10 20 30

SAMPLE TYPE: AUGER GRAB ⊠ SPLIT SPOON

CONTRACTOR: Paddock Drilling Ltd. — INSPECTOR: J. MCKAY — APPROVED — DATE: 20/06/03

KGS GROUP — SUMMARY LOG

HOLE NO. **TH3** SHEET 1 of 1

CLIENT	CITY OF WINNIPEG
PROJECT	409 MULVEY AVENUE
SITE	409 MULVEY AVENUE, WINNIPEG
LOCATION	Lower Bench near Edge of River
DRILLING METHOD	125 mm dia. Solid Stem Auger, ACKER SS Drill Rig

JOB NO. 03-107-06
GROUND ELEV. 226.02 m, Geodetic
WATER ELEV.
DATE DRILLED 28 Apr 03

ELEVATION m (ft)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲ / CONE blows/0.15 m △ (10 20 30)	Cu from Uncon. Comp. Test (kPa) ◇ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
225	1	5		**CLAY (FILL) (CL)** - Wet, firm, low plastic, silty, some sand, trace organics, frequent glass fragments.					
224	2			- Saturated, high plastic, trace gravel, approximate 2 mm laminations visible below 1.83 m. - Organic layer from 2.44 to 2.59 m.					
223	3	10			⊠	21	67	▲6	
222	4			- Glass fragment at 3.96 m.	⊡	22			
221.45		15		**CLAY (LACUSTRINE) (CH)** - Olive grey, saturated, soft to firm, high plastic, silty, trace gravel (-), trace sand.	⊠	23	61	▲7	
221	5				⊡	24			
220	6	20			⊠	25	100	▲4	
219	7								
218.25		25			⊠	26	100	▲27	
218.10	8			**SILT (TILL) (ML)** - Grey, saturated, dense, low plastic, trace clay, trace sand, trace gravel (+).	⊡	27			
218				**AUGER REFUSAL @ 7.92 m**					
217	9	30		Note: 1. Backfilled with 1 bag of bentonite chips and cuttings. No installation.					
216	10								
215	11	35							
214	12								
213	13	40							
		45							

SAMPLE TYPE ⊠ SPLIT SPOON ⊡ AUGER GRAB

CONTRACTOR Paddock Drilling Ltd. INSPECTOR J. MCKAY

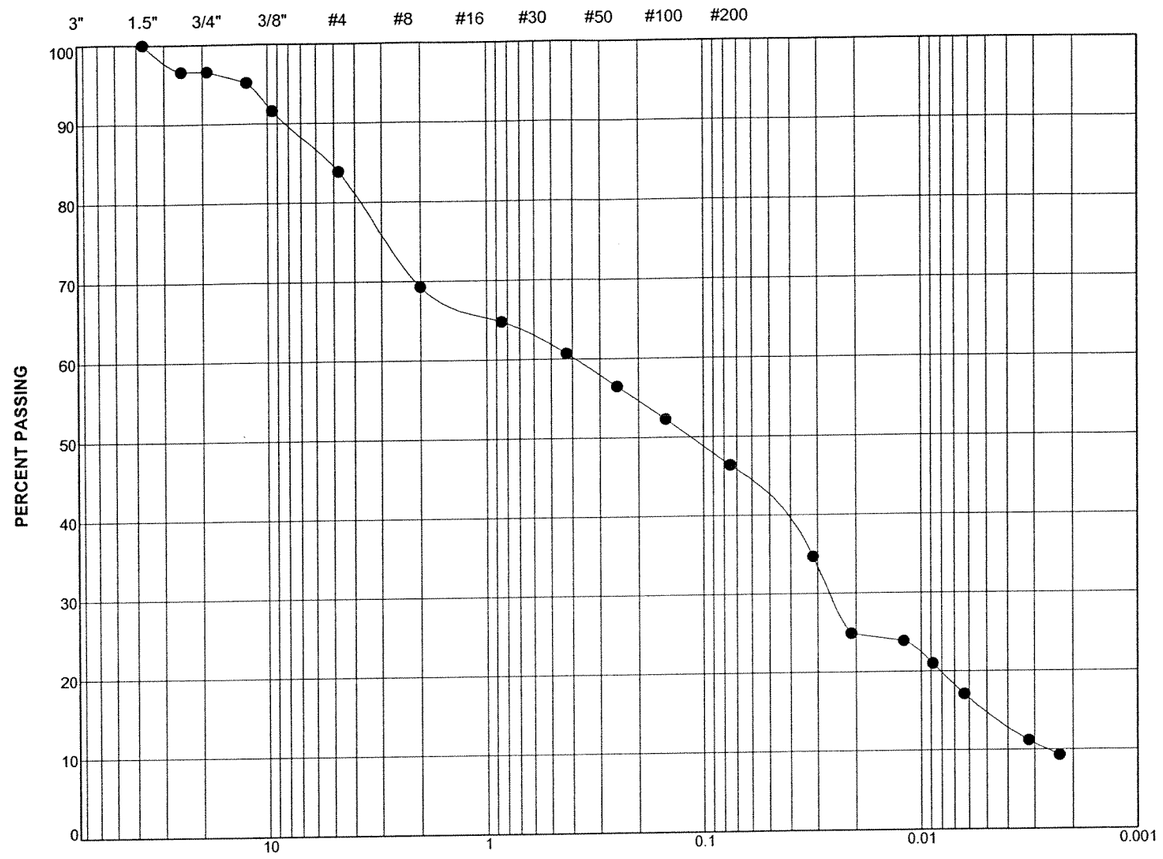
APPROVED [signature] DATE 20/06/03

PT_FT_M_CALC P:\PROJECTS\2003\03-0107-06\GEOLOGS\03-107-06 LOGS (SPT_FT_M_CALC).GPJ

APPENDIX B

LABORATORY TEST RESULTS

SIEVE ANALYSIS | HYDROMETER ANALYSIS



PARTICLE SIZE IN MILLIMETERS

GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*TH1*	*14.9*	*12*	*16.1*	*37.5*			*46.4*	*149.8*	*0.67*	*SM*

KGS GROUP

CITY OF WINNIPEG

409 MULVEY AVENUE

GRAIN SIZE ANALYSIS

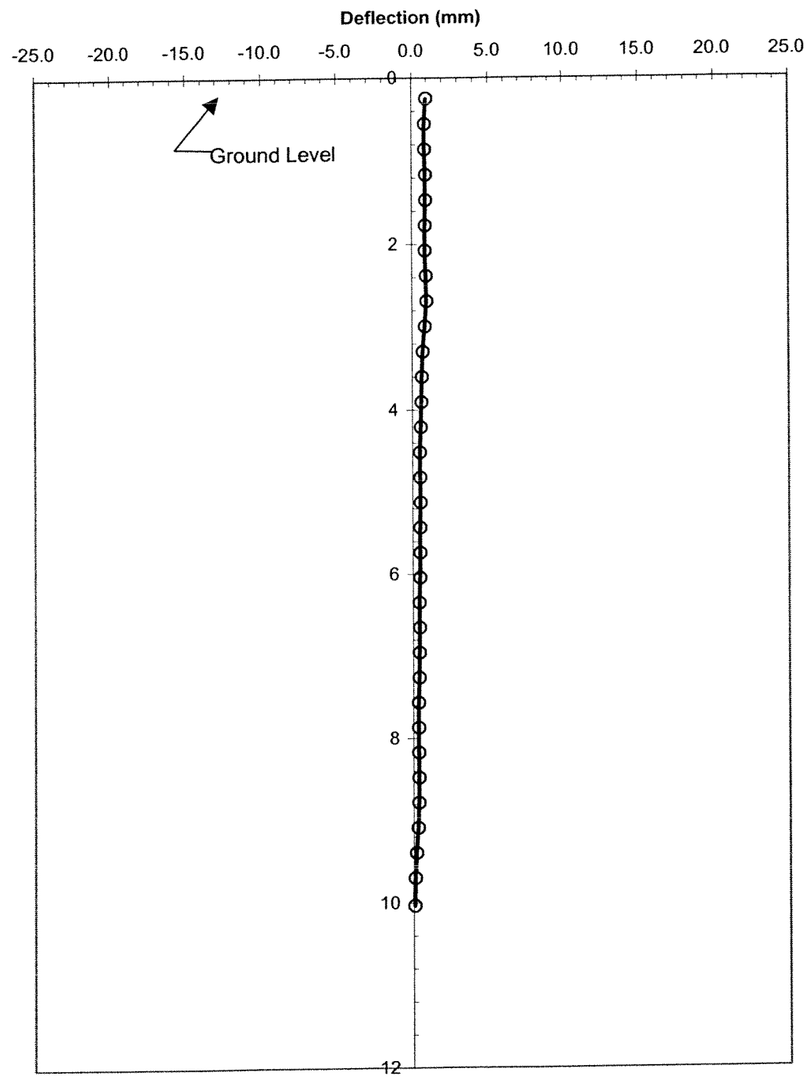
May 2003 | **FIGURE A-2**

APPENDIX C

SLOPE INDICATOR RESULTS

KGS GROUP

PROJECT NUMBER: 03-107-06
PROJECT DESCRIPTION: 409 Mulvey Ave.
SLOPE INDICATOR: BH2

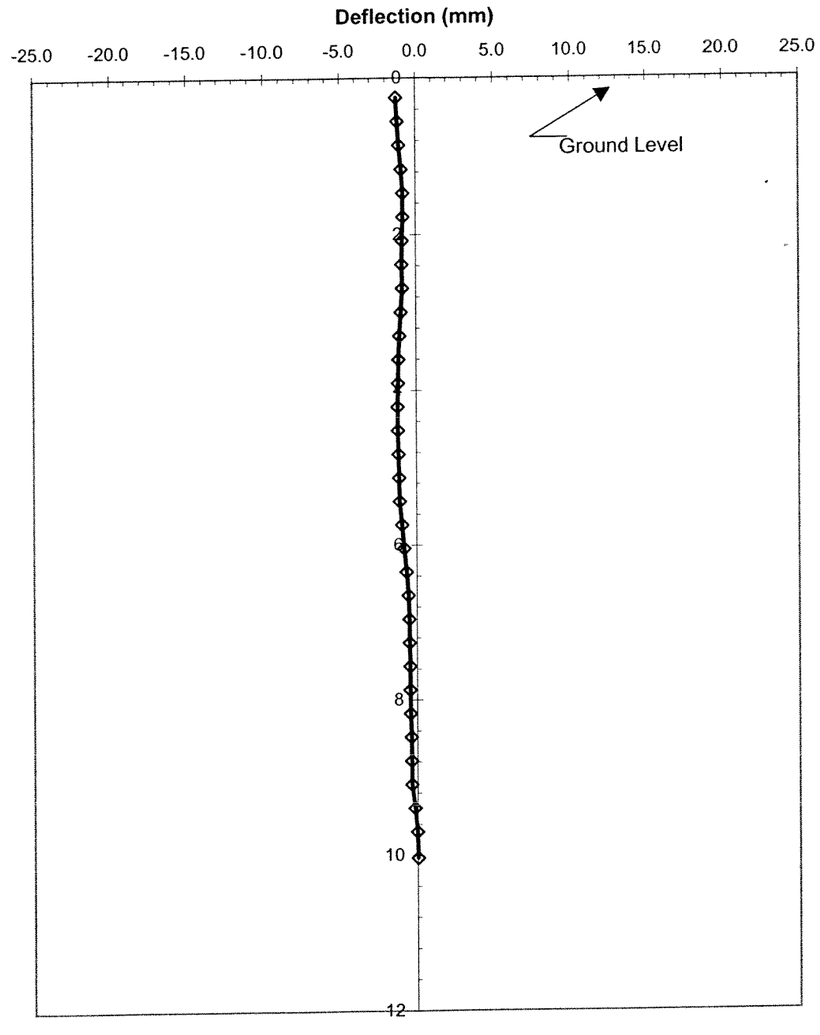


A-PLOT

22-MAY-03

KGS GROUP

PROJECT NUMBER: 03-107-06
PROJECT DESCRIPTION: 409 Mulvey Ave.
SLOPE INDICATOR: BH2

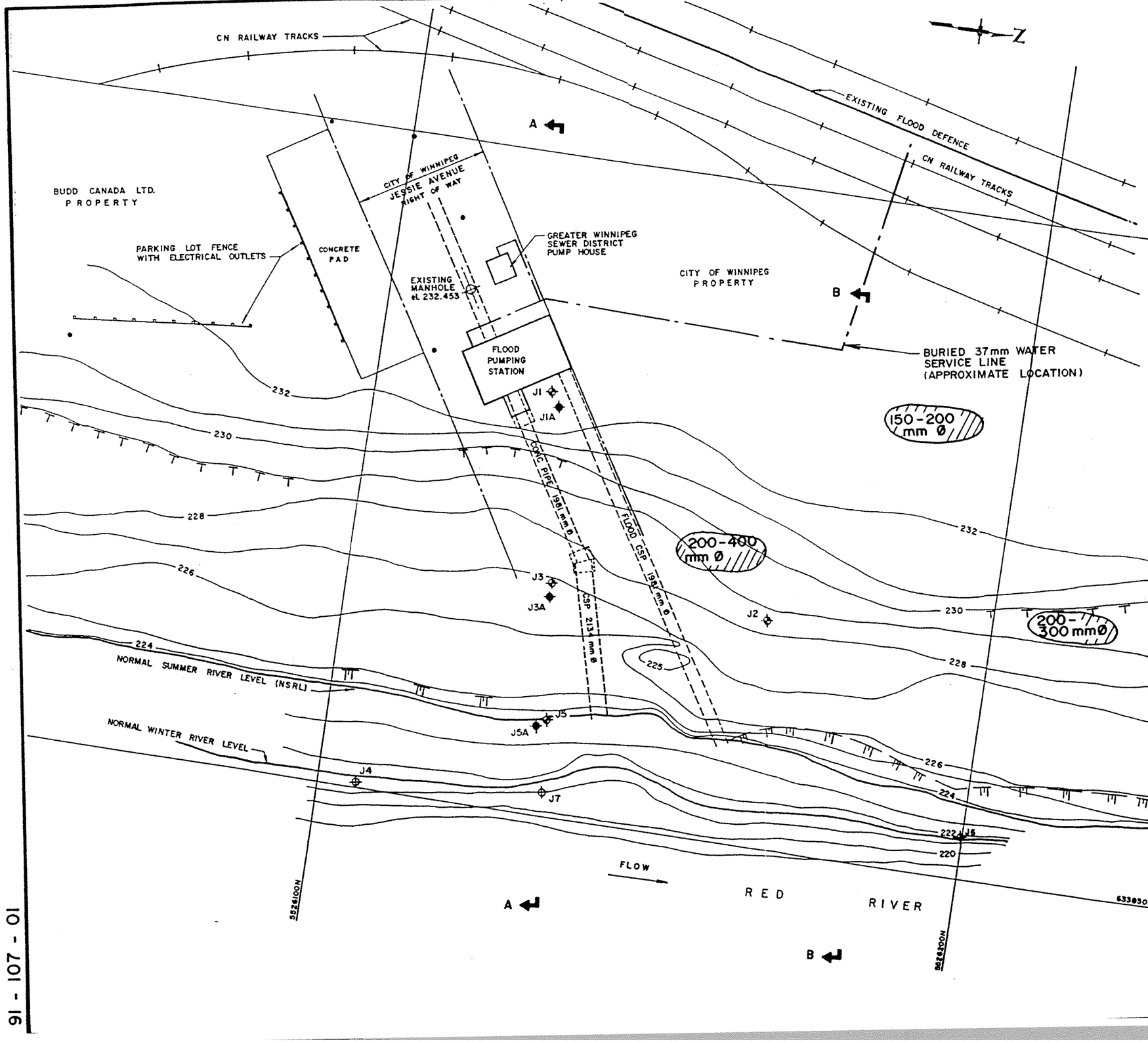


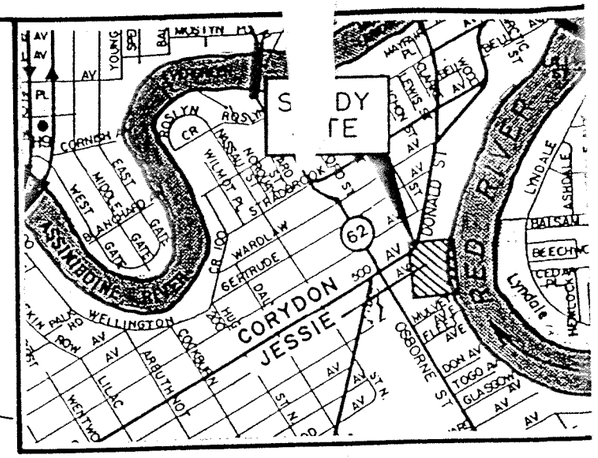
B-PLOT

22-MAY-03

APPENDIX D

PREVIOUS TESTHOLE LOGS AND SITE PLANS





LEGEND

- ACTIVE SLUMP
- INACTIVE SLUMP
- INCLINOMETER INSTALLATION
- PIEZOMETER INSTALLATION
- DRILL HOLES
- HYDRO POLES
- mm Ø — APPROXIMATE LARGE TREE CLUMP LOCATION WITH APPROXIMATE RANGE OF TRUNK DIAMETER

SCALE 1 : 600

0 5 10 20 30 40 50m

KGS GROUP

CITY OF WINNIPEG

JESSIE AVENUE PUMPING STATION

FUNCTIONAL DESIGN

SITE PLAN

OCTOBER 1991

FIGURE 1

91 - 107 - 01

KGS GROUP

SUMMARY LOG

HOLE NO. **J1**

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL	JOB NO.	90-107-01
PROJECT	RIVERBANK STABILIZATION	GROUND ELEV.	232.3
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION	ROCK SURFACE	218.4
LOCATION	APPROX. UTM COORD. N 5,526,127 E 633,786	WATER ELEV	224.2
DRILLING METHOD	200mm hollow stem auger	DATE DRILLED	90/2/22

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N
	0		**FILL** -dry -brown, black -silty -some organics -trace sand, trace clay -very low plastic -occasional partially decomposed wood chips				1		
229.9	2	CH	**BROWN SILTY CLAY** -stiff -moist -varved				2	100	
	3								
	4		-trace gypsum -fissured				3	25	
	5								
	6		-occasional silt pockets 1 to 5 mm diam.				4	100	
	7								
224.7	8	CH	**GREY SILTY CLAY** -stiff, firm below 9m -moist to very moist -trace fine gravel -Casagrande piezometer, J1-2 static level - dry (90/05/25)		7.9 8.5 8.8		5	100	

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮▮ CORE ▨ AUGER

CONTRACTOR PADDOCK DRILLING LTD

INSPECTOR B.G. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

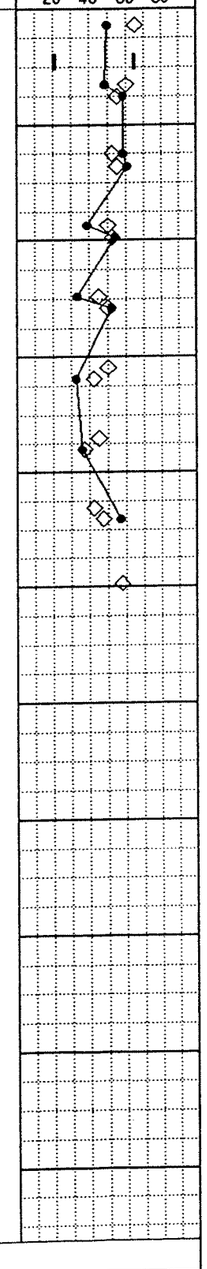
SUMMARY LOG

HOLE NO. **J1**

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	9		-firm below 9m -occasional silt pockets
	10		-clayey sand and silt pockets -trace gravel 25 to 50 mm diam.
221.7			-slickenside at 60 deg. to horizontal
221.4	11	CH	**MOTTLED GREY SILTY CLAY WITH BROWN SILT** -firm -very moist -trace sand and gravel -slickenside at 60 deg. to horizontal
220.4	12		
219.8		CH	**GREY SILTY CLAY** -firm -wet -trace sand and gravel -Pneumatic piezometer, J1-1 static level at el. 224.22 (90/05/25)
218.5	13		
218.4		ML TILL	**SANDY SILT TILL**
218.0	14		**AUGER REFUSAL** **BEDROCK** - dolomitic limestone - triconed 2 7/8 inch hole
	15		
	16		**INCLINOMETER** installed from elev. 233.1 to 218.0 m with lockable steel casing - 2.75 inch O.D. plastic casing c/w end caps and couplings at 10 ft c/c GROUT MIX: 45% water - 45% cement - 10% bentonite (from 14.3 to 13.7 m) 70% water - 20% cement - 10% bentonite (from 13.7 m to top of hole)
	17		
	18		
	19		

PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N
	9.1		6	100	
			7	100	
			8	100	
			9	100	
			10	100	
	12.2		11	100	
	13.1		12	25	
	13.2				
	13.4		13	75	
	14.3				

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80



SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮ CORE ▨ AUGER

CONTRACTOR RADDOCK DRILLING LTD.

INSPECTOR R.G. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. J2

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL
PROJECT	RIVERBANK STABILIZATION
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION
LOCATION	APPROX. UTM COORD. N 5,526,165 E 633,816
DRILLING METHOD	200mm hollow stem auger
JOB NO.	90-107-01
GROUND ELEV.	228.4
ROCK SURFACE	N/A
WATER ELEV	223.0 (J2-1)
DATE DRILLED	90/2/23

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N
	1		**FILL** -light brown -sandy, silty -trace clay -trace organics above 0.6 m				1		
	2						2		
226.1			CH **LIGHT BROWN SILTY CLAY** -stiff -moist -occasional roots and organics -silt pockets -sandy clay, some silt and gravel, trace gypsum				3	100	
225.0	3						4	83	
224.7			OL **ORGANIC SILT** -slightly moist -pockets of grey clay -some gravel						
	4		CH **LIGHT BROWN SILTY CLAY** -stiff -very moist -varved -highly slickensided, 0 to 30 deg. to horizontal -silt content decreases to trace		5.0		5	75	
223.9									
223.7									
223.6									
223.2	5						6	100	
222.7			-slickensided at 30 deg. to horizontal						
222.5									
222.4	6				6.1		7	100	
222.1			-Casagrande piezometer, J2-2 static level at el. 221.92 (90/05/25)		6.4				
221.9			-slickensides at 0 to 30 deg. to horizontal		6.7		8	100	
	7						9	100	
	8						10	100	
219.9									
219.8			ML -silt seam CH **GREY SILTY CLAY**				11	100	

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮ CORE ▨ AUGER

CONTRACTOR INSPECTOR APPROVED DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. J2

SHEET 2 of 2

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY (%)	N
	9		CH -firm -wet -occasional silty clay pockets 5mm to 100mm diam. -trace sand and gravel		9.1	12	100	
			-Pneumatic piezometer, J2-1 static level at el. 222.98 (90/05/25)		10.1	13	83	
218.2	10				10.2			
			ML TILL **SILT TILL** -hard -dry		10.3	14	100	
217.5			-some sand and gravel		10.9			
	11		**AUGER REFUSAL DRY HOLE**					
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮▯ CORE ▨ AUGER

CONTRACTOR INSPECTOR APPROVED DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. J3

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL
PROJECT	RIVERBANK STABILIZATION
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION
LOCATION	APPROX. UTM COORD. N 5,526,132 E 633,815
DRILLING METHOD	200mm hollow stem auger
JOB NO.	90-107-01
GROUND ELEV.	226.8
ROCK SURFACE	N/A
WATER ELEV	223.0
DATE DRILLED	90/2/23

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N	Cu ○ (kPa) TORVANE ◇ (kPa) PLASTIC MC LIQUID 20 40 60 80
	1		CH **BROWN SILTY CLAY** -firm -moist -trace organics				1			
	2		-dry				2	100		
223.8	3				3.1					
	4		CH **GREY SILTY CLAY** -very moist -Pneumatic piezometer, J3-2 static level at el. 222.91 (90/05/25)		4.0 4.1 4.6		3	100		
221.4	5		-moist -some silt pockets -slickenside at 45 deg.				4	100		
	6						5	100		
219.6	7		ML -silt seam, 5 cm thick				6	100		
219.6			-occasional sulphate pockets		7.6		7	100		
	8		-Pneumatic piezometer, J3-1 static level at el. 223.13 (90/05/25)		8.5		8	50		
218.4			ML TILL **SILT TILL**, some gravel, trace clay and sand -soft		8.6					

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮ CORE ▨ AUGER

CONTRACTOR BADROCK DRILLING LTD.

INSPECTOR R.C. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. **J3**

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY (%)	N	Cu ○ (kPa) TORVANE ◇ (kPa) PLASTIC MC LIQUID 20 40 60 80
	9		ML TILL -very moist						
216.9	10		**AUGER REFUSAL**		9.9				
	11		**INCLINOMETER** installed from elev. 227.7 to 216.9 m with lockable steel casing - 2.75 inch O.D. plastic casing c/w end caps and couplings at 10 ft c/c GROUT MIX: 45% water - 45% cement - 10% bentonite (from 9.9 to 8.8 m) 70% water - 20% cement - 10% bentonite (from 8.8 m to top of hole)						
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮▯ CORE ▨ AUGER

CONTRACTOR RADDOCK DRILLING LTD

INSPECTOR R.G. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. **J4**

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL
PROJECT	RIVERBANK STABILIZATION
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION
LOCATION	APPROX. UTM COORD. N 5,526,106 E 633,849
DRILLING METHOD	200mm hollow stem auger
JOB NO.	90-107-01
GROUND ELEV.	221.6
ROCK SURFACE	N/A
WATER ELEV	218.6
DATE DRILLED	90/2/27

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY (%)	N
220.1	1		**BROWN SILTY CLAY** -occasional silt pockets					
	2	CH	**GREY SILTY CLAY**, trace organics and sand -very moist			1	100	
			-small light brown silt pockets			2	100	
218.2	3		-wet -occasional roots			3	44	
217.8		ML TILL	**SILT TILL**, with gravel; angular -soft to firm			4	100	
	4		**AUGER REFUSAL**					
	5							
	6							
	7							
	8							

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▩ SPLIT SPOON ▨ SHELBY ▮▯ CORE ▩ AUGER

CONTRACTOR RADDOCK DRILLING LTD

INSPECTOR B.G. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. **J5**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL
PROJECT	RIVERBANK STABILIZATION
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION
LOCATION	APPROX. UTM COORD. N 5,526,134 E 633,836
DRILLING METHOD	200mm hollow stem auger
JOB NO.	90-107-01
GROUND ELEV.	223.5
ROCK SURFACE	217.9
WATER ELEV	223.4
DATE DRILLED	90/2/27

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N
			BROWN SILTY CLAY -occasional small silt pockets						
222.0	1						1	58	
	2	CH	**GREY SILTY CLAY**, trace mottled brown clay, trace silt, sand and gravel -soft -wet				2	92	
	3						3	100	
219.8			-slickensides at 30 deg. to horizontal				4	100	
219.3	4				4.1		5	100	
218.8			-slickensides at 30 to 45 deg. to horizontal				6	100	
	5		-Pneumatic piezometer, J5-1 static level at el. 223.35 (90/05/25)		5.3		7	100	
218.1		ML TILL	-some gravel ≤ 25mm diam.		5.4				
217.9	6		**LIGHT BROWN SILT TILL**						
			AUGER REFUSAL						
217.1			**BEDROCK** - Dolomitic limestone - Tricone 2 7/8 inch hole		6.4				
	7		**INCLINOMETER** installed from elev. 223.7 to 217.1 m with lockable steel casing - 2.75 inch O.D. plastic casing c/w end caps and couplings at 10 ft c/c GROUT MIX: 45% water - 45% cement - 10% bentonite (from 6.4 to 5.5 m) 70% water - 20% cement - 10% bentonite (from 5.5 m to top of hole)					
	8								

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮ CORE ▨ AUGER

CONTRACTOR RADROCK DRILLING LTD.
INSPECTOR R.C. Macdonald
APPROVED
DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. **J6**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL	JOB NO.	90-107-01
PROJECT	RIVERBANK STABILIZATION	GROUND ELEV.	221.6
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION	ROCK SURFACE	N/A
LOCATION	APPROX. UTM COORD. N 5,526,200 E 633,850	WATER ELEV	
DRILLING METHOD	200mm hollow stem auger	DATE DRILLED	90/2/28

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY (%)	N
			BROWN SILTY CLAY -occasional silt pockets						
220.1	1								
		CH	**GREY SILTY CLAY**, trace silt -firm -wet -occasional silt pockets				1	100	
219.2	2						2	100	
218.9		ML	**LIGHT GREY SILT**, some sand trace clay and gravel -loose -wet				3		
	3	CH					4	89	
218.3		SM	**GREY SILTY CLAY**, some sand and gravel -firm -wet				5	100	
	4		**MEDIUM BROWN SILTY SAND**, trace gravel -very loose -wet -cobbles at 4.3m -below 4.3m auger possibly in a sand filled fracture in bedrock -hole alignement bent towards the river				6	100	
	5						7	100	
	6								
	7		-auger stuck on cobbles or bedrock						
214.0			-auger abandonned						
	8		**END OF HOLE**						

Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

SAMPLE TYPE ▨ SPLIT SPOON ▨ SHELBY ▮▯ CORE ▨ AUGER

CONTRACTOR

INSPECTOR R.C. Macdonald

APPROVED

DATE 90/06/01

KGS GROUP

SUMMARY LOG

HOLE NO. J7

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG, WATERWORKS, WASTE AND DISPOSAL	JOB NO.	90-107-01
PROJECT	RIVERBANK STABILIZATION	GROUND ELEV.	221.6
SITE	JESSIE AVE WASTEWATER/FLOOD PUMPING STATION	ROCK SURFACE	N/A
LOCATION	APPROX. UTM COORD. N 5,526,134 E 633,847	WATER ELEV	221.5
DRILLING METHOD	125mm solid stem auger	DATE DRILLED	90/2/28

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION
	1	CH	**BROWN SILTY CLAY** -firm -moist
219.8	2	CH	**GREY SILTY CLAY**, trace sand -soft -wet -tan silt pockets -some sand and gravel
217.6	4		**AUGER REFUSAL**
	3, 5, 6, 7, 8		

PIEZ. LOG | DEPTH (m) | SAMPLE TYPE NUMBER | RECOVERY (%) | N

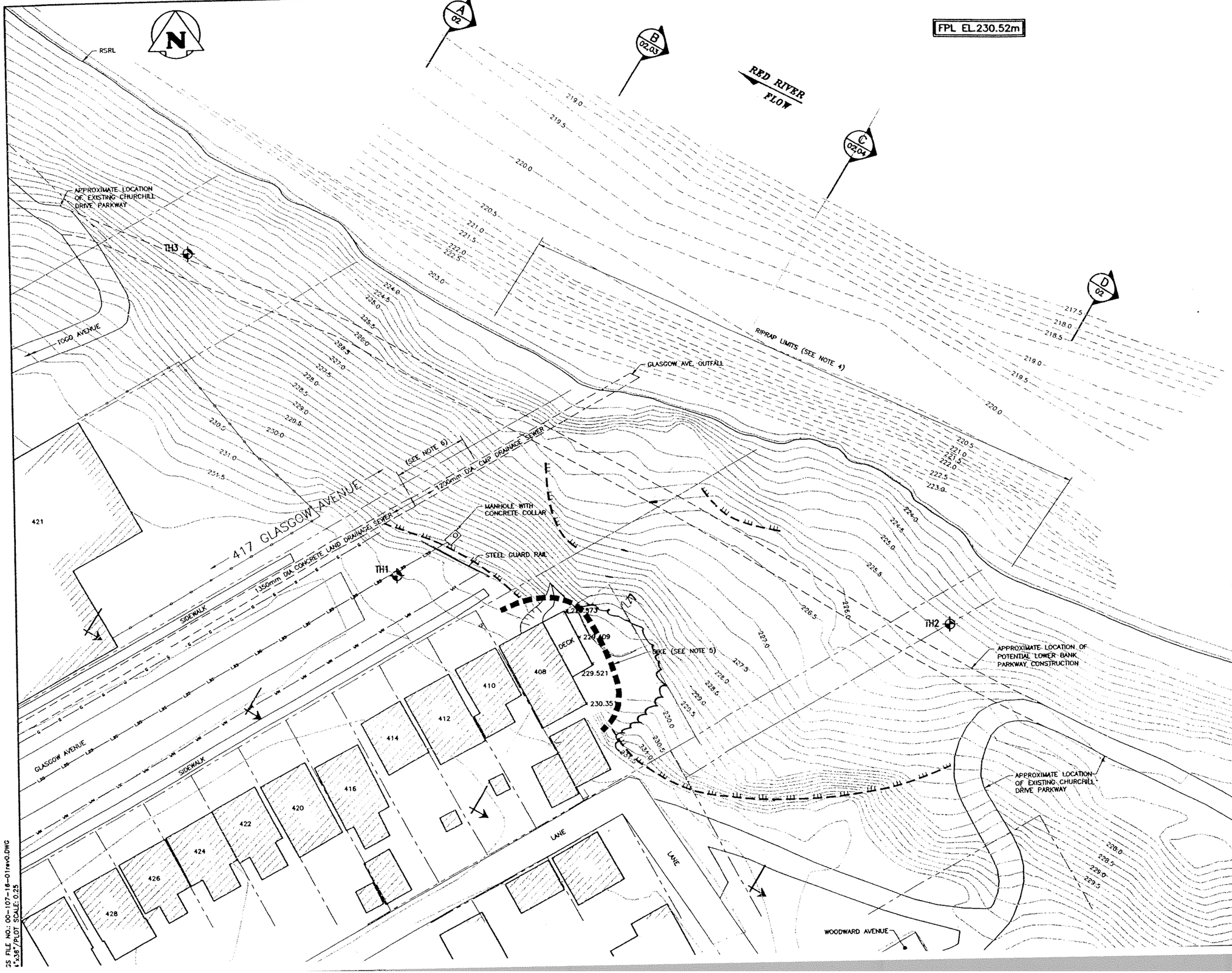
Cu ○ (kPa)
TORVANE ◇ (kPa)
PLASTIC MC LIQUID
20 40 60 80

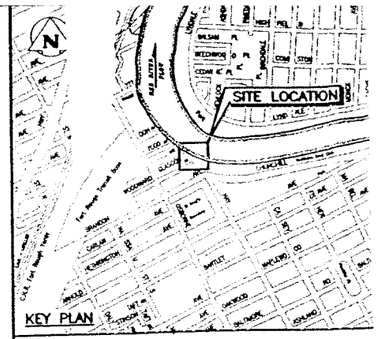
SAMPLE TYPE: SPLIT SPOON | SHELBY | CORE | AUGER

CONTRACTOR RADDOCK DRILLING LTD

INSPECTOR M. Gregoire

APPROVED _____ DATE 90/06/01





LEGEND

- PROPERTY LINE
- FENCE
- 224.0 GEODETIC CONTOURS (m)
- TH1 KGS GROUP TEST HOLE LOCATION (DEC 2000)
- RSRL REGULATED SUMMER RIVER LEVEL
- FPL FLOOD PROTECTION LEVEL
- × 229.860 SPOT ELEVATION (m, GEODETIC)
- —G— 100mm DIA. GAS LINE
- —SS— 300mm DIA. SEWER
- —WM— 150mm DIA. WATER MAIN
- POTENTIAL CONCRETE WALL DIKE
- APPROXIMATE LOCATION OF OBSERVED SLOPE MOVEMENTS FROM NOVEMBER 1986 SITE PHOTOGRAPH.

NOTES:

1. TOPOGRAPHIC CONTOURS ARE A COMPOSITE OF CITY OF WPG. 1999 DIGITAL-ORTHOBASE MAPPING SUPPLEMENTED BY KGS GROUP SURVEY, DECEMBER 21, 2000. RIVER BOTTOM SOUNDINGS COMPLETED BY KGS GROUP JANUARY, 2001.
2. TEST HOLE DRILLING PERFORMED BY KGS GROUP DECEMBER 2000.
3. APPROXIMATE LIMITS OF ROCKFILL RIPRAP PLACEMENT AND 6.0m EFFECTIVE WIDTH ROCKFILL SHEAR KEY TO MEET FLOOD PROOFING REQUIREMENTS AT 408 GLASGOW AVENUE.
4. APPROXIMATE LOCATION OF POTENTIAL CONCRETE WALL DIKE.
5. LIMITS OF 2001 OUTFALL INSPECTION WITHIN CMP PORTION OF PIPE.

0 5 10 15 20 25m

SCALE: 1:250 METRIC 24"x36"
1:500 METRIC 11"x17"

NO	D / M / Y	DESCRIPTION	BY
0	03/05/01	ISSUED WITH FINAL REPORT	RK

REVISIONS / ISSUE

A. SECTION LETTER OR DETAIL NUMBER
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
OR
DRAWING WHERE SECTION OR DETAIL WAS INDICATED
— SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP
CONSULTING ENGINEERS & PROJECT MANAGERS
WINNIPEG (204) 896-1209
THUNDER BAY (807) 345-2233

CLIENT: CITY OF WINNIPEG
PROPERTY AND DEVELOPMENT SERVICES DEPARTMENT

PROJECT: CHURCHILL DRIVE PATHWAY
RIVERBANK STABILITY ASSESSMENT

DWG. DESCRIPTION: EXISTING SITE PLAN AND APPROXIMATE LIMITS OF POTENTIAL WORKS

ENG. STAMP

DESIGNED BY: TC CHECKED: RK
DRAWN BY: A.M. CHECKED:
APPROVED: RK
SCALE: AS NOTED
DATE: JAN.30/2001
KGS DWG. NO. 00-107-16 01
CLIENT DWG. NO.
REV: 0

KGS FILE NO.: 00-107-16-01rev0.DWG
11"x17"/PLOT SCALE: 0.25

KGS GROUP

SUMMARY LOG

HOLE NO. **TH1**

CLIENT CITY OF WINNIPEG

PROJECT CHURCHILL DRIVE PARKWAY

SITE WOODWARD TO TOGO AVENUE

LOCATION Upper Bank Are, See Dwg. 00-107-16 01

DRILLING METHOD 200 mm dia. Hollow Stem Auger, RM30

JOB NO. 00-107-16

GROUND ELEV. 231.90 m, Geodetic

TOP OF PVC ELEV.

WATER ELEV.

DATE DRILLED 19/12/00

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE RECOVERY %
			SILTY CLAY FILL AND TOPSOIL - Black, damp, very stiff, low plasticity, with rootlets and organic matter, blocky structure.		1	100
			-partially frozen to 1 m depth			
			-some medium grained gravel at 0.3 m		2	30
			-poor sample recovery between 0.5 and 1.0 m			
230.89	1		SILT FILL - Tan, dry to damp, firm, non plastic, with fine grained sand, blocky structure to very poorly bedded, oxidation staining.		3	50
230.26			LACUSTRINE SILTY CLAY (CH) - Dark brown, moist, stiff, high plasticity, some silt, trace silt nodules (2-3 mm ø), blocky structure.		4	100
	2		-very stiff, clay swelling in tube between 2.03 and 2.54 m		5	100
			-dark brown to olive brown, poorly laminated with silt and clayey silt between 2.54 and 3.05 m		6	100
	3		-stiff between 2.54 and 4.06 m		7	100
			-10 cm thick layer of laminated silt and fine grained sand between 2.95 and 3.05 m			
			-trace oxidation staining, trace new root growth between 3.05 and 3.55 m		8	100
			-silt laminae at 3.15 and 3.3 m			
	4		-slickensided surface at 40° from horizontal at 3.16 m		9	100
			-clay swelling in tube between 3.55 and 4.06 m			
			-slickensided surface at 30° from horizontal at 3.86 m		10	100
			-firm to stiff between 4.06 and 7.11 m			
	5		-Grain Size Distribution: 20.5% silt, 79.5% clay at 4.3 m		11	100
			-silt nodule at 4.62 m			
			-frequent horizontal slickensides between 5.08 and 5.59 m		12	100
	6		-slickensided surfaces at 35-40° from horizontal at 5.21, 5.33 and 5.49 m		13	100
			-light brown between 6.1 and 7.11 m		14	100
			-wet, poorly laminated, trace fine grained gravel size carbonate drop stones, some silt nodules (2-3 mm ø) below 6.1 m			
	7		-drop stone at 6.9 m		15	100
			-dark grey between 7.11 and 9.75 m			
			-firm below 7.11 m		16	100
	8				17	100
					18	100
	9		-trace to some silt nodules (1-4 mm ø) between 9.15 and 9.75 m		19	100
			-dark grey to blue grey below 9.75 m			

Cu from Unconfined Comp. Test (kPa) ◇

Cu TORVANE (kPa) ◆

PL MC LL

% - kPa

20 40 60 80

>98 >98 >98

SAMPLE TYPE ▯ SPLIT BARREL ▨ SHELBY

CONTRACTOR Paddock Drilling Ltd

INSPECTOR J.D. MANN

APPROVED T.C. DATE 08/03/01

KGS GROUP

SUMMARY LOG

HOLE NO. **TH1**

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE RECOVERY %
	11		-trace coarse grained gravel size drop stones, and silt nodules below 10.26 m -coarse grained sand lamina at 10.57 m -angular carbonate rock 8 cm ø at 11.18 m -slickensided surface at 45° from horizontal at 11.43 m -Grain Size Distribution: 0.8% gravel, 10.2% sand, 30.9% silt, 58.1% clay at 12 m		20	60
	12				21	100
					22	100
					23	100
					24	100
					25	100
	13				26	100
218.70			CLAYEY SILT TILL - Tan, wet, soft, non plastic to low plasticity, structureless. -interbedded silty clay and clayey silt till, firm below 13.3 m		27	100
218.19						
218.04			SILT TILL		28	100
	14		AUGER REFUSAL ON BOULDER OR POSSIBLE ROCK @ 13.87 m Notes: 1. Test hole backfilled with auger cuttings at completion of drilling. 2. Water level observed at 7.0 m depth at the completion of drilling and may not be static.			
	15					
	16					
	17					
	18					
	19					
	20					
	21					

Cu from Unconfined Comp. Test (kPa) ◇
Cu TORVANE (kPa) ◆
PL MC LL
% - kPa
20 40 60 80

SAMPLE TYPE ▮ SPLIT BARREL ▨ SHELBY

CONTRACTOR INSPECTOR

KGS GROUP

SUMMARY LOG

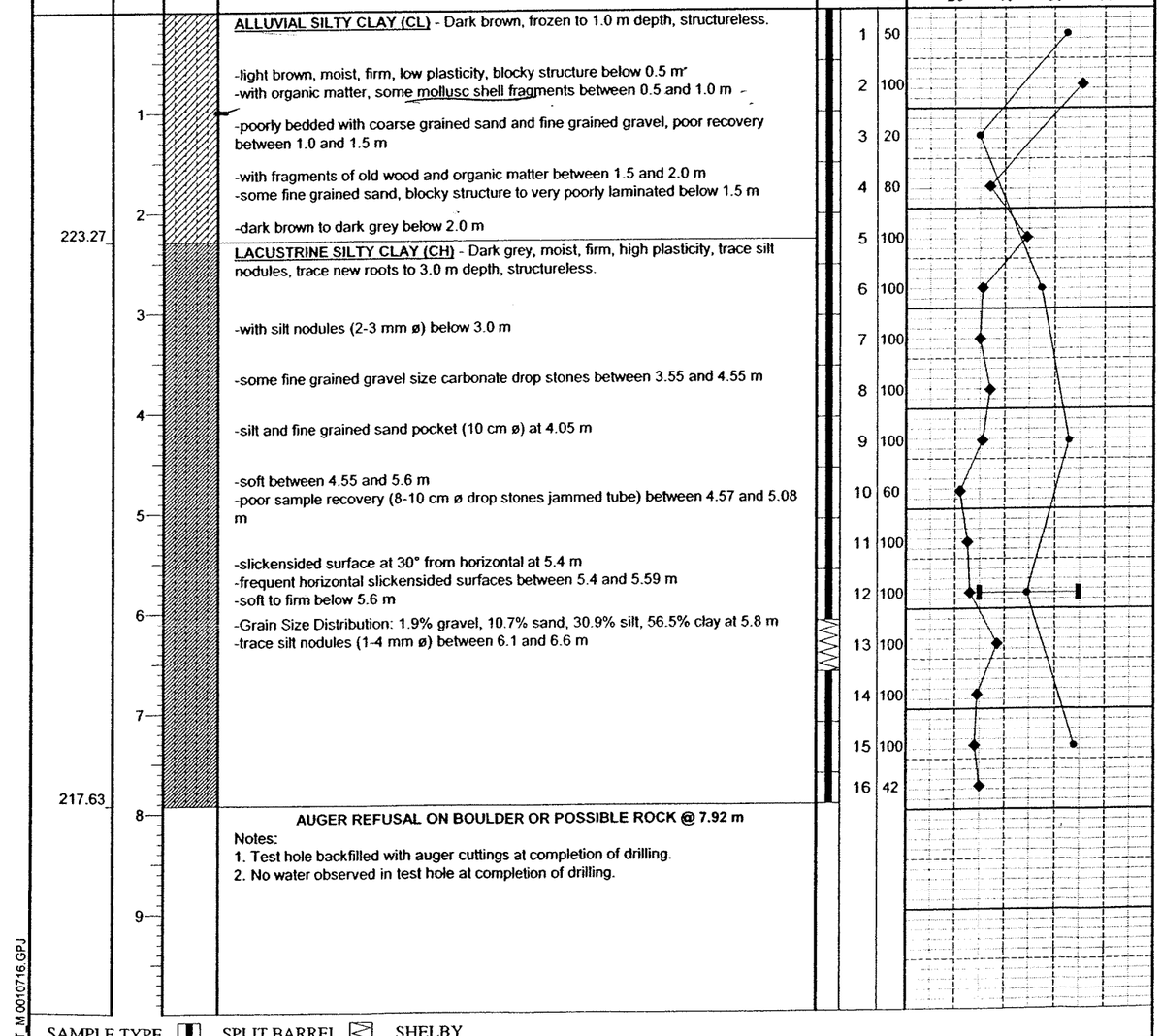
HOLE NO. **TH2**

CLIENT	CITY OF WINNIPEG
PROJECT	CHURCHILL DRIVE PARKWAY
SITE	WOODWARD TO TOGO AVENUE
LOCATION	Lower Bank Are, See Dwg. 00-107-16 01
DRILLING METHOD	200 mm dia. Hollow Stem Auger, RM30

JOB NO.	00-107-16
GROUND ELEV.	225.56 m, Geodetic
TOP OF PVC ELEV.	
WATER ELEV.	
DATE DRILLED	19/12/00

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE RECOVERY %
	0		ALLUVIAL SILTY CLAY (CL) - Dark brown, frozen to 1.0 m depth, structureless.		1	50
			-light brown, moist, firm, low plasticity, blocky structure below 0.5 m -with organic matter, some mollusc shell fragments between 0.5 and 1.0 m		2	100
	1		-poorly bedded with coarse grained sand and fine grained gravel, poor recovery between 1.0 and 1.5 m		3	20
			-with fragments of old wood and organic matter between 1.5 and 2.0 m -some fine grained sand, blocky structure to very poorly laminated below 1.5 m		4	80
	2		-dark brown to dark grey below 2.0 m		5	100
223.27			LACUSTRINE SILTY CLAY (CH) - Dark grey, moist, firm, high plasticity, trace silt nodules, trace new roots to 3.0 m depth, structureless.		6	100
	3		-with silt nodules (2-3 mm ø) below 3.0 m		7	100
			-some fine grained gravel size carbonate drop stones between 3.55 and 4.55 m		8	100
	4		-silt and fine grained sand pocket (10 cm ø) at 4.05 m		9	100
			-soft between 4.55 and 5.6 m -poor sample recovery (8-10 cm ø drop stones jammed tube) between 4.57 and 5.08 m		10	60
	5		-slickensided surface at 30° from horizontal at 5.4 m -frequent horizontal slickensided surfaces between 5.4 and 5.59 m -soft to firm below 5.6 m		11	100
	6		-Grain Size Distribution: 1.9% gravel, 10.7% sand, 30.9% silt, 56.5% clay at 5.8 m -trace silt nodules (1-4 mm ø) between 6.1 and 6.6 m		12	100
					13	100
	7				14	100
					15	100
217.63					16	42
	8		**AUGER REFUSAL ON BOULDER OR POSSIBLE ROCK @ 7.92 m**			
	9		Notes: 1. Test hole backfilled with auger cuttings at completion of drilling. 2. No water observed in test hole at completion of drilling.			

Cu from Unconfined Comp. Test (kPa) ◇
Cu TORVANE (kPa) ◆
PL MC LL
% - kPa
20 40 60 80



SAMPLE TYPE ▯ SPLIT BARREL ▨ SHELBY

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR J. D. MANN

APPROVED T.C. DATE 08/03/01

KGS GROUP

SUMMARY LOG

HOLE NO. **TH3**

SHEET 1 of 1

CLIENT: CITY OF WINNIPEG

PROJECT: CHURCHILL DRIVE PARKWAY

SITE: WOODWARD TO TOGO AVENUE

LOCATION: Lower Bank Are, See Dwg. 00-107-16 01

DRILLING METHOD: 200 mm dia. Hollow Stem Auger, RM30

JOB NO. 00-107-16

GROUND ELEV. 226.96 m, Geodetic

TOP OF PVC ELEV.

WATER ELEV.

DATE DRILLED 20/12/00

ELEV. (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE RECOVERY %
	1		SILTY CLAY FILL - Dark brown to black, hard, frozen, low plasticity, with coarse grained gravel, trace glass, some oxidation staining.		1	60
			-tube not loaded between 0.51 and 1.02 m			
			-only catcher loaded, slag and fill material, difficult drilling between 1.02 and 1.6 m			
5.36	2		LACUSTRINE SILTY CLAY (CH) - Dark grey to brown, moist, firm, high plasticity, trace new roots to 2.0 m depth, structureless.		2	40
			-moist to wet, trace silt nodules between 2.03 and 3.05 m		3	50
	3				4	12
			-brown, moist below 3.55 m			
			-trace silt nodules (1-3 mm ø) between 3.55 and 4.16 m		5	92
	4		-soft to firm between 4.16 and 5.18 m		6	100
	5		-some drop stones, with silt nodules below 5.18 m		7	100
			-firm between 5.18 and 7.21 m		8	100
	6		-Grain Size Distribution: 9.4% sand, 30.6% silt, 60% clay at 5.9 m		9	100
			-clayey silt till inclusion (10 cm thick) at 6.5 m		10	100
	7		-soft to firm below 7.21 m		11	100
					12	100
	8		-clayey silt till inclusion 15 cm thick at 8.33 m and 10 cm thick at 8.53 m		13	100
					14	100
7.97	9				15	100
7.82			SILT TILL			
			AUGER REFUSAL ON BOULDER @ 9.14 m			

Cu from Unconfined Comp. Test (kPa) ◇

Cu TORVANE (kPa) ◆

PL MC LL

% - kPa

20 40 60 80

Notes:
1. Test hole backfilled with auger cuttings at completion of drilling.
2. Water level observed at 3.0m depth at completion of drilling and may not be static.

SAMPLE TYPE ▮ SPLIT BARREL ▨ SHELBY

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR J.D. MANN

APPROVED T.C. DATE 08/03/01