

**Appendix B**  
**Hydrogeologic Assessment Report**

UMA Engineering Ltd.  
1479 Buffalo Place  
Winnipeg, Manitoba R3T 1L7  
T 204.284.0580 F 204.475.3646 www.uma.aecom.com

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The City of Winnipeg  
Water and Waste Department  
109 – 1199 Pacific Avenue  
Winnipeg, Manitoba  
R3E 3S8

**Attention: Mr. Chris Carroll, P. Eng.  
Project Engineer**

Dear Mr. Carroll:

**RE: Perimeter Road Pumping Station  
6821 Wilkes Avenue, Winnipeg, MB  
Hydrogeologic Assessment Report**

UMA Engineering Ltd. (UMA) is pleased to provide you with the following assessment of the potential to encounter adverse groundwater conditions during the construction of the proposed upgrades to the Perimeter Road Pumping Station (PRPS) at 6821 Wilkes Avenue (Drawing No. 01). Based on current design information, it is understood that excavations to a depth of 14 metres below grade are required at this site as part of the upgrades. Long term monitoring of groundwater levels at a provincial groundwater monitoring station located on Wilkes Avenue west of the Perimeter (Appendix A, Station G05MJ005) indicates that the piezometric pressure within the underlying bedrock aquifer is approximately 2.0 to 2.5 metres below grade. Due to the depth of the excavation, the preliminary assessment of the geologic and hydrogeologic conditions indicated that there was potential for seepage due to heaving of the base of the excavation, or movement of water along pre-existing pathways (fractures, permeable strata) into the excavation. The seepage typically occurs gradually over time but in some cases the failure of the soils can be sudden and can result in the influx of large volumes of groundwater. To address this concern, investigations were undertaken as outlined in this report.

## 1.0 BACKGROUND INFORMATION REVIEW

As part of the assessment of the potential to encounter adverse groundwater conditions during the construction of the proposed upgrades to the Perimeter Road Pumping Station, the available information on the geology and hydrogeology was reviewed. The information reviewed included:

- The Driller's Report for the existing on-site water well as documented in the GWDrill database maintained by the province (Appendix B);
- The updated hydrograph for Provincial Observation Well G05MJ005 located on the north side of Wilkes Avenue and approximately 300 metres west of the Perimeter Highway (Appendix A – Hydrograph, Appendix B – Drillers Report for well G05MJ005);
- The published information on the geology and hydrogeology of the area (Baracos, Shields and Kjartanson, 1983); and,
- Updated surficial geology (Matille, 2004) and bedrock geology (Bezys et al, 2002) maps.

The review of the Driller's Report for the on-site water well (dated May 14, 1964) indicates that the well was drilled subsequent to the construction of the PRPS and was drilled through the floor of the existing structure at a depth of 9.1 m. The stratigraphy underlying the floor was documented to consist of (in descending order): clay till to a depth of 12.5 m; followed by weathered/fractured limestone to a depth of 22.0 m; clay/shale to a depth of 30.2 m; and, limestone to the maximum depth of drilling of 39.0 m. Based on this Driller's Report, the proposed 14 m deep excavations would extend into the upper portion of the weathered/fractured limestone, and therefore into a potential aquifer.

The bedrock geology maps published by Bezys et al (2002) provide the most recent interpretation of the bedrock geology beneath the City of Winnipeg. The maps indicate that the site is underlain by an east-west trending channel eroded into the Ordovician Stony Mountain Formation and infilled by the Jurassic Amaranth Formation. The Amaranth Formation consists of argillaceous dolomitic siltstones and sandstones with occasional gypsum and anhydrite interbeds. In the immediate area of the site, the Stony Mountain Formation consists of interbedded mudstones, limestones and dolomites of the Gunn and Penitentiary Members. The depth to bedrock varies from 7.5 m below grade to the north of the PRPS site to 17.5 m below grade to the south.

The regional bedrock geology information published by Bezys et al (2002) indicates that the site is underlain by siltstones and sandstones rather than the weathered and fractured limestones reported in the 1964 Driller's Report. In order to resolve this apparent discrepancy, an exploration test hole was drilled as part of this program and a test well installed. The purpose of this work was to confirm if the site is underlain by siltstones and sandstones rather than the limestones indicated on the historic Driller's Report. An additional purpose of this work was to obtain preliminary information on the permeability of the siltstones, sandstones and limestones.

## **2.0 FIELD INVESTIGATIONS**

### **2.1 Geotechnical Test Hole Drilling**

As part of the geotechnical assessment for this site, three test holes (TH07-1 to 3) were drilled at the locations shown on Drawing No. 01 to confirm the overburden soil conditions. The test holes were drilled to a maximum depth of 22.1 metres using solid stem augers. Piezometers were installed in all three test holes with the screen portion located within the tills. Test hole logs and piezometer construction details are included in Appendix C. Two test holes were drilled to auger refusal at depths of 18.4 and 22.1 m. Drilling into the bedrock was not attempted as part of the geotechnical investigation.

Based on these test hole logs, the undisturbed soil profile consists of approximately 7 metres of silty clay, underlain by silt and clay till to the maximum depth of investigation. Proximate to the PRPS building, clay fill is present to a maximum depth of 19.5 m. The measured depth to water in these piezometers varied from 5.0 to 5.1 m below grade on June 5, 2007, approximately 6 weeks after the piezometers were installed. Note: At the time of all measurements, groundwater levels were being affected by groundwater pumping underway at the West End Water Pollution Control Centre (WEWPCC). Groundwater levels in the bedrock aquifer were being lowered by 2 to 3 m in association with this pumping. The measured groundwater levels as part of this investigation are therefore not considered representative of normal, non-pumping conditions. Higher groundwater levels will occur when pumping ceases at the WEWPCC.

## 2.2 Groundwater Test Well Construction

UMA Engineering Ltd. retained the services of Friesen Drilling Ltd. to complete the drilling of test hole TH07-4 to the west of the PRPS building (Drawing No. 01). The test well drilling was completed on June 5, 2007 under the supervision of UMA personnel. A Driller's Report outlining the final test well construction details is provided in Appendix B.

The test well construction consisted of the installation of a 150 mm steel casing to a depth of 23.9 m followed by the drilling of a nominal 150 mm open borehole to a maximum depth of 42.7 m below grade. The observed stratigraphy in this test well consisted of (in descending order): silty clay to a depth of 5.8 m; silt till to a depth of 21.9 m; Amaranth Formation siltstones and sandstones to a depth of 36.6 m; followed by dolomitic limestones to the maximum depth of drilling of 42.7 m. The dolomitic limestones were fractured below a depth of 38.1 m. The measured depth to water in this well upon completion of drilling was 7.5 m below grade. The measured water level in this well is considered representative of the groundwater pressure within the fractured limestone. The field measured chemistry of the groundwater from this well includes: electrical conductivity – 6,900 uS, total dissolved solids – 5,300 ppm, and pH – 8.2.

During the drilling of the test well, the ability of the bedrock formations to transmit water was tested by air-lift pumping. The first test was conducted with the open borehole advanced to a depth of 31.1 m to test the Amaranth Formation. It was found that the formation was only capable of transmitting 0.08 to 0.16 litres per second (lps, 1 to 2 lgpm) indicating that the permeability of the Amaranth Formation is low. A second air-lift pumping test was conducted with the open borehole drilled to 42.7 m. The well was capable of producing 0.16 to 0.30 lps (2 to 4 lgpm) at that depth with the majority of the water interpreted to be coming from the lower fractured limestones. Subsequent testing of the well capacity using a submersible pump confirmed that the well is only capable of producing 0.16 to 0.30 lps.

## 3.0 ASSESSMENT OF RESULTS

The investigations have confirmed that the following geologic and hydrogeologic conditions are present at this site:

- The upper portion of the soil profile consists of approximately 6 to 7 m of silty clay with no evidence of significant silt or sand layers noted. The clays are moist and do not appear to be capable of transmitting significant volumes of groundwater. The area around the PRPS structure appears to have been backfilled with silty clay that has been logged as being dry to moist. No evidence of significant seepage into the test holes was noted within the fill materials.
- The silty clays are underlain by silt to clay till which has been logged as being dry to moist. No layers of pervious sand or gravel appear to be present within the tills at this location. The standpipe piezometers installed within the tills did accumulate groundwater and therefore the tills are capable of producing some groundwater. The available information indicates that the permeability of the tills is low. The measured groundwater pressure within the tills is at approximately 5.0 to 5.1 m below grade.
- Bedrock beneath the PRPS site has been confirmed to be located at a depth of 21.9 m below grade, and the upper portion of the bedrock profile consists of low permeability Amaranth Formation siltstones and sandstones. Stony Mountain Formation limestones were encountered at a depth of 36.6 m, and are fractured below a depth of 38.1 m. The fractured limestones are capable of transmitting some groundwater (approximately 0.16 to 0.30 lps (2 to 4 lgpm)). The

measured groundwater pressure within the fractured limestones is 7.5 m below grade, however, this groundwater pressure is being artificially lowered by pumping at the WEWPCC.

Relative to the geotechnical assessment of the potential for base heave to occur, it is reasonable to assume that both the tills and Amaranth Formation siltstones and sandstones will act as aquitards restricting the upward movement of groundwater from the underlying limestones. No evidence of fractures or other permeable pathways have been found that would allow groundwater to move in significant volumes upwards from the limestones. Monitoring of the excavation during construction is recommended to confirm the conditions observed during this investigation. The monitoring should include the inspection of the soils for fractures and/or permeable pathways, and the monitoring for evidence of unusual seepage conditions.

Relative to the potential for seepage to occur laterally into the excavation from the adjoining silty clays or tills, no evidence has been found of the presence of any significant permeable layers or saturated zones within the overburden profile. Some seepage should be expected and standard construction dewatering equipment will be required.

#### 4.0 CONCLUSIONS AND RECOMMENDATIONS

The City of Winnipeg retained UMA Engineering Ltd. to complete the required exploration, testing and assessment of the groundwater conditions at the PRPS site located at 6821 Wilkes Avenue in Winnipeg, MB. Based on the results of this work program, the following conclusions are made:

- The geologic profile beneath the PRPS site consists (in descending order) of: 6 to 7 m of silty clay; silt and clay till to a depth of approximately 21.9 m; Amaranth Formation siltstones and sandstones to a depth of 36.6 m; and, Stony Mountain Formation limestones to the maximum depth of investigation of 42.7 metres. The limestones are fractured below a depth of 38.1 m.
- Significant pervious zones were not encountered in the overburden profile, nor within the tested bedrock profile. The siltstones, sandstones and limestones at the tested location were only capable of transmitting approximately 0.16 to 0.30 lps of groundwater, indicating that the bedrock transmissivity is low. The transmissivity of the bedrock will vary laterally with the degree of fracturing. The pumping test results from 1964 for the well located directly beneath the structure indicate that well was originally capable of sustaining a flow rate of 7.1 lps (94 l/gpm) but discussions with site personnel indicate that the well is no longer capable of sustaining that flow rate. The indicated transmissivity based on the 1964 pumping test is approximately  $1.7 \times 10^{-3} \text{ m}^2/\text{s}$  (12,000 USgpd/ft).
- The measured groundwater pressure within the bedrock is approximately 7.5 m below grade. However, groundwater pressures are being affected by pumping at the WEWPCC and will rise when pumping ceases. The groundwater pressure at the time of construction at the PRPS will need to be confirmed.

The following recommendations are made:

- Prior to the start of construction, remeasure the groundwater pressures at the site and obtain updated information on groundwater pressure trends from provincial observation well G05MJ005. Review the geotechnical assessment to confirm that any groundwater pressure changes have not adversely affected the assessment.
- During construction, the soil and water conditions in the excavation should be monitored by site personnel. Any significant variations (pervious soils, unusual seepage) from the conditions observed

during this investigation should be reported to project geotechnical and hydrogeologic personnel so that the significance of these variations on this assessment can be determined and corrective actions taken if required.

- Test well TH07-4 should be retained during construction for use if necessary to depressurize the limestone aquifer. The well should be abandoned upon completion of construction by a licensed well driller.
- Monitor excavation

We thank you for the opportunity to work on this project. Should you have any questions concerning this report, please contact Mr. Blair Moore, P.Eng. at (204) 284-0580.

Sincerely,

**UMA ENGINEERING LTD.**



Steve Wiecek, P.Ge., P.Eng.  
 Senior Geological Engineer  
 Earth & Environmental Division



SJW/dh

## REFERENCES

Baracos, A., Shields, D.H., Kjartanson, B. February 1983. Geological Engineering Report for Urban Development of Winnipeg. Winnipeg, Manitoba.

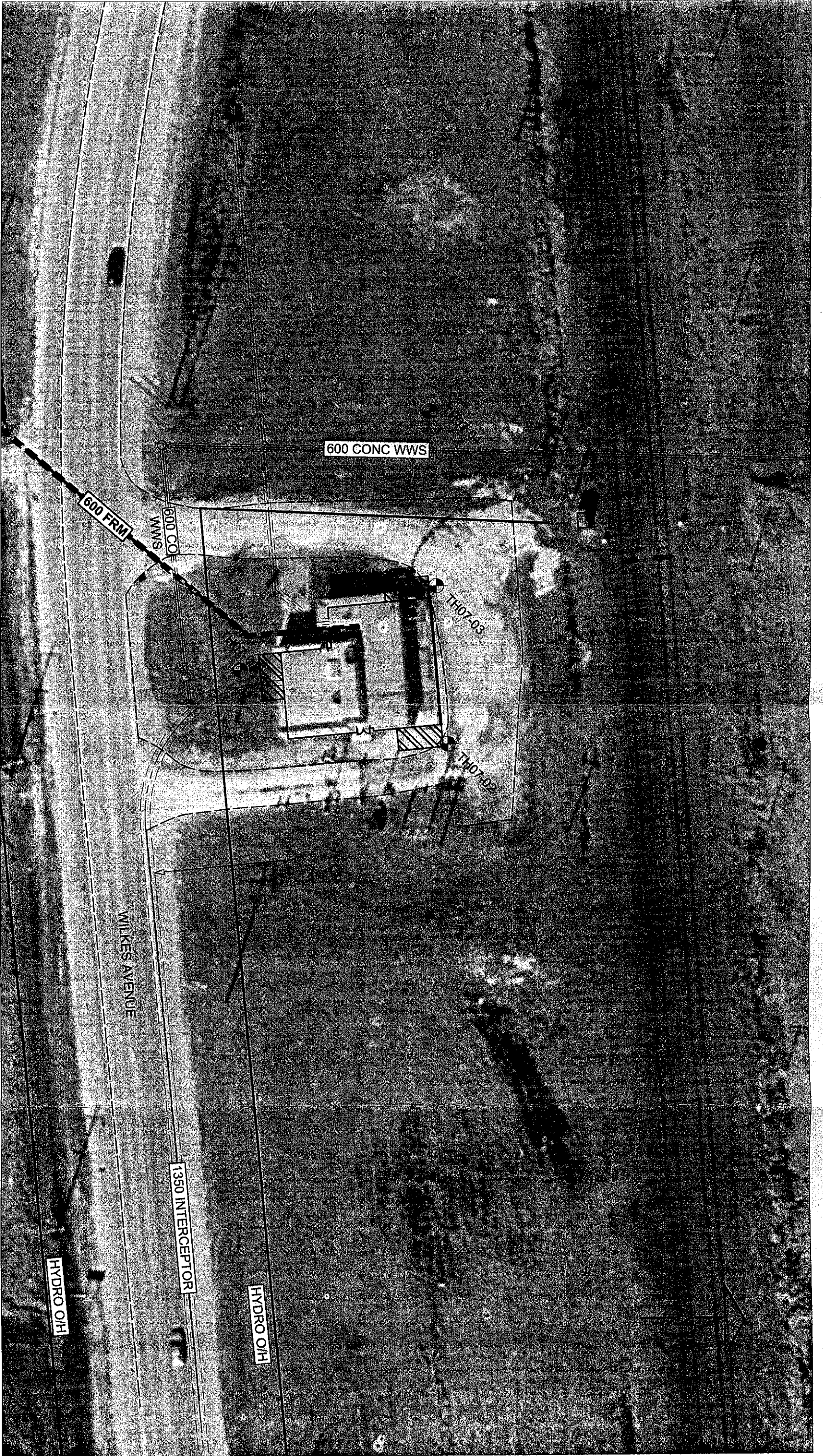
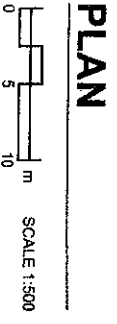
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Manitoba Conservation, 2003. GWDRILL Water Well Records, Water Branch Groundwater Management Section, Winnipeg, MB.

Matille, G. 2004. Surficial Geology, Steinbach, Manitoba, Geological Survey of Canada Map 2056A, Manitoba Geologic Survey Map 2003-8.

**DRAWING**



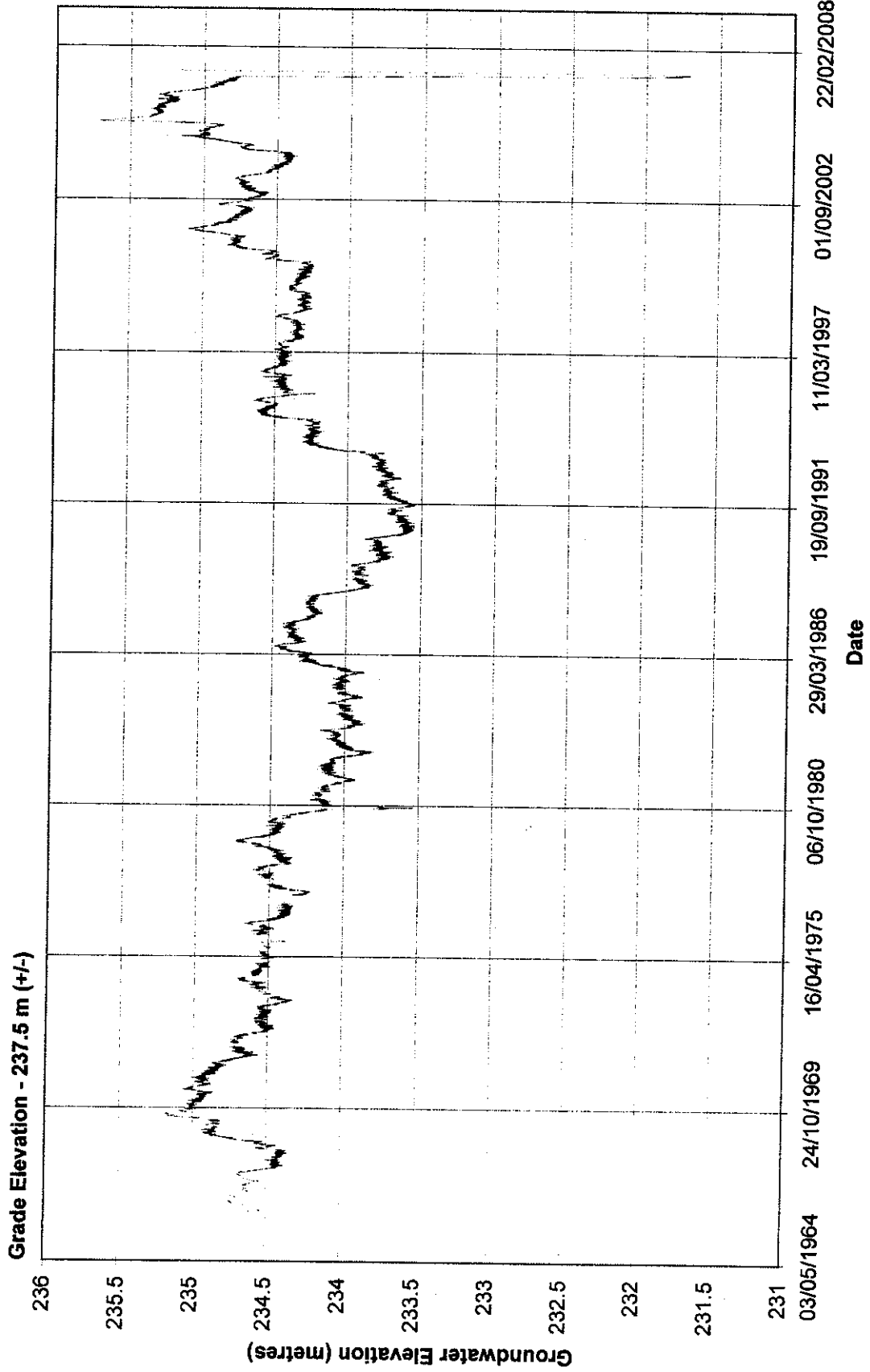


City of Winnipeg  
Perimeter Road Sewage Pumping Station Reliability  
PRPS Upgrades  
**Test Holes Location Plan**

Figure - 01

**APPENDIX A**  
**Provincial Observation Well Hydrograph**

**Groundwater Station G05MJ005  
Perimeter Highway And Wilkes Avenue**



**APPENDIX B**  
**Drillers Reports**  
**(Water Wells)**

WELL INFORMATION  
REPORTMANITOBA  
Manitoba Water Stewardship  
Water Branch

2005 Jul 14

LOCATION - RIVER LOT 70 IN PARISH OF St. Charles

Owner - CITY OF WINNIPEG

Driller - WAKSHINSKI, M.

Well Name -

Well Use - PRODUCTION

Well Status - UNKNOWN

Date Completed - 1964 May 14

Aquifer - LIMESTONE OR DOLOMITE

Top of Casing - 0.0 ft. above ground

## Remarks:

EAST JUNCTION OF PERIMETER HWY + WILKES AVE, GROUND LEVEL ELEV  
EST 780 FT*Perimeter Road Pumping Station*

## WELL LOG (Imperial units)

From	To (ft.)	Log
0.0	27.5	OLD 6 INCH PIPE
27.5	29.9	REINFORCED CONCRETE SLAB
29.9	30.3	CONCRETE
30.3	32.9	MEDIUM CLAY TILL
32.9	40.9	GREY CLAY TILL
40.9	45.3	WEATHERED LIMESTONE
45.3	72.3	FRACTURED LIMESTONE, CLAY IN CRACKS
72.3	99.2	RED CLAY, SHALE
99.2	127.8	LIMESTONE

## WELL CONSTRUCTION

From	To (ft)	Casing	Inside Outside Slot			Type	Material
			Dia. (in)	Dia. (in)	Size (in)		
0.0	49.3	casing	6.0				
49.3	69.0	perforations	5.0			SL. PIPE	
69.0	93.4	casing	5.0				
93.4	127.1	perforations	5.0			SL. PIPE	

## PUMPING TEST

Date : 1964 May 14                      Pumping 94.0 Imp. gallons/minute  
 Water level before test            : 4.0 ft below ground  
 Water level at end of test        : 22.0 ft below ground  
 Test duration: 7:00:00            Water temperature: degree(s) F  
 Test duration: 7:00:00            Water temperature: degree(s) F

## WATER USE

Industrial

WELL INFORMATION  
REPORT

MANITOBA  
Manitoba Water Stewardship  
Water Branch



2005 Jul 14

LOCATION - RIVER LOT 0072 IN PARISH OF St. Charles  
 Owner - WRB  
 Driller - PRUDEN DRILLING CO. LTD.  
 Well Name - G05MJ005 MO-4  
 Well Use - OBSERVATION  
 Date Completed - 1966 Feb 05                      Aquifer - SHALE  
 Top of Casing - 1.2 ft above ground

## Remarks:

175 FT N OF PR 427, .2 MI W OF HWY 101, SE OF GRAIN ELEVATOR  
 CHEMICAL ANALYSIS, GROUND LEVEL ELEV MEASURED 238.405 M

## WELL LOG (Imperial units)

From	To(ft.)	Log
0.0	13	CLAY
13.0	35	TILL
35.0	43	CARBONATE BEDROCK
43.0	56	SHALE

## WELL CONSTRUCTION

From	To(ft)	Casing	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0.0	35.0	casing	5.0				IRON
35.0	56.0	open hole	4.5				