M. Block & Associates Ltd.
Consulting Engineers
CSA CERTIFIED CONCRETE LABORATORY

· Geotechnical Investigations · Environmental Assessments · C.S.A. Certified Material Testing

November 8th, 2018

The City of Winnipeg
3rd Floor – 65 Garry Street
Winnipeg, Manitoba
R3C 4K4
Attention: Ms. Maria Petsa, EIT, M.Sc. (Eng.), PMP

Dear Madam:

RE: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED ONE-STOREY, STEEL-FRAME, 14,000 FT^2 BILL & HELEN NORRIE LIBRARY TO BE LOCATED AT 1301 GRANT AVENUE IN WINNIPEG, MANITOBA

1.0 TERMS OF REFERENCE

On October 17th, 2018, M. Block & Associates Ltd. (MBA) received e-mailed authorization from Mr. Peter Wertepny, P. Eng., representing Tower Engineering Group Limited Partnership, to proceed with the geotechnical investigation for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 1301 Grant Avenue in Winnipeg, Manitoba. Therefore, on October 30th, 2018, nine test holes in total were bored implementing a track-mounted Acker MP-5, using interconnected 5' long x 5" diameter continuous flight solid stem augers, supplied by Maple leaf Drilling Ltd. of Winnipeg, Manitoba. Representative “disturbed” soil samples were retrieved from the test holes and brought back to MBA’s CSA certified materials testing laboratory in Winnipeg for moisture content testing and verification of the field soil classifications. Alternatively, during the field investigation, the fine grained soils’ respective ‘disturbed’ undrained shear strengths were measured implementing a hand-held calibrated Pocket Geotester and torque shear vane. Upon the completion of this investigation, the test holes’ elevations and the groundwater elevations in them, if any, were measured and referenced to their respective surfaces and also the top of the fire hydrant situated immediately to the north of the subject property, as illustrated on pages 18 – 30 of this report. In addition, the test holes were completely backfilled with bentonite and the soil cuttings.

2.0 SOIL LITHOLOGY AND GROUNDWATER CONDITIONS

Test holes #1, #2, #3, #4, #5, #6, #7, #8 and #9 were covered with, approximately, 1'6", 1'6", 1', 2', 2', 2', 1'6", 6" and 1'6", respectively, of black/grey/brown, very stiff, damp, silty clay fill. Black, becoming grey and then brown in colour with increasing depth, alluvially deposited, very stiff, damp, silty clay was then traversed in test holes #1, #2, #3, #4, #5, #6, #7, #8 and #9 down to the 5'6", 5'6", 4', 4'6", 5'6", 5'6", 4'6", 6' and 5'6" depths, respectively. Next, brown, alluvially deposited, powdery dry to wet, silt was observed in, only, test holes #8 and #9 down to the 8' and 7' depths, respectively. Brown, becoming grey in colour below the 24' depth, glaciolacustrine, very stiff to firm, damp to moist, silty clay with silt and gypsum inclusions was then noted in test holes #4, #7, #8 and the shallow probe holes down to the 31', 32', 31' and 10' depths, respectively. Grey, soft, wet, sandy clayey silt with potential cobbles and boulders (glacial till) was next recorded in the deep test holes, #4, #7 and #8, down to the 33', 34' and 33' depths, respectively. Finally, brown, compact to very dense, practically non-plastic, gravelly sandy silt with cobbles and boulders (glacial till) that varied in stiffness and relative porosity from soft and saturated to hard and dry, respectively, was encountered in test holes #4, #7 and #8 down to the 51'6", 45' and 40'6" depths, respectively, where the auger refused on suspected fractured limestone bedrock (TH #4) or boulders. As such, the deep test holes were terminated at the aforementioned depths. Alternatively, the shallow probe holes were discontinued at the 10' depth. Upon penetrating the possible fractured limestone bedrock's aquifer, groundwater flowed into test hole #4 at a very high inflow rate. In addition, within ten minutes of obtaining auger refusal, the groundwater elevations in test hole #4 was measured 24' below its current ground elevation. Furthermore, it is anticipated that this phreatic surface could rise by an additional 14' during wet spring runoffs and/or heavy rainfall runoff events. As such, that contingency will be incorporated into the project's geotechnical designs presented in this report. The soil lithology in the test holes and their specific locations were appended to this report on pages 18 – 30.

3.0 SUMMARY OF FIELD AND LABORATORY TESTS

DEPTH	UNCONFINED COMPRESSION	MOISTURE CONTENT
10'	1921 psf	53.2 %
20'	1911 psf	58.0 %

The soils' measured torque shear vane strengths are located on the test holes' log sheets.
The soils' measured Pocket Geotester strengths are located on the test holes' log sheets.
Moisture content vs. Depth graphs are located on the test holes' log sheets.
A summary of the laboratory data is appended to this report on pages 34 – 36.

4.0 FOUNDATION DESIGN ALTERNATIVES

4.1 CONCRETE FOOTINGS AND SURFACE SLABS ON GRADE

Predicated upon the well-documented, volumetrically sensitive, glaciolacustrine silty clay deposition in the former Lake Agassiz that has caused significant structural distresses in typical below grade footings and surface slabs on grade in similarly constructed structures in the Red River Basin and the alluvial and upper glaciolacustrine depositions' very stiff unconfined compressive strengths, its estimated extremely high liquid limit and plasticity index, and/or "far below normal" moisture content on this site above or at the 9' depth, it is the writer's professional opinion that a concrete footing foundation system and a surface slab on grade, constructed on the glaciolacustrine soil above or at the 9' depth, is still extremely susceptible to significant soil swelling, shrinkage and/or rebound, and, as such, strongly not recommended as feasible foundation and/or surface floor support systems for this project.

However, one must question how relevant is the soil's current moisture content, porosity and swell potential, since these will obviously vary, possibly substantially, from the time the excavation is opened until the concrete main floor slab is placed. As such, it is the writer's professional opinion that, predicated upon the distinct possibility of the soil situated at the proposed surface slab on grade elevation drying out significantly, from the time it is excavated until it is concreted, and events beyond the writer's and consultants' control, the maximum soil swelling and rebound potential would be, approximately, 450 mm.

4.2 DRILLED CAST IN PLACE CONCRETE FRICTION PILES

Alternatively, drilled cast in place concrete friction piles could be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 1301 Grant Avenue in Winnipeg, Manitoba. Predicated upon the neutral plane of this pile type modeled near the 8' depth around the proposed structure and the risk of basal instability occurring in this foundation type below the 28' depth, the allowable effective functional friction length of glaciolacustrine silty clay at this site, **from the present grade of test hole #4**, is **28' – 8' = 20'.** The laboratory data indicates that the factored geotechnical resistance (FGR), using ultimate limit states (ULS) where $\Phi = 0.4$, of the soil/concrete interface from the 8' to 28' depths, only, is 385 psf (350 psf in the SLS analysis for 1" deflection). Based upon these calculations, a 16" diameter friction pile drilled 28' deep, properly constructed, would safely transfer, using ULS, 30 kips of load down to the underlying glaciolacustrine deposition. The concrete, relative to the soil, has an additional net weight of, approximately, 40 pcf in the upper 28' of overburden. Therefore, the additional net weight of the concrete is included in the above analysis. In addition, in order to avoid reducing the piles' net efficiency, they must be spaced at least three pile diameters, on center. Furthermore, in order to resist potential soil swelling and frost jacking uplift stresses, these piles shall have minimum embedment lengths of 25' and 28' in heated and unheated areas of the site, respectively. Finally, full-length reinforcing steel shall also be installed in all the piles implemented in an unheated service condition. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm.

It is recommended that the geotechnical engineer's personnel inspect the installation of this foundation type in order to verify that it conforms to the contents of this report, the structural drawings and project's specifications.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the overburden and, as such, may slough and seep significantly into some or several of the piles' drilled open excavations during wet seasons and/or years. Therefore, should that situation transpire, steel casing through that entire deposition would then be required. Since soil sloughing during concreting may cause improper foundation performance, special care must be given when removing the steel sleeve not to cause sloughing soil from entering a pile's excavation from in behind it. As such, the foundation contractor should be diligent when removing the steel sleeve not to cause sloughing soil from entering the pile's excavation from in behind it. In addition, the top 8' of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are its relatively fast rate of pile installation, frequency of being more economical than other piled foundation designs in this area, efficiency of installation in comparison with driven pre-cast concrete end-bearing piles, the many piling businesses located in the vicinity and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are the limited functional depth of serviceable clay and, as such, frictional pile capacity on this site, the extra cost, if any, associated with temporary steel sleeving, and pile settlement, if constructed improperly.

4.3 DRILLED SPREAD BORE CONCRETE END-BEARING PILES

Similarly, drilled, cast in place, spread bore concrete end-bearing piles could also be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 1301 Grant Avenue in Winnipeg, Manitoba. These piles shall only be mechanically constructed on the stiff glaciolacustrine silty clay 6 m below test hole #4's current elevation, where the FGR, using ULS where $\Phi = 0.4$, and the piling installation supervised by qualified geotechnical personnel, would be 125 kPa (125 kPa in the SLS analysis for 1" deflection). In addition, in order to avoid reducing the piles' net efficiency, they must be spaced at least two-and-a-half bell and three shaft diameters, on center, from each other.

In order to protect these short piles from frost jacking stresses in unheated applications, only, they shall have sono-tube casings installed along their upper 3.0 m of embedment length. Furthermore, the sono-tube shall be wrapped in 6 mil poly and completely greased on its inside. In addition, full-length reinforcing steel shall also be installed in all the piles implemented in an unheated service condition.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the overburden and, as such, may slough and seep significantly into some or several of the piles' drilled open excavations during wet seasons and/or years. Therefore, should that situation transpire, steel casing through that entire deposition would then be required. Since soil sloughing during concreting may cause improper foundation performance, special care must be given when removing the steel sleeve not to cause sloughing soil from entering a pile's excavation from in behind it. As such, the foundation contractor should be diligent when removing the steel sleeve not to cause sloughing soil from entering the pile's excavation from in behind it. In addition, the top 2.4 m of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are its anticipated relatively short pile embedment length, moderate allowable axial compressive, tensile and frost jacking resistances and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are its higher cost and longer foundation installation time per pile associated with mechanically constructing the bell and temporary steel sleeving, if any, and the potential for pile settlement, if incorrectly constructed. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm.

4.4 DRIVEN PRE-CAST CONCRETE END BEARING PILES

Finally, driven pre-cast concrete end-bearing piles could also be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 1301 Grant Avenue in Winnipeg, Manitoba. All driven pre-cast concrete piles should be pre-drilled 5 m below present site grade, due to the proposed structure's proximity to the adjacent dwellings, possibly constructed on shallow foundations, prior to being driven to refusal onto a dense stratum, such as, a hard glacial till matrix, a dense granular stratum or bedrock. The estimated length of properly driven pre-cast concrete piles required at this location would be **in the order of 12 m – 17 m from the present ground elevation of test hole #4.** However, the foundation contractor should still verify the estimated length of pre-cast concrete piles required at this site and become fully cognizant with the contents of this report. Following their successful installation, in order to maximize their lateral support and minimize their adhesion and frictional capacity with the underlying volumetrically sensitive glaciolacustrine silty clay, all the piles' oversized pre-bores should then be backfilled with clean sand or another pre-approved equivalent substitute alternative. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm. Furthermore, the geotechnical engineer's personnel should inspect the foundation installation in order to verify the FGR, using ULS where Φ = 0.6, based upon the following pile driving criteria:

PILE DIAMETER	MIN. CONCRETE COMP. STRENGTH	DRIVING ENERGY	REFUSAL CRITERIA	ULS FGR	SLS
305 mm	40 mPa	30 foot * kips	5 blows / 1" (25 mm)	75 tons	65 tons
350 mm	40 mPa	30 foot * kips	10 blows / 1" (25 mm)	105 tons	90 tons
400 mm	40 mPa	30 foot * kips	15 blows / 1" (25 mm)	135 tons	115 tons

Note: Max 1" (25.4 mm) penetration per set, for 3 consecutive sets

MBA has performed many pile load tests in The City of Winnipeg during the 1960s. It was through these static pile load tests in The City of Winnipeg that the SLS criteria used by all the labs here were established for the geology underlying The Red River Valley and, as such, The City of Winnipeg. As such, when the new ULS criteria was mandated, MBA just reviewed those pile load tests and modified the pile driving criteria based upon the direct relationship between driving energy, deflection for a set number of blows at that energy and ultimate pile capacity to establish the ULS pile capacities based upon these static load tests inside The City of Winnipeg. Furthermore, based upon these static load tests, all design work in the City of Winnipeg from the 1960s onwards was based upon a direct relationship between driving energy, deflection for a set number of blows at that energy and ultimate pile capacity. In the last few years, these pre-cast pile capacities have been also verified to be true through PDA testing. However, these static pile load test reports cannot be forwarded due to the privacy laws in Canada. However, they are on file at MBA. However, as critically mentioned previously though, all the design and construction work, previously implemented from the 1960s onwards, was using the data from these static load tests that did not require to be constantly re-proven from site to site in The City of Winnipeg from the 1960s to 2010.

In addition to the aforementioned specifications for driven pre-cast concrete piles, MBA offers the following recommendations:

- Pre-drilling through the zone of frost may be required for winter or early spring construction.
- If a drop hammer is to be used to install these piles, the mass of the hammer shall be 3 times greater than the mass of the pile.
- Pile spacing shall not be less than three pile diameters, on center.
- Piles driven within five pile diameters, on center, shall be monitored for heave. Where observed; the piles shall be re-driven to the aforementioned refusal criteria.
- Once pile driving is initiated, all piles shall be driven continuously to their respective refusal depth.

The advantages of this piling system are its very heavy allowable axial compressive capacities and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are its frequently greater cost per foot of pile and the potentially variable depths to practical refusal across this site.

5.0 CONCRETE DESIGN

Due to the visibly high concentration of sulphate in the glaciolacustrine deposition at this site, Sulphate Resisting Cement shall be used in all the concrete implemented for the aforementioned concrete foundation systems. Its concrete shall have a minimum 28-Day laboratory compressive strength of 32 mPa. Furthermore, the concrete shall contain at least 550 pounds of cement per cubic yard, have a maximum water cement ratio, a plastic concrete air content and slump of 0.45, 4 to 6 percent and 60 mm to 100 mm, respectively.

Alternatively, due to the higher elevation of the proposed structure in relation to the elevations of these test holes and the likely low concentration of sulphate in the proposed filled layers, Normal Portland Cement could be used in all the concrete implemented for the structure's grade beams and floor slabs.

All other concrete exposed to freezing and thawing cycles shall contain an air entraining admixture that corresponds to the applicable class of exposure listed in tables 2-4 of the recent addition of CSA. Concrete poured in cold weather shall be heated and protected in accordance with CSA A23.1-04 clause 21.2.3.

In addition, all concrete poured shall be tested in accordance with CSA A23.1-04 every day and at least once every 50 m^3 per day by a CSA certified concrete testing laboratory.

6.0 PAVEMENT DESIGNS

All the soil depositions located above the pavements' designated working sub-grade elevation, as designated by the project's forthcoming civil engineering consultant, shall be stripped and then transported off of the site. In addition, all the deleterious soil encountered at or below the project's recommended working sub-grade elevation, if any, shall also be excavated and then transported off of the site. Next, prior to placing the proposed pavement structures' granular sub-base and base courses, the in-situ, primarily fine-grained silty clay possibly fill, with a high plasticity index, located at or below the working sub-grade elevation, shall then be proof-rolled using a sheepsfoot roller until it has at least 95 % of its standard proctor density (SPD). Areas failing the aforementioned proof-roll test and any other deleterious material encountered at or below the working sub-grade elevation shall be verified and documented by the geotechnical engineer’s personnel. Predicated upon this consultant’s recommendations, the project’s pavement sub-contractor shall then excavate and replace the documented failed proof-rolled soil and any other deleterious material encountered at or below the working sub-grade elevation with 100 mm or 50 mm down crushed limestone fill or another pre-approved equivalent bridging material placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

Next, any segments of the proposed pavement areas naturally lower than the proposed sub-grade elevation, if any, shall then be brought up to the working sub-grade elevation implementing either a highly plastic silty clay; 100 mm or 50 mm down crushed limestone fill; granular C-Base fill or another pre-approved equivalent bridging material, placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

In order to provide adequate structural support in areas designated for heavy truck traffic, concrete plaza’s and sidewalks’ concrete slabs, their sub-bases shall consist of at least two layers of 50 mm down crushed limestone fill, C-Base fill or another pre-approved equivalent material placed in 150 mm deep lifts and compacted until each layer has at least 98 % of its SPD. However, only one lift of granular sub-base is structurally required for the light car traffic’s pavement construction. Alternatively, in all traffic areas, the granular base course shall be composed of a 150 mm deep layer of A-Base, compacted until it has at least 100 % of its SPD. Finally, the light car traffic’s asphalt pavement shall be laid in two layers with each lift having a minimum thickness of 32 mm. Similarly, areas with heavier truck traffic shall have 2 - 45 mm lifts of asphalt pavement. Each asphalt pavement area shall be consolidated until it has at least 98 % of its respective laboratory Marshall Density. An elevation drawing of the car and heavy truck traffic’s pavement structures is illustrated on page 31 of this report.

The plaza's and sidewalks' concrete slab shall have a design thickness of 150 mm, overlying its aforementioned granular base's structural support, and an air-entrainment, slump and water cement ratio in accordance with all the relevant CSA standards in A23.1-04.

The asphalt aggregate shall have a crushed count of >60%. The asphalt shall be placed at a temperature of 125°C to 155°C. The ambient temperature may be no less than 6°C when the asphalt is to be laid. The geotechnical engineer's personnel shall test the asphalt of the following aggregate gradation specifications and physical properties.

METRIC SIEVE SIZE (microns)	(% Passing)
16,000	100
10,000	70 – 85
5,000	55 – 70
2,500	40 – 60
1,250	25 – 50
630	15 – 40
315	5 – 20
160	4 – 11
80	3 – 7

Asphalt Cement, % total sample weight	5.0 % - 6.0 %
Voids in Mineral Aggregate	14% minimum
Air Voids	3.0% - 5.0%
Marshall Stability, N at 60° C	7 kN minimum
Flow Index, units of 250 µm	6.0 – 16.0

The pavement's slope and catch basin placement should be designed by the project's municipal engineering consultant. Currently, the writer has not been provided the proposed municipal site plan indicating the proposed cut and fill depths. Ultimately, however, this office should be contacted of any proposed change to the aforementioned range of working sub-grade elevations. Finally, the slope of the pavement, at a minimum, should be sufficiently graded at 2 % for expedient drainage into catch basins or towards the perimeter of the site.

7.0 LATERAL EARTH PRESSURE

Typically, new structures, such as, the one proposed for this site, have all of their below grade walls rigidly designed and constructed. Therefore, the "at-rest" earth pressures (K_o) will apply for all cases on this project. The distribution of the lateral earth pressures are dependent upon the following key factors; backfill type, compaction effort and drainage conditions. As such, the following two equations should be used for the calculation of the lateral earth pressures where sub-drainage is provided and not provided, respectively.

Sub-drainage provided

$P_h = K_o \gamma H$

where:
- P_h = lateral earth pressure at any depth (psf)
- K_o = earth pressure coefficient
- γ = unit weight of the soil (pcf)
- H = height of the wall in (ft.)

Sub-drainage not provided

$P_h = K_o \gamma' H + \gamma_w H$

where:
- P_h = lateral earth pressure at any depth (psf)
- K_o = earth pressure coefficient
- γ' = buoyant unit weight of the soil (pcf)
- γ_w = unit weight of water (pcf)
- H = height of the wall in (ft.)

If the sub-grade located adjacent to the structure is utilized to support a surface concrete slab on grade or any pavement structures, 98% - 100% of its SPD (well compacted) will be required and therefore the following K_o values listed in the table below should be used.

COMPACTION SPEC. & SOIL TYPE	**K_o**	**TOTAL UNIT WEIGHT (pcf)**
98% - 100% of its SPD (Sands & Gravels)	0.43	145
98% - 100% of its SPD (Silty Clays)	0.58	110

When the sub-grade soils compaction is required to be in the range of 90% - 95% of its SPD (moderate compaction) then the following table of K_o values should be implemented.

COMPACTION SPEC. & SOIL TYPE	**K_o**	**TOTAL UNIT WEIGHT (pcf)**
90% - 95% of its SPD (Sands & Gravels)	0.55	135
90% - 95% of its SPD (Silty Clays)	0.71	100

If surcharge loadings (i.e. line loads and point loads) are to be incorporated into this projects design then the figure located on page 32, obtained from the Canadian Engineering Foundation Manual, should be used to determine their associated respective lateral pressures on the rigidly structurally designed member. For a uniformly distributed surcharge load, the lateral earth pressure is simply determined by multiplying the load by the aforementioned applicable K_o factor. In addition, for the soils that require 98% - 100% of their SPD (well compacted), the size and type of compaction equipment used to compact the backfill induces additional lateral earth pressures. Therefore, in order to calculate the lateral earth pressures caused by the compaction equipment, a design chart has been provided on page 33 of this report. In addition, it still may also be necessary to provide temporary bracing of the wall during construction in order to resist those lateral earth pressures associated with the compaction equipment.

Alternatively, if the sub-grade located adjacent to the crawlspace is not required to support surface concrete slab on grade or pavement structures, then the standard triangular earth pressure distribution should be used for design purposes.

8.0 RECOMMENDATIONS

Predicated upon the soils' aforementioned respective strength parameters, lithology and physical properties, the current and modeled groundwater elevations, the field and laboratory test data, and the proposed one-storey, steel-frame, 14,000 ft^2, structure's anticipated moderate applied foundation stresses, drilled cast in place concrete friction piles, drilled spread bore concrete end-bearing piles or driven pre-cast concrete end-bearing piles could be implemented as the foundation design for the proposed Bill & Helen Norrie Library to be located at 1301 Grant Avenue in Winnipeg, Manitoba. Based upon the aforementioned advantages and disadvantages of these foundation systems, a driven pre-cast concrete end-bearing piled foundation design would likely be a well performing, more economical and efficient one for the proposed one-storey, moderately-loaded, 14,000 ft^2, structure placed on a site with the aforementioned geotechnical design parameters and implemented in a heated service condition. Alternatively, MBA recommends that the wooden deck's foundation type should be installed implementing a spread bore concrete piled foundation type. However, the choice of foundation type implemented for this project will ultimately depend upon their respective, previously described, advantages and disadvantages, estimated installation costs and the applied foundation loads that will be calculated by the project's structural engineering consultant.

It is recommended in the strongest of terms that the geotechnical engineer's personnel inspect the installation of all the foundation elements in order to verify that they all conform with the contents of this report, the structural drawings and the project's specifications.

Any areas of the yard naturally lower in elevation, if any, shall be brought up to its future grade implementing a highly plastic silty clay fill, 50 mm down limestone fill, granular C-Base fill or another pre-approved equivalent material, placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

The backfill material around the perimeter of the proposed structure shall be brought up to its future grade implementing either a 20 mm down limestone fill; granular C-Base fill; or another pre-approved equivalent material, placed in sufficient 150 mm deep lifts and compacted until each layer has densities in the range of 92 % to 97 % of its SPD.

All the various proposed concrete and asphalt pavement surfaces shall be constructed as per the recommendations outlined in section 6.0 of this report. Furthermore, the pavement contractor shall also take precautions to prevent the fine-grained sub-grade soil from the following conditions; freezing, excessive soil moisture loss or gain, water ponding and heavily loaded axle traffic. In addition, the granular fill placed for this project shall be free of frost, frozen material and placed at an ambient air temperature of at least 6° Celsius. In order to verify compliance with the aforementioned standard proctor and Marshall Density specifications, field compaction tests shall be taken on every lift of granular material and asphalt placed for this project, respectively. All concrete poured shall be tested in accordance with CSA A23.1-04 every day and at least once every 50 m^3 per day by a CSA Certified concrete testing laboratory.

The selected 50 mm down and 20 mm down crushed limestone, A-Base and C-Base gravels implemented for this project shall all meet the following gradation specifications:

METRIC SIEVE SIZE (μm)	20 mm Limestone (% Passing)	50 mm Limestone (% Passing)	A-BASE (% Passing)	C-BASE (% Passing)
50,000		100		
25,000			100	100
20,000	100		80 – 100	
5,000	40 – 70	25 – 80	40 – 70	25 – 80
2,500	25 – 60		25 – 55	
315	8 - 25		13 – 30	
80	6 - 17	5 – 18	5 – 15	5 – 18

In order to minimize frost penetration under the building, 50 mm thick rigid horizontal insulation, or another pre-approved equivalent frost protection, shall be placed around the structure's entire exterior. This insulation shall be placed along the faces of the proposed building out to a distance 1200 mm away from it at a depth of 300 mm below future ground elevation and also along the outside faces of the structure's exterior concrete grade beams.

The proposed structure shall have properly designed and installed weeping tile drainage system connected to sump pit(s) with operational sump pump(s), in accordance with the National Building Code of Canada (NBCC) and the City of Winnipeg Building Code. In addition, the building's superstructure shall all be entirely structurally supported by only one of the aforementioned approved foundation systems. In all the aforementioned feasible piled foundation designs, a void space, of at least 300 mm in thickness, shall be constructed under the concrete walls, pile caps and grade beams to allow for the potential expansive and rebound capabilities of the alluvial and glaciolacustrine deposited, very stiff, silty clays underlying this site. The structurally supported concrete main floor shall overlay either a minimum 750 mm deep vented crawlspace or a minimum 300 mm thick biodegradable void form. The surface of any crawlspace shall be covered by a minimum 100 mm deep layer of clean sand fill overlying a 6 mm thick impervious poly vapour barrier. Lastly, the writer understands that a crawl space is intended for the proposed structure.

Since an underground crawlspace is intended underlying the proposed structure, its associated lateral earth pressures should be calculated as per section 7.0 of this report. Furthermore, the proposed crawlspace's excavation and shoring should, at a minimum, comply with all the Manitoba Department's Workplace Health and Safety guidelines for confined underground work and be designed by the project's structural engineering consultant, respectively. Their respective constructions should then proceed as per those standards and the project's sealed drawings and specifications.

If any of the aforementioned design elements are modified or deleted, please contact the undersigned to determine if that course of action will be acceptable.

In addition, MBA respectfully requests an opportunity to review all the relevant finalized structural drawings and the project's foundation and materials testing specifications for this project in order to verify their conformance with the contents of this report.

The test holes drilled during the investigation represent only those specific areas tested. The soil conditions on this site may vary from that described in this report. Should that situation occur, please contact this office for further instructions.

All the geotechnical engineering design recommendations presented in this report are predicated upon the assumption that a sufficient degree of inspection will be provided during the project's construction and that a qualified and experienced foundation contractor properly installs an aforementioned pre-approved, engineered and sealed foundation type.

Any uses which a third party makes of this report, or any reliance on decisions to be made based on it, are the sole responsibility of such third parties. MBA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based upon this report.

Yours Truly,
M. Block & Associates Ltd.

Jeffrey Block, P. Eng., Senior Geotechnical Engineer

M. Block & Associates Ltd.

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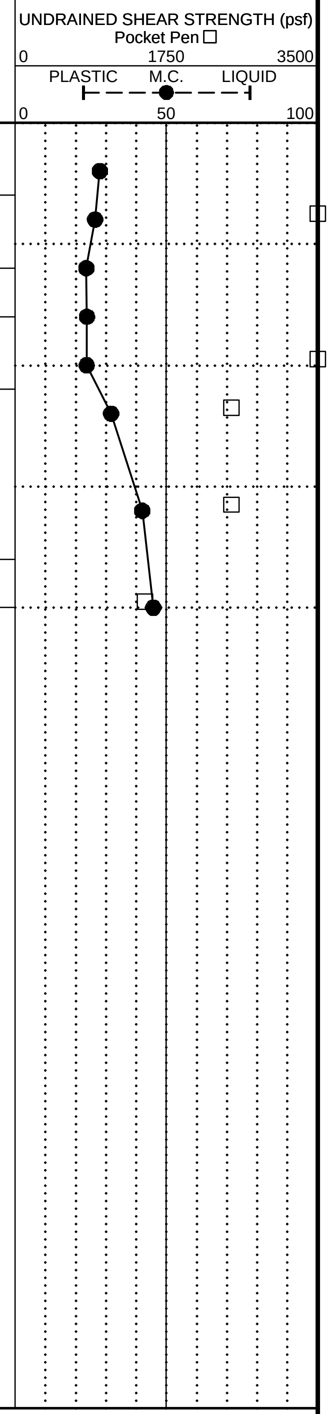
.

TEST HOLE NO.: 1

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 9:00 AM
Location:	1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.05m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		1			
		2	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		3	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		4	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		5			
		6	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
					7' - Brown dry SILT lens
7.5		7			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		8			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

M. Block & Associates Ltd.

2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

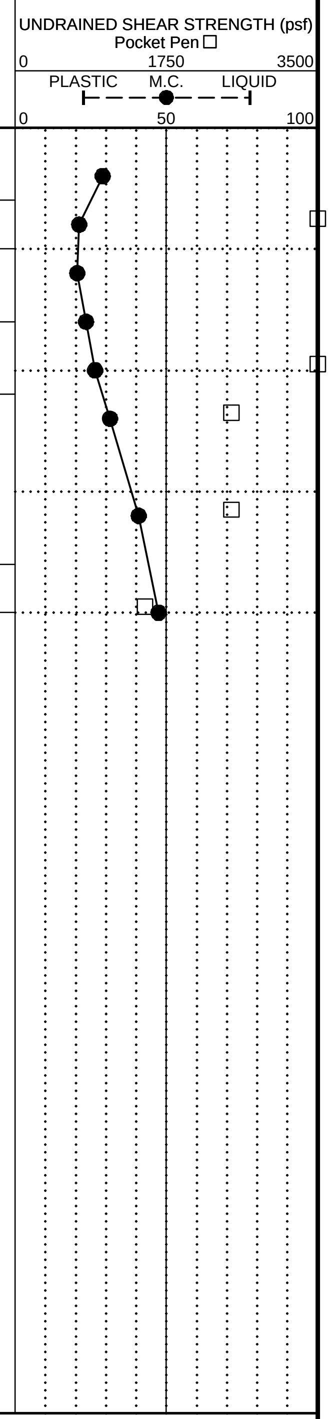
.

TEST HOLE NO.: 2

Sheet 1 of 1

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 9:15 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.10m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		9			
		10	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		11	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		12			
			CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		13			
		14	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions 6' - Brown dry SILT lens
7.5		15			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		16			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

M. Block & Associates Ltd.

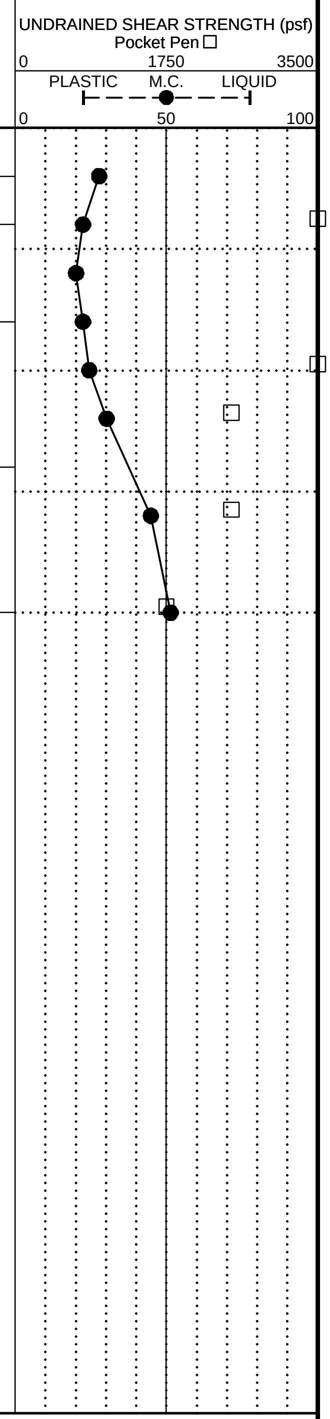
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

.

TEST HOLE NO.: 3

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 9:30 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.13m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
	■	17			
	■	18	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5			CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
	■	19			
	■	20			
			CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
5.0	■	21			
	■	22			
7.5			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
	■	23			
10.0	■	24			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon	Shelby Tube
Vane Shear	Auger Cuttings
Grab Sample	Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

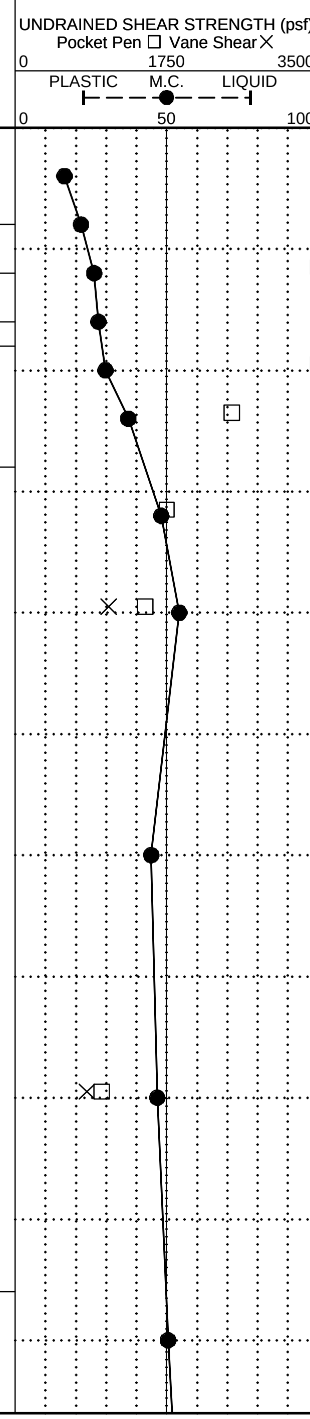
WATER LEVELS

No Ground Water Encountered

M. Block & Associates Ltd. 2484 Ferrier Street Winnipeg, Manitoba, R2V 4P6 Telephone: (204)-334-5356 Fax: (204)-339-7976	.	**TEST HOLE NO.: 4** Sheet 1 of 2

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 9:45 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.11m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		25			
		26	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		27	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		28	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		29	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
		30			6' - Brown dry SILT lens
7.5		31	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		32			
12.5					
15.0		33			
17.5					
20.0		34			
22.5					
			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
25.0		35			



Continued Next Page

SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

∇ Phreatic Surface #1: 24.0 ft

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 7/11/18

TEST HOLE NO.: 4

M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

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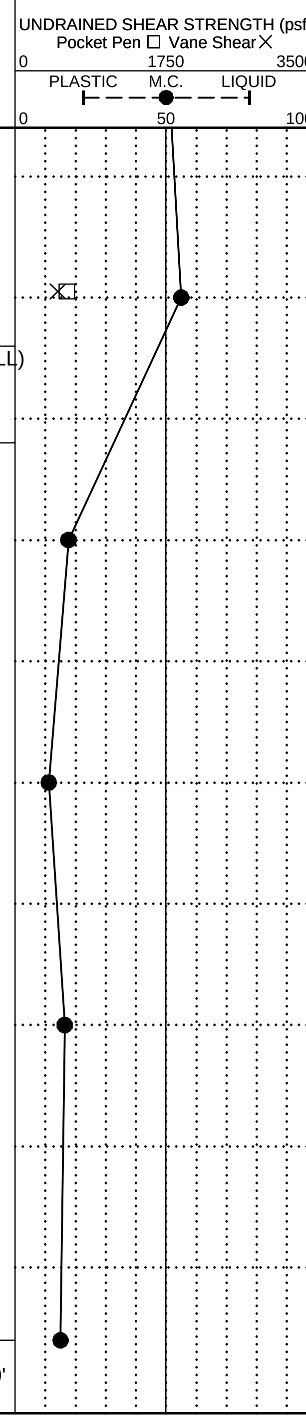
Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 9:45 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.11m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
27.5					
30.0		36			
			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
32.5					
			CL-ML		Grey, soft, saturated, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
35.0		37			
37.5					
40.0		38			
42.5					
45.0		39			
47.5					
50.0					
		40			
					51'6" - Auger refusal on suspected fractured LIMESTONE BEDROCK; - Upon completion, the groundwater & sloughed soil was measured at the 24' and 50' depths, respectively
52.5					



SAMPLE TYPE SYMBOLS

Split Spoon	Shelby Tube
Vane Shear	Auger Cuttings
Grab Sample	Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

∇ Phreatic Surface #1:	24.0 ft

M. Block & Associates Ltd.

2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

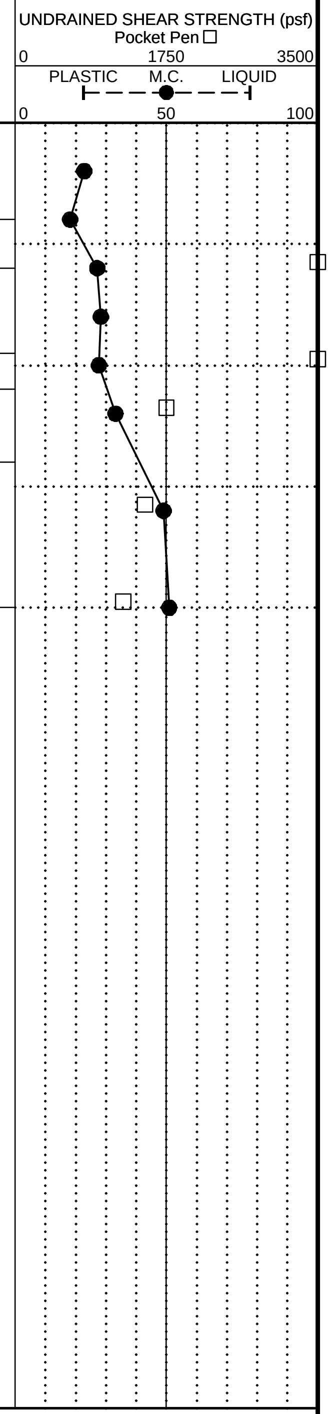
.

TEST HOLE NO.: 5

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.		Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.		Time: 11:00 AM
Location:	1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.12m	Drawing Number: 5883		

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
	Shelby Tube	41			
	Shelby Tube	42	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5	Shelby Tube	43	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
	Shelby Tube	44			
5.0	Shelby Tube	45	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
	Shelby Tube	46	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions 6' - Brown dry SILT lens
7.5			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
	Shelby Tube	47			
10.0	Shelby Tube	48			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon	Shelby Tube
Vane Shear	Auger Cuttings
Grab Sample	Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 7/11/18

M. Block & Associates Ltd.

2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

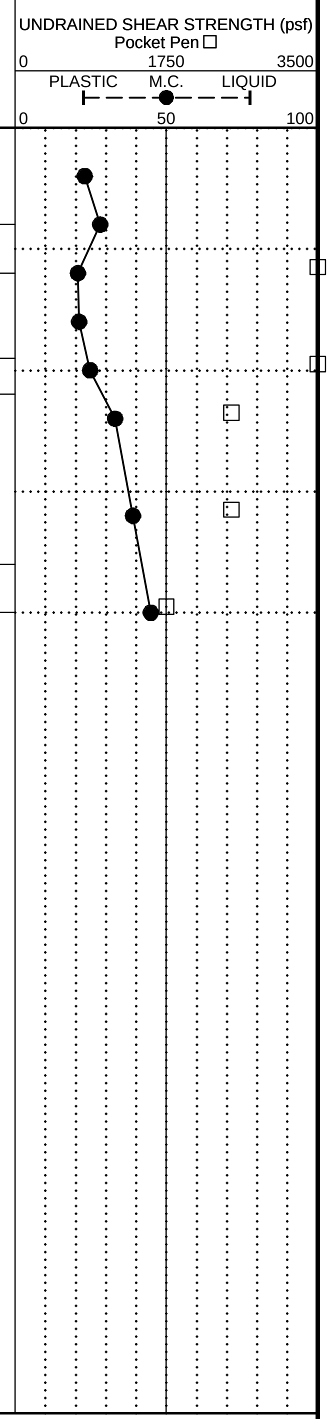
.

TEST HOLE NO.: 6

Sheet 1 of 1

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 11:15 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.18m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		49			
		50	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		51	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		52			
5.0		53	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		54	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
7.5		55			
		56	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0					10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 7/11/18

M. Block & Associates Ltd.

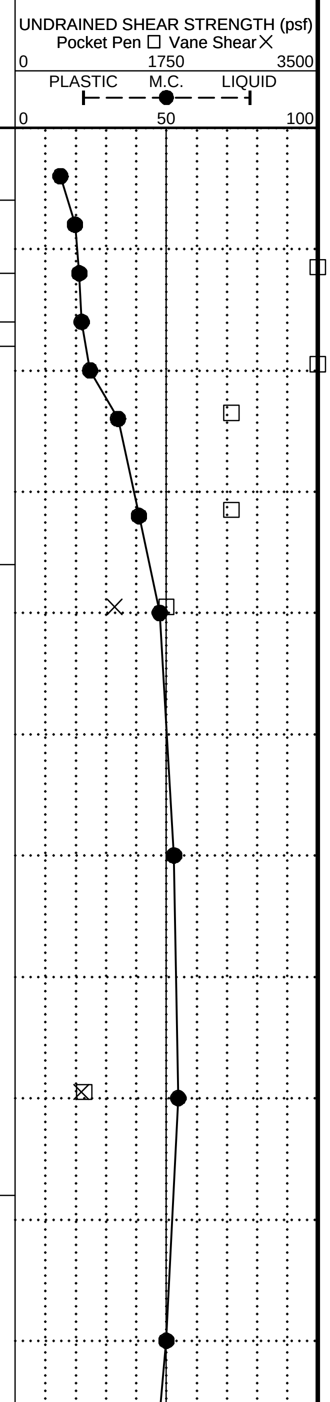
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

.

TEST HOLE NO.: 7

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 11:30 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		57			
		58	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		59	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		60	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		61	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
		62			
7.5		63			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		64			
12.5					
15.0		65			
17.5					
20.0		66			
22.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
25.0		67			



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SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 7/11/18

M. Block & Associates Ltd.

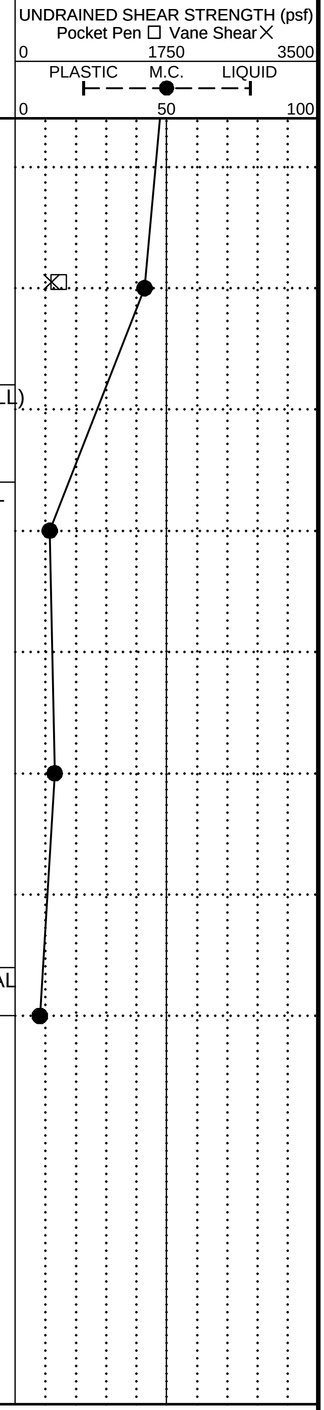
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

TEST HOLE NO.: 7

Sheet 2 of 2

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 11:30 AM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
27.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
30.0		68			
32.5			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
35.0		69	CL-ML		Grey, stiff, moist, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
37.5					
40.0		70			
42.5					
45.0		71	CL-ML		Grey, hard, dry, very dense, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
					45' - Auger refusal on suspected boulder; - No groundwater seepage and/or soil sloughing in test hole
47.5					
50.0					
52.5					



SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

M. Block & Associates Ltd.

2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

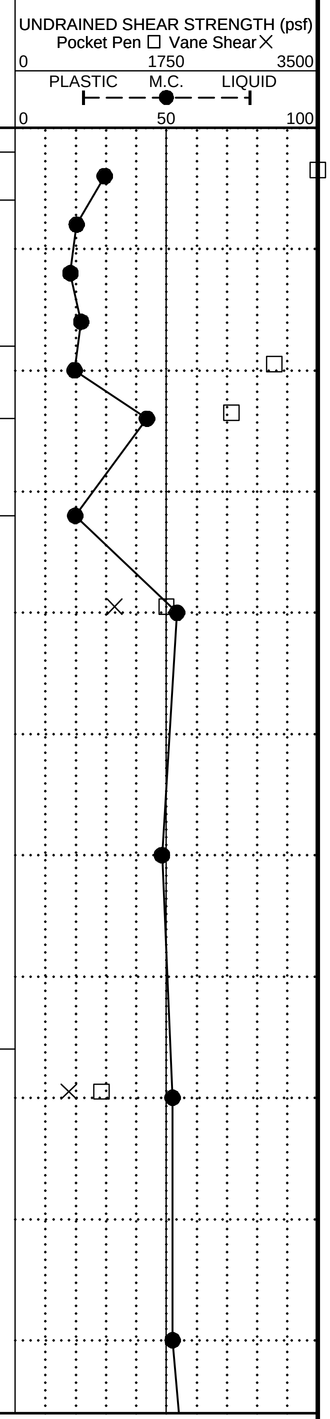
.

TEST HOLE NO.: 8

Sheet 1 of 2

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 12:45 PM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		72	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		73	ML		Brown, alluvially deposited, powdery dry, SILT
2.5		74			
		75			
5.0		76	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		77			
			ML		Brown, alluvially deposited, soft, wet, SILT
7.5		78			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		79			
12.5					
15.0		80			
17.5					
			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
20.0		81			
22.5					
25.0		82			



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SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

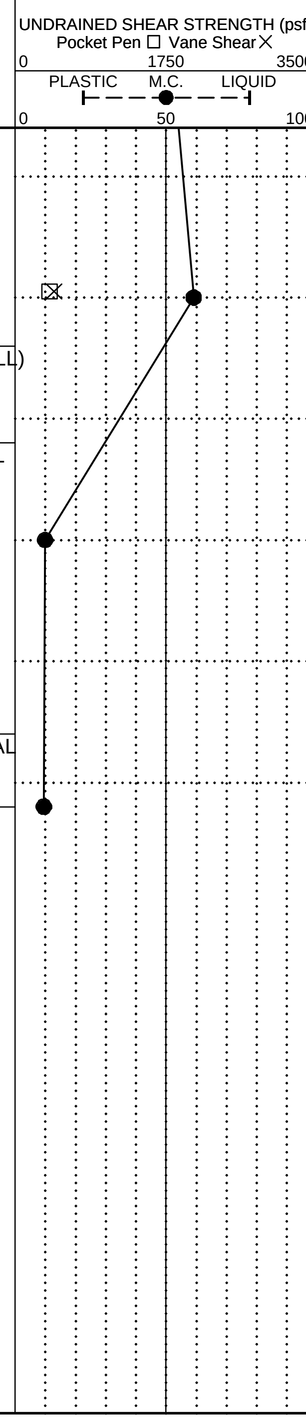
No Ground Water Encountered

M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

TEST HOLE NO.: 8

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 12:45 PM
Location:	1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
27.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
30.0		83			
			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
32.5					
			CL-ML		Grey, stiff, moist, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
35.0		84			
37.5					
			CL-ML		Grey, hard, dry, very dense, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
40.0		85			
					40'6" - Auger refusal on suspected boulder; - No groundwater seepage and/or soil sloughing in test hole
42.5					
45.0					
47.5					
50.0					
52.5					



SAMPLE TYPE SYMBOLS

Split Spoon	Shelby Tube
Vane Shear	Auger Cuttings
Grab Sample	Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

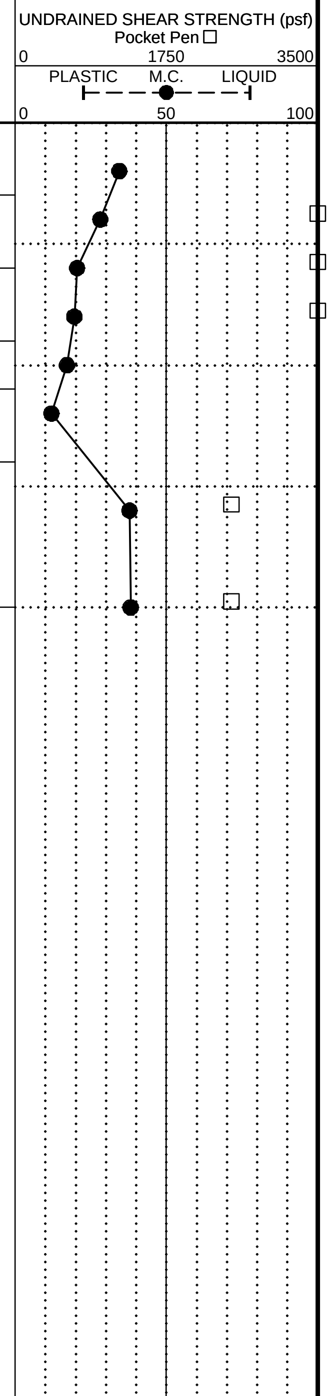
WATER LEVELS

No Ground Water Encountered

M. Block & Associates Ltd.		TEST HOLE NO.: 9
2484 Ferrier Street Winnipeg, Manitoba, R2V 4P6 Telephone: (204)-334-5356 Fax: (204)-339-7976	.	Sheet 1 of 1

Client: The City of Winnipeg	Job No.: 2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By: J. Block, P. Eng.	Time: 2:00 PM
Location: 1301 Grant Avenue, Winnipeg, Manitoba	Elevation: 99.07m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		86	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		87	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		88, 89	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
5.0		90	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		91	ML		Brown, alluvially deposited, powdery dry, SILT
7.5		92, 93	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
10.0					10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

Split Spoon
Shelby Tube
Vane Shear
Auger Cuttings
Grab Sample
Rock Core

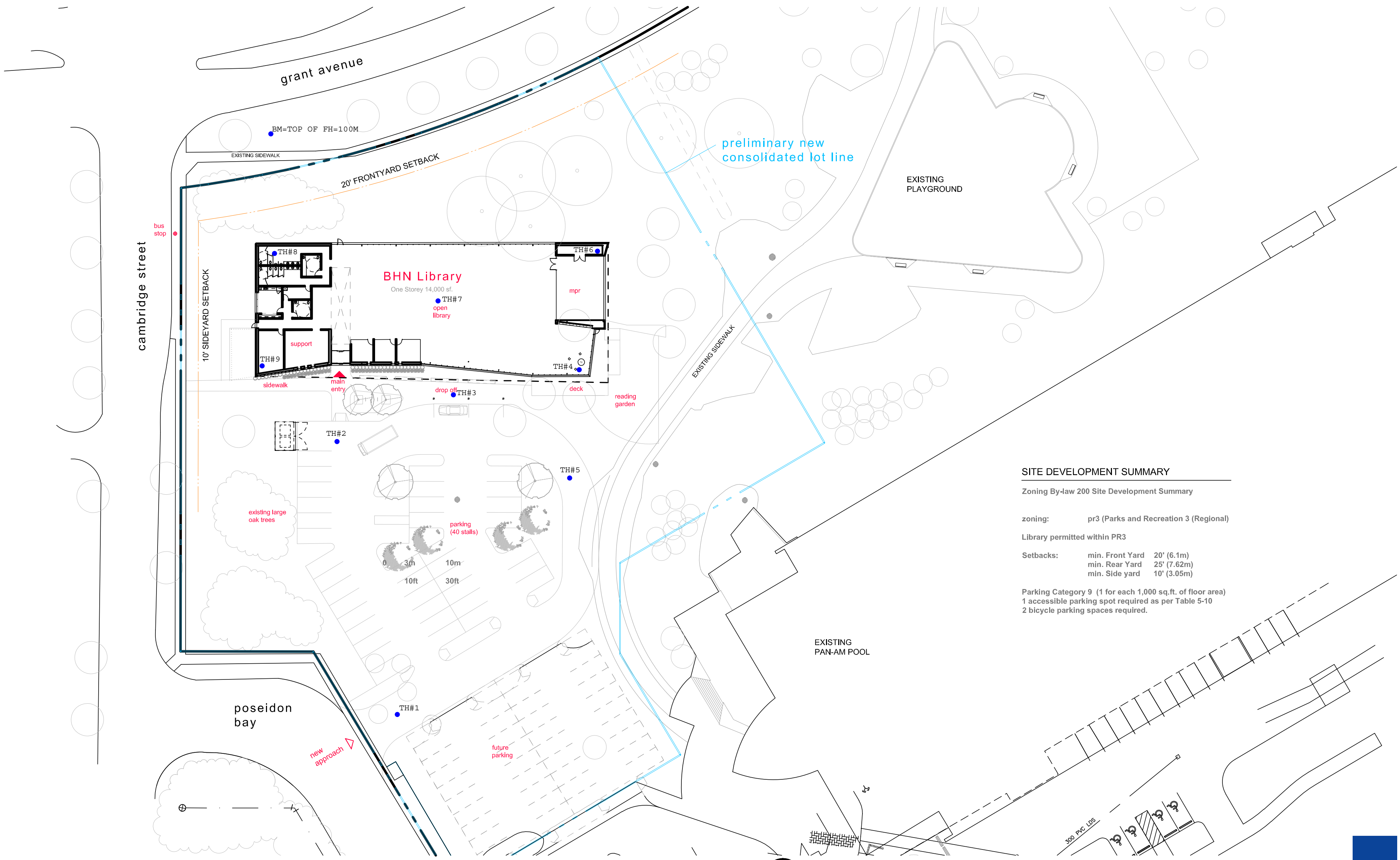
Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 7/11/18

LEGEND - • TEST HOLE



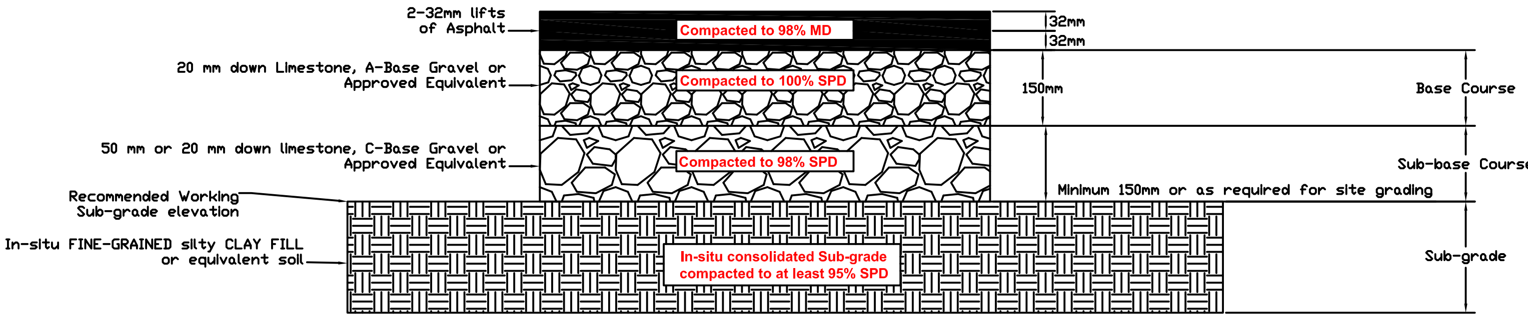
City of Winnipeg - Bill and Helen Norrie Library - **Preliminary Building Location Plan**

scale 1:600

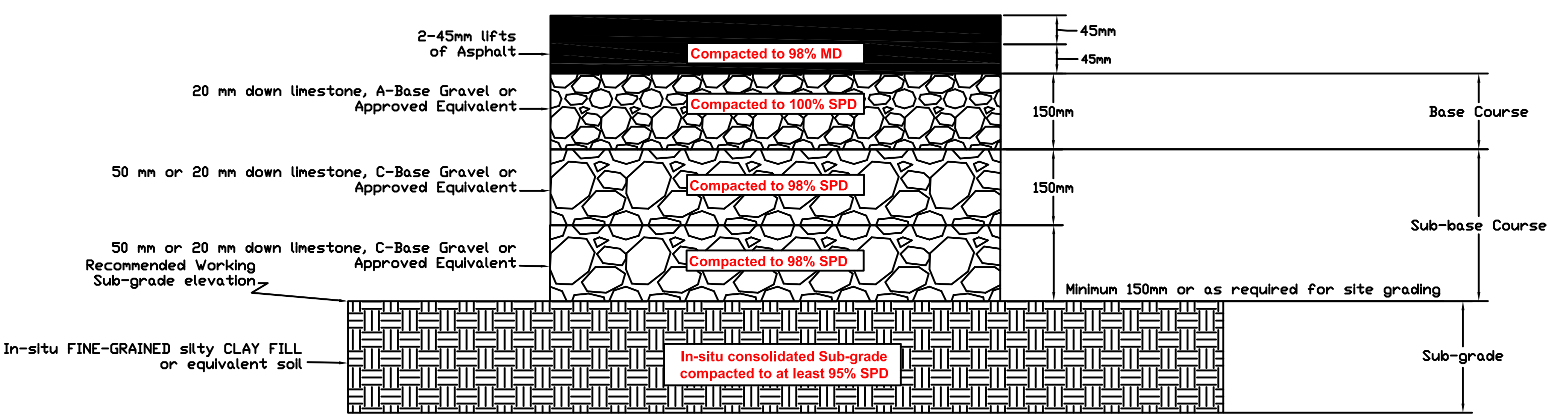
october 17, 2018

PAVEMENT DETAILS

Car Traffic Areas



Truck Traffic Areas



M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba
R2V 4P6
Phone: (204)-334-5356
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Drawing: PAVEMENTS' STRUCTURES
Drawn By: TG/JB
Reviewed By: J. Block, P. Eng.

Project: Bill & Helen Norrie Library in Winnipeg
Project Number: 2018-1842
Drawing Number: 5883

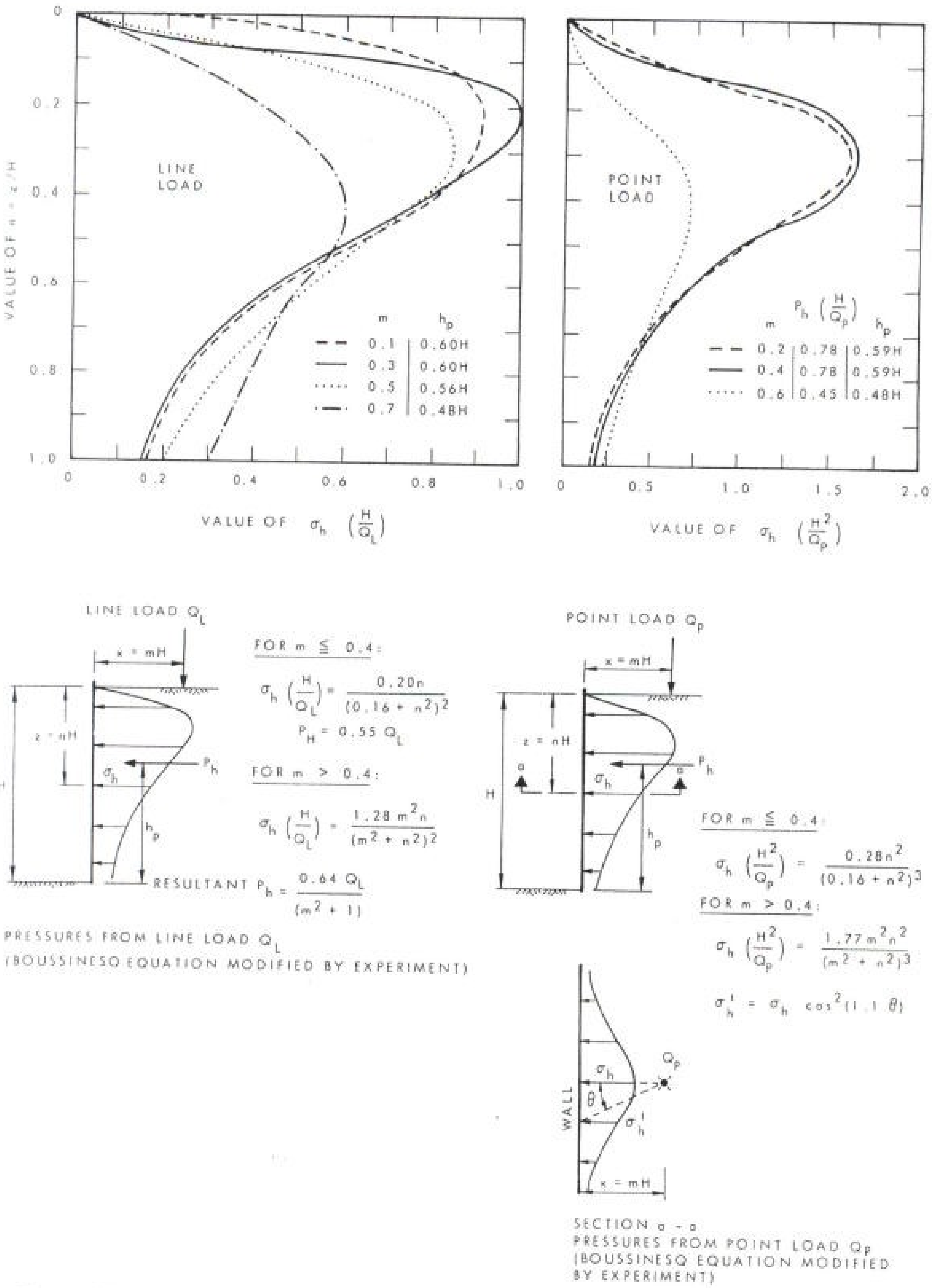
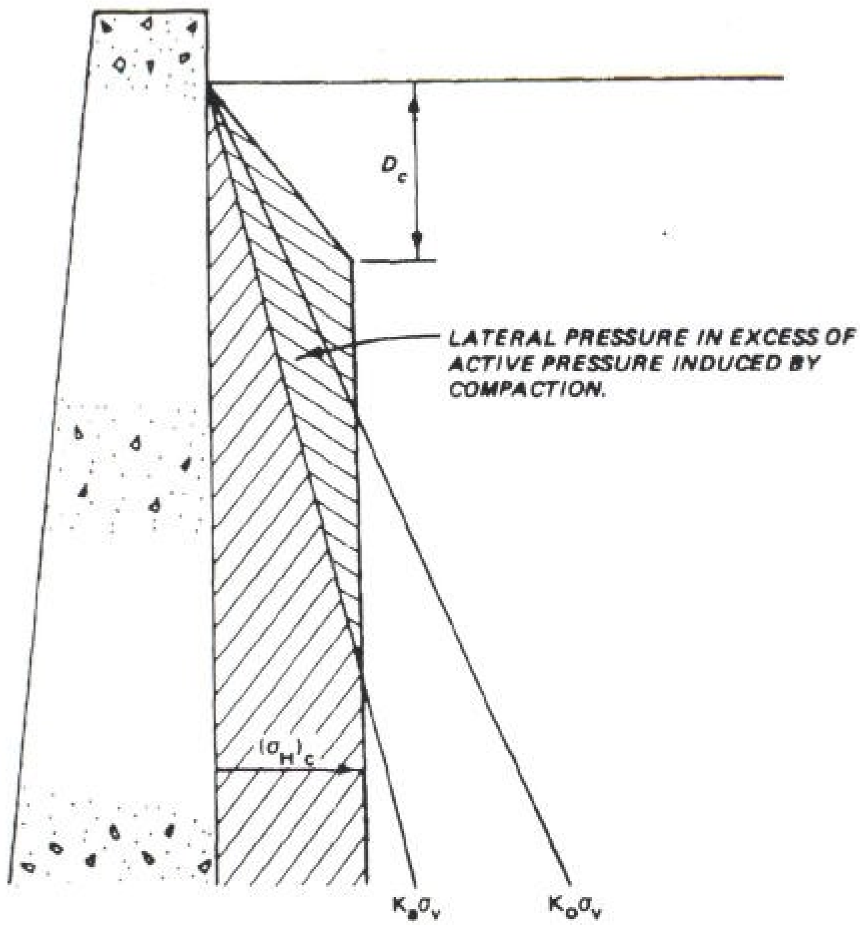


Figure 25.5: Horizontal pressures on a wall due to point and line load surcharges.



COMPACTION EQUIPMENT	CRITICAL DEPTH, D_c, ft	$(\sigma_H)_c$ psf
10-TON SMOOTH WHEEL ROLLER	1.9	420
3.2-TON VIBRATORY ROLLER	1.7	400
1.4-TON VIBRATORY ROLLER	1.2	260
400-KG VIBRATORY PLATE	1.5	340
120-KG VIBRATORY PLATE	1.0	240

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
1	1.0							28.0			
1	2.0							26.4			
1	3.0							23.5			
1	4.0							23.7			
1	5.0							23.6			
1	6.0							31.7			
1	8.0							42.0			
1	10.0							45.7			
2	1.0							28.9			
2	2.0							21.2			
2	3.0							20.5			
2	4.0							23.4			
2	5.0							26.4			
2	6.0							31.3			
2	8.0							40.8			
2	10.0							47.4			
3	1.0							27.8			
3	2.0							22.4			
3	3.0							20.1			
3	4.0							22.4			
3	5.0							24.5			
3	6.0							30.2			
3	8.0							44.9			
3	10.0							51.4			
4	1.0							16.2			
4	2.0							21.7			
4	3.0							26.1			
4	4.0							27.4			
4	5.0							29.8			
4	6.0							37.3			
4	8.0							48.2			
4	10.0							54.1			
4	15.0							44.9			
4	20.0							46.9			
4	25.0							50.4			
4	30.0							55.0			
4	35.0							17.6			
4	40.0							11.1			
4	45.0							16.4			
4	51.5							15.0			
5	1.0							22.8			
5	2.0							18.1			
5	3.0							27.1			

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Summary of Laboratory Results

Client: The City of Winnipeg
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library
Location: 1301 Grant Avenue, Winnipeg, Manitoba
Number: 2018-1842

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
5	4.0							28.3			
5	5.0							27.6			
5	6.0							33.1			
5	8.0							49.0			
5	10.0							50.9			
6	1.0							23.0			
6	2.0							28.1			
6	3.0							20.7			
6	4.0							21.1			
6	5.0							24.8			
6	6.0							33.0			
6	8.0							38.9			
6	10.0							44.8			
7	1.0							14.9			
7	2.0							19.7			
7	3.0							21.2			
7	4.0							22.0			
7	5.0							24.8			
7	6.0							34.0			
7	8.0							40.9			
7	10.0							47.8			
7	15.0							52.5			
7	20.0							53.9			
7	25.0							50.0			
7	30.0							42.7			
7	35.0							11.4			
7	40.0							13.0			
7	45.0							8.1			
8	1.0							29.6			
8	2.0							20.3			
8	3.0							18.2			
8	4.0							21.8			
8	5.0							19.6			
8	6.0							43.6			
8	8.0							19.9			
8	10.0							53.5			
8	15.0							48.5			
8	20.0							52.0			
8	25.0							52.1			
8	30.0							59.1			
8	35.0							9.9			
8	40.5							9.5			
9	1.0							34.4			

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Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
9	2.0							28.1			
9	3.0							20.4			
9	4.0							19.5			
9	5.0							17.1			
9	6.0							12.0			
9	8.0							37.8			
9	10.0							38.2			

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