March 28th, 2017

Horizon Builders Ltd.
1040 – 20th Street
Brandon, Manitoba
R7B 1M8
Attention: Mr. Rod Lindenberg, Project Manager

Dear Sir:

RE: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED 3 – 11,529 FT^2, FOUR-STORY, CONDO DEVELOPMENT AND TWO-STORY PRO SHOP AT WHEAT CITY GOLF COUSE LOCATED AT 3500 MCDONALD AVENUE IN BRANDON, MANITOBA

1.0 TERMS OF REFERENCE

On March 14th, 2017, M. Block & Associates Ltd. (MBA) received e-mailed authorization from Mr. Rod Lindenberg, representing Horizon builders Ltd., the project's design builder, to proceed with the geotechnical investigation for the proposed 3 – 11,529 ft^2, four-story, condo development and 4725 ft^2, two-storey, pro shop to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. Therefore, on March 21st to March 23rd, 2017, a total of six-teen test holes were bored implementing a truck-mounted Canterra and track-mounted Acker drill rigs, using interconnected 5' long x 5" diameter continuous flight solid stem augers, supplied by Paddock Drilling Ltd. of Brandon, Manitoba. Representative "disturbed" soil samples were retrieved from those 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 predominantly fine-grained glacial till matrix's 'disturbed' undrained shear strengths were measured implementing a hand-held calibrated Pocket Geotester (PG). 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 a nearby fire hydrant, as illustrated on pages 17 – 46 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 #2 and #9 were covered with, about, 2'9" and 3'6", respectively, of brown, moist, silty gravelly sand fill. Alternatively, test holes #3, #4, #5, #6, #7, #8, #10, #11, #12, #13, #14, #15 and #16 were covered with, approximately, 22', 1'6", 5', 22', 22', 18', 5', 25', 16', 11', 10', 11' and 5', respectively, of black/grey, moist to saturated, sandy silt fill. Grey, alluvially deposited, soft, saturated, clayey silt was then traversed in, only, test holes #11, #12, #13, #14, #15 and #16 down to the 34', 28', 24', 26', 26' and 22' depths, respectively. Next, brown or grey, soft to stiff, wet to moist, compact, clayey sandy silt with cobbles and boulders (glacial till) was observed in, only, test holes #1, #2, #4, #9, #11 and #12 down to the 7'6", 4'6", 3'6", 4'6", 36' and 34' depths, respectively. Finally, brown, becoming grey in colour with increasing depth, very stiff to hard, damp, dense to very dense, clayey sandy silt with cobbles and boulders (glacial till) was recorded in, only, test holes #1 , #2, #3, #4, #5, #6, #7, #8, #9, #10, #11, #12, #13, #14, #15, and #16 down to the 50', 40', 45', 20', 45', 24', 30', 40', 50', 25', 50', 50', 50', 50', 50' and 50' depths, respectively. All the test holes either refused above the 50' depth or were terminated at the 50' depth. During this investigation, groundwater seepage and soil sloughing, emanating from the soft, saturated, sandy silt fill layer and also the clayey silt stratum, flowed and sloughed into test holes #6 - #8 and #11 - #16 at significant and severe inflow rates, respectively. The soil lithology in the test holes and their specific locations were appended to this report on pages 17 – 46.

3.0 SUMMARY OF FIELD AND LABORATORY TESTS

The soils' measured PG strength vs. Depth graphs 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 48 – 53.

4.0 FOUNDATION DESIGN ALTERNATIVES

4.1 CONCRETE FOOTINGS (FOR PRO SHOP BUILDING, ONLY)

A concrete footing design is a feasible foundation system ***ONLY*** for the proposed 4725 ft^2, two-storey, pro shop to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. As such, reinforced concrete perimeter strip footings, having a minimum width of 600 mm, with possible interior concrete pads and piers shall all be constructed at the same elevation, bearing, only, on the in-situ, very stiff clayey sandy silt with cobbles and boulders (glacial till) matrix at a feasible elevation of 98.52 m, approximately, 1.80 m below test hole #1's present grade, where the soil's the factored (Φ = 0.5) bearing pressure, once verified via proctor penetrometer testing by MBA's geotechnical personnel, would be 300 kPa.

First, the deposition overlying the bearing granular soil shall be carefully excavated in order to expose the bearing soil with only minimal disturbance and loosening. The foundation contractor should also take precautions to prevent the fine-grained soil from freezing, excessive soil moisture loss or gain and/or an influx of water ponding. Finally, the minimum 300 mm deep reinforced concrete footing shall then be poured having a slump in the range of 70 mm to 100 mm. The concrete shall have a maximum water cement ratio of 0.45 and contain a water-reducing admixture.

Predicated upon the data obtained in the geotechnical investigation and the recommendations provided in this section of the geotechnical report, the anticipated modeled short-term and long-term settlement of this foundation type, constructed in accordance with all the recommendations outlined in this report, will be, approximately, 15 mm and 25 mm, respectively.

The footing or pad excavations could be dug implementing typical construction excavating equipment. However, the footings' excavations shall all be properly and safely cutback and/or shored by the project's structural engineer. The backfill material overlying them, if any, shall be composed of the non-deleterious excavated soils, a 50 mm or 20 mm down granular pit-run fill, a A-Base gravel fill or another similarly pre-approved equivalent material compacted in 150 mm deep lifts until each layer has at least 98 % of its standard proctor density (SPD). However, all the aforementioned soils shall only be placed and compacted in ambient air temperatures above 1° Celsius. In cooler ambient air temperatures, a lean mix concrete, or another pre-approved equivalent material, shall be placed instead. In addition, all the aforementioned fills placed for this project shall be free of frost and frozen material.

In order to minimize frost penetration under the building, in, only, this foundation type, 100 mm thick rigid horizontal insulation, or another pre-approved equivalent frost protection, shall be placed around the perimeter of the entire structure. This insulation shall be placed along the face of the proposed building out to a distance 1800 mm away from it at a depth of 300 mm below future site grading. Similarly, 100 mm thick rigid horizontal insulation, or another pre-approved equivalent frost protection, shall also be placed on top of the reinforced concrete footings and full-length along and around its concrete piers and/or walls.

The advantages of this foundation system are its moderate factored allowable bearing pressure, minimal magnitude of modeled long-term foundation settlement, cost effectiveness, the potential use of local labour and equipment during the foundation installation and all the boulders encountered during the foundation installation will be more expeditiously excavated using a large backhoe rather than piling equipment. The disadvantages of this foundation type are its level of difficulty and inefficiency for proper installation during the winter months, the possibility of unexpected foundation settlement if a softened bearing soil is not shoveled off of a foundation element, and the potential for significant foundation settlement, if constructed improperly. Therefore, prior to concreting, the geotechnical engineer's personnel should inspect each foundation element, in order to verify the in-situ glacial till's allowable bearing pressure at every footing location, measure the foundations' actual dimensions and confirm that any softened soil is excavated.

4.2 SPREAD BORE CONCRETE PILES OR STRAIGHT SHAFT CAISSONS (FOR PRO SHOP BUILDING, ONLY)

Similarly, drilled, cast in place, straight shaft or spread bore concrete caissons could also be implemented as the foundation design ***ONLY*** for the proposed 4725 ft^2, two-storey, pro shop to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. These piles shall only be constructed on the in-situ, very stiff, damp, dense, predominantly fine-grained, glacial till matrix at a feasible elevation of 94.32 m, approximately, 6.00 m below test hole #1's present ground elevation, where the factored geotechnical resistance (FGR), using ultimate limit states (ULS) where $\Phi = 0.4$, once hand-cleaned or mechanically-cleaned, with both supervised by this consultant's geotechnical personnel, is 500 kPa or 345 kPa, respectively. In addition, in order to avoid reducing the piles' net efficiency, they must be spaced at least two shaft diameters, on centre, from each other.

Since boulder removal within the glacial till matrix can lead to foundation installation difficulties, costly structural re-designs and project delays, the project's structural engineer shall specify a minimum shaft diameter size of 600 mm in order to facilitate the removal of any large diameter boulders encountered during the piling installation. However, in order to comply with the Manitoba Department's Workplace Health and Safety guidelines for confined underground work, a minimum shaft diameter of 750 mm shall be implemented in all the hand cleaned piles.

In order to protect these piles from frost jacking stresses in unheated applications, only, they shall have sono-tube casings installed along their upper 3.0 m or less if shorter pile 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 should be fully cognizant that there will be boulders and cobbles in the underlying granular deposition and also the glacial till matrix. As such, these boulders and/or cobbles will have to be removed in order to properly install this foundation type. Furthermore, there is no correlation between the frequency of cobbles and boulders encountered in 125 mm diameter test holes compared with larger diameter piles.

In order to properly construct the bell portion of this pile, a sufficient depth of very stiff, damp, dense, predominantly fine-grained, glacial till matrix will be required overlying the aforementioned bearing stratum. In addition, the depth of the mechanical bell is a function of the actual bell size and shaft diameter designated by the project's structural engineer.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the upper 15 m of overburden and, as such, may slough and seep 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 layer 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. Finally, the top 2.13 m of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are dimensionally dependant, potentially significant, allowable axial compressive, tensile and frost jacking resistances, relatively fast rate of pile installation and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are the possibility of encountering boulders in the glacial till matrix, subsequent difficulty removing these boulders, its potentially higher cost and longer foundation installation time per pile associated with mechanically constructing the bell, boulder removal and steel sleeving, and pile settlement, if improperly constructed.

4.3 DRILLED CAST IN PLACE CONCRETE FRICTION PILES (FOR PRO SHOP BUILDING, ONLY)

Next, drilled cast in place concrete friction piles could also be implemented as the foundation design ***ONLY*** for the proposed 4725 ft^2, two-storey, pro shop to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. Predicated upon the neutral plane of this pile type modeled near the 7' depth and the intentionally limited depth investigated in the deep test hole of 50' below present grade, the allowable effective functional friction length of cohesive soil at this site is **50' – 7' = 43'**. The laboratory data indicates that the FGR, using ULS where $\Phi = 0.4$, of the soil/concrete interface from the 7' depth down to the 50' depth, only, is 1475 psf (1475 psf in the SLS analysis for 1" deflection). Based upon these calculations, a 16" diameter friction pile drilled 50' deep, properly constructed, would safely transfer, using ULS, 265 kips of load down to the underlying glacial till matrix. The concrete, relative to the soil, has an additional net weight of approximately, 10 pcf in the upper 50' of overburden soil. 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. In order to resist potential frost jacking uplift stresses, these piles shall also have a minimum embedment length of 25' in unheated applications. Finally, full-length reinforcing steel shall also be installed in all these piles implemented in an unheated service condition.

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 should be fully cognizant that there will be boulders and cobbles in the underlying granular deposition and also the glacial till matrix. As such, these boulders and/or cobbles will have to be removed in order to properly install this foundation type. Furthermore, there is no correlation between the frequency of cobbles and boulders encountered in 125 mm diameter test holes compared with larger diameter piles.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the upper 15 m of overburden and, as such, may slough and seep 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 layer 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. Finally, the top 2.13 m of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are its dimensionally dependant, potentially significant, allowable axial compressive, tensile and rotational overturning moment resistances and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are the limited functional depth of investigated, predominantly fine-grained glacial till matrix and, as such, frictional pile capacity on this site, the possibility of encountering boulders in the glacial till matrix, boulder removal and/or steel sleeving, and potential pile settlement, if constructed improperly.

4.4 DRIVEN PRE-CAST CONCRETE END BEARING PILES

Finally, driven pre-cast concrete end-bearing piles could be implemented as the foundation design for the proposed 3 – 11,529 ft^2, four-story, condo development to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. All driven pre-cast concrete piles should be pre-drilled by an oversize auger that is 50 mm in diameter greater than the pre-cast pile diameter and also through the depth of the fill stratum, to avoid contact and, as such, the associated potentially extremely large down drag forces developed by the possibly unconsolidated sandy silt fill stratum situated over a large portion of the proposed buildings' areas, prior to being driven down to refusal onto a dense stratum, such as, a hard glacial till matrix or a dense granular stratum. The estimated length of properly driven pre-cast concrete piles required for these three buildings would be **in the order of 6 m – 15 m from the present ground elevation of these test holes.** Please see the appended specific test holes' logs. 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, all the piles' oversized pre-bores should then be backfilled with clean sand or another pre-approved equivalent substitute alternative. Furthermore, the geotechnical engineer's personnel should inspect the foundation installation in order to verify the FGR, using ULS where $\Phi = 0.6$, 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

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 and where it is 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 anticipated 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.

4.5 DRIVEN TREATED TIMBER END BEARING PILES

Alternatively, driven treated Douglas Fir timber end-bearing piles are not a feasible foundation system for the proposed 3 – 11,529 ft^2, four-story, condo development to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba due to the potentially very high down drag forces applied to this pile type from the very deep sandy silt fill stratum documented across parts of all three of these proposed buildings.

5.0 CONCRETE DESIGN

Due to the low concentration of sulphate in all the depositions encountered at this site, Normal Portland Cement shall be used in all the concrete implemented for this project. The aforementioned foundation systems' concrete shall have a minimum 28-Day laboratory compressive strength of 30 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.

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 SURFACE SLAB ON GRADE CONCRETE SLAB DESIGN

However, due to the extremely large down drag forces developed by the by the possibly unconsolidated sandy silt fill stratum situated over a large portion of the proposed buildings' areas and the vast current difference in elevation across the buildings' footprints, a surface slab on grade floor support system is not a feasible floor support design for this project.

7.0 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, damp, compact, poorly-graded silty sand, located at or below the working sub-grade elevation shall then be proof-rolled by a heavy roller until it has at least 95 % of its 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 rock 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 rock 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 and the sidewalk's concrete slab, their sub-bases shall consist of at least two layers of 50 mm down crushed rock 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 47 of this report.

The sidewalk's 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.

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 3 – four-story condominiums anticipated foundation stresses, driven pre-cast concrete end-bearing piles foundation design could be implemented as the foundation design for the proposed 3 – 11,529 ft^2, four-story, condo development to be located at Wheat City Golf Course located at 3500 McDonald Avenue in Brandon, Manitoba. Therefore, 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, economical and efficient one for the proposed four-story condominium project placed on a property with the aforementioned geotechnical design parameters. Alternatively, the proposed 4725 ft^2, two-storey, pro shop could be constructed using either footings, cast in place concrete friction piles or straight shaft or spread bore end-bearing piles. 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 crushed rock 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.

Similarly, the backfill material around the perimeter of the proposed structure shall be brought up to its future grade implementing either a 20 mm down crushed rock 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.

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

METRIC SIEVE SIZE (µm)	20 mm Crushed rock (% Passing)	50 mm Crushed rock (% 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 exterior of the entire structure. This insulation shall be placed along the face 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 grade beams.

All the various proposed asphalt pavement surfaces shall be constructed as per the recommendations outlined in section 7.0 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 buildings' superstructures and suspended main floors shall be entirely structurally supported by only one of the aforementioned approved foundation systems. In addition, in all the aforementioned feasible piled foundation designs, a void space, of at least 150 mm in thickness, shall be constructed under all pile caps, grade beams and/or walls to allow for the potential expansive capability of the various soil depositions underlying this site. The structurally supported concrete main floor shall overlay either a minimum 600 mm deep vented crawlspace or a minimum 150 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 basements and/or crawlspaces are not intended for the proposed structures.

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.

PROVINCE OF MANITOBA
3/28/17
S. J.
BLOCK
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
M. Block & Associates Ltd.
No. 1527 Expiry: April 30, 2017

Jeffrey Block, P. Eng., Senior Geotechnical Engineer