McINTOSH•LALANI ENGINEERING LTD.

PRELIMINARY GEOTECHNICAL EVALUATION
CAREFREE ESTATES ASP
M.D. of FOOTHILLS, ALBERTA

April 2014

M•L 6588

GEOTECHNICAL EVALUATION
CAREFREE ESTATES ASP
M.D. of FOOTHILLS, ALBERTA

SUBMITTED TO:

Carefree Communities
Calgary, Alberta

PREPARED BY:

McIntosh•Lalani Engineering Ltd.
Calgary, Alberta

April 2014

M•L 6588

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1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by McIntosh•Lalani Engineering Ltd. (M•L) for a proposed residential development in the M.D. of Foothills, Alberta. This preliminary evaluation was undertaken at the request of Mr. Robert Calvert of Carefree Communities. The objective of this evaluation was to assess the general subsurface soil conditions at the site for preliminary design purposes. A complete sub-surface evaluation should be completed prior to final design and construction.

This report presents the results of the drilling program and provides preliminary geotechnical recommendations for design and construction.

2.0 PROJECT DETAILS

The project is understood to include the design and construction of a residential development. This report provides recommendations for site grading, utility installation and surface construction as well as single family home construction.

The subject property is made up of portions of E½ 20-21-9 W4. Current site uses include mixed agriculture and country residential. From north to south, the site slopes down slightly but is generally flat. The terrain is typical broken prairie with occasional sloughs.

3.0 FIELD AND LABORATORY WORK

The fieldwork consisted of advancing seventeen boreholes within the subject property. The boreholes were advanced to depths of 9.1 metres or refusal. The boreholes were advanced using a truck mounted solid-stem drill rig contracted from All Service Drilling Inc. of Airdrie, Alberta. The boreholes were advanced on March 4th, 5th and 23rd. Soil was classified from the disturbed auger samples and SPT blow counts were utilized to aid in determining in-situ soil strengths.

Upon completion of the boreholes, 25 mm PVC piezometers were installed in each of the boreholes for future groundwater monitoring. Borehole locations were selected by representatives of M•L. Locations of the boreholes are illustrated in Figure 1. Borehole logs are presented in Appendix A.

Natural moisture content tests, soluble sulphate tests, Atterberg Limits grain size analysis and organic content tests were completed on select soil samples recovered from the auger flights and SPT sampling. The results of these tests are presented on the borehole logs and elsewhere in this report.

4.0 SUBSURFACE CONDITIONS

4.1 Surficial Geology

The soils in this region are expected to consist of glacial tills of the Balzac, Lochend and Spyhill drifts. "Surficial Geology of the Calgary Urban Area" (Moran, 1986) describes

each of the soil units. Tills of the Balzac and Lochend drifts typically consist of 10 – 20 percent sand, 45 – 60 percent silt and 20 – 40 percent clay. The older Spy Hill drift typically contains 15 – 20 percent sand, 40 – 45 percent silt and 40 – 45 percent clay. Each contains limestone, however the younger Balzac and Lochend drifts generally contain yellow or tan stones while the Spy Hill drift contains darker grey to black stones. Each of these overlies the Porcupine Hills formation.

4.2 Soils

The general subsurface stratigraphy consisted generally of silt or clay tills, in some cases overlying bedrock. Topsoil was encountered in a majority of boreholes and varied in thickness from 50 millimetres to 1.3 metres.

4.2.1 Silty Clay

Clay till was encountered at the surface or below the topsoil in fifteen of the seventeen boreholes and below a layer of sandy silt in one other borehole. This material was firm to hard in consistency and dry to moist in moisture content. It contained variable amounts of gravel and trace to some sand. The silty clay extended to depths ranging from approximately 1.8 to 5.2 metres below grade and at least to the ends of eleven boreholes. Oxide staining was noted in these soils and the colour varied from light to medium brown and to grey at greater depth.

4.2.2 Silt Till

Silt tills were encountered below the silty clay in one borehole and below the topsoil in three boreholes. This material extended to depths ranging from approximately 1.8 to 3.6 metres below grade. A pocket of the same material was encountered in one borehole from 1.6 to 2.6 metres. This material was generally compact and damp with variable amounts of sand and clay. It was medium or golden brown.

4.2.3 Gravel

Gravel was encountered in one borehole at a depth of approximately 4.6 metres. Refusal was encountered in this material at a depth of 6.7 metres. It was dense and wet with trace sand and cobbles. The gravel was medium brown in colour.

4.2.4 Bedrock

Sedimentary bedrock (generally siltstone) was encountered in four boreholes. This material varied from weak to very strong and was generally damp. The colour was highly variable including a range of browns and greys.

The preceding descriptions represents a majority of the subsurface conditions encountered in the boreholes, however some variations were encountered. A more detailed soil description is presented in the borehole logs which are included in Appendix A.

At the time this report was prepared, information on subsurface stratigraphy was available only at discrete borehole locations. Conditions were extrapolated and

interpolated from the borehole locations to develop recommendations. Adequate monitoring should be provided during construction to check that these assumptions are reasonable.

4.3 Groundwater

There was evidence of groundwater seepage during drilling of some of the boreholes and four were wet upon completion. Groundwater levels were measured in the standpipes on March 18, 2014 for the boreholes drilled earlier and April 2, 2014 for the boreholes drilled later. At the times recorded, the water levels varied from 0.64 to 5.98 metres below grade.

5.0 DISCUSSION AND RECOMMENDATIONS

Design recommendations presented in this report are based on the assumption that an adequate level of inspection will be provided during construction and that all construction will be carried out by a suitably qualified contractor, experienced in underground utility installation and earthworks. An adequate level of inspection is considered to be necessary for:

- For earthworks – full time monitoring and compaction testing.
- For underground utility installation and backfilling – full time monitoring and compaction testing.
- Residential Foundations – bearing inspections completed by a qualified geotechnical engineering company.

Inspection should be carried out by suitably qualified persons, independent of the contractor. The purpose of providing an adequate level of inspection is to check that recommendations, based on the data obtained at discrete test pit locations, are relevant to other areas of the site.

5.1 General Recommendations

The site consists of suitable bearing soil provided the recommendations within this report are followed. The following is a list of a few of the highlighted geotechnical aspects of the site. This summary should be read in conjunction with the entire report:

- On site soils are suitable for use as general engineered fill.
- The encountered silty clay, silt and gravel soils are capable of supporting residential structures with an allowable bearing capacity of 100 kPa. Some perched groundwater seepage may be encountered in basement excavations.
- Excavations within the silty clay soils may be constructed with sidesloping at a rate of 1 horizontal to 1 vertical (1H:1V) above a maximum vertical cut of 1.5 metres. Where non-cohesive soils are encountered, sidesloping at a rate of 1H:1V is required from the base of the excavation. Additional sidesloping may be required if excessive sloughing or groundwater infiltration is encountered.
- Deep cuts within the sandy gravel in borehole 8 will experience higher groundwater flows.

- Shallow bedrock was encountered in boreholes 9 through 12 at depths of 3 to 4.5 metres. Consideration of excavations and earthworks in the rock should be made.
- Weeping tile will be required in at least portions of the site where groundwater is within 2.1 metres of the lowest top of footings.

5.2 Construction Excavation and Temporary Dewatering

The composition and consistencies of the soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials. It is anticipated that open excavations of up to 3.0 metres deep will be required for installation of utilities and construction of foundations.

Where cohesive silty clay soils are encountered, it may be possible that excavations could be made with up to a 1.5 metre vertical cut and a 1 Horizontal to 1 Vertical (1H:1V) side slope above that. Excavations in the cohesionless silt and sand will require at least 1H:1V side sloping from the base of the excavation. Additional (i.e. shallower) side sloping in the soils will likely be necessary if water seepage is encountered, or if sloughing is occurring. Excavations must be carried out in accordance with Alberta Occupational Health and Safety (OH & S) Regulations. A qualified geotechnical engineering firm should be notified to inspect excavations to verify the excavation is a safe working slope.

Should space constraints not allow adequate side sloping for the excavation to ensure a safe temporary excavation, shoring or trench boxes will be necessary.

Any seepage that occurs should be dewatered using a system of ditches, sumps and pumps. Significant water seepage from wet layers should be periodically expected. Well point dewatering is not expected to be necessary.

5.3 Shallow Foundations

Based on the results of the preliminary geotechnical investigation, conventional strip and spread footings may be used for the residential structures within this development. The footings should be designed for an Ultimate Limit State (ULS) unfactored bearing resistance of 260 kPa in the competent native soils on site. A geotechnical resistance factor of 0.5 may be used in conjunction with this ULS value.

To undertake the shallow foundation design using the Working Stress Method, a net allowable bearing pressure of 100 kPa (excluding overburden soil pressure) may be used within the competent native or engineered fill soils on site.

The footing sizes and depths have been estimated to provide the above design values. Should unconventional footing sizes be utilized, a review of the footing sizes and bearing resistances should be undertaken. Footings should be placed on homogenous soils to avoid differential settlements that could occur if footings span non-uniform soil types (e.g. fill to native).

All foundation excavations should be protected from meteorological elements such as rain, snow, freezing and excessive drying. Foundations should be placed soon after excavation.

5.4 Frost Protection

Footings within heated structures should be founded at a depth of 1.4 metres below grade, measured from bottom of footing to final grade. All unheated structures should be founded at a depth of 2.1 metres below grade to protect against the effect of frost heaving. Portions of a heated structure that extends away from the main heated building such as deck piles or any portion of the foundation that extends more than 1.0 metres from the foundation wall of the heated structures should be considered an unheated foundation and the appropriate 2.1 metres of soil cover or an insulation design cover should be used.

5.5 Weeping Tile

Groundwater was encountered as shallow as 0.64 metres below grade. Weeping tile subsurface drainage at footing elevation is required when groundwater is within 2.1 metres of the lowest top of footing.

Weeping tile drains should consist of a minimum of 100 mm diameter perforated pipe around the perimeter of below grade structures at the bottom of footing elevation. The pipe should be backfilled with free draining washed gravel and positively drained to a storm sewer, possibly through a sump and pump. Alternatively, the weeping tile can daylight to a ditch/swale or storm ponds as appropriate.

All backfill around the foundation walls of residential structures should be compacted.

5.6 Site Grading

Some cuts and fills may be required within the proposed development. All organic topsoil, deleterious soils and vegetation should be removed from areas to be filled. The backfill should be placed in uniform lifts compacted to a minimum of 98 percent of Standard Proctor Density at a moisture content in the range of optimum to 3 percent above optimum.

Grading all slopes will require a 5H:1V backsloping in building areas prior to placing fill. Upon determination of a site grading plan, M•L should be consulted to review the stripping requirements for the site. M•L should be notified to inspect all soil surfaces prior to placement of fill soils to verify the fill soils have been properly removed. The site soils are suitable for use as engineered fill.

It is recommended that final site grading be provided to direct water to areas remote from all proposed structures. Minimum landscape gradients of 2 percent are recommended to reduce the risk of run-off ponding in localized areas. Furthermore, downspouts should be positively directed away from the buildings.

5.7 Pipe Support

The composition and consistencies of the soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials. It is anticipated that open excavations of up to 3.0 metres deep will be required for the installation of deep utilities.

Fine-grained non-cohesive sand and silt seams are present. Should excessive water collect in the bedding gravel be allowed to flow in the bedding gravel some scour and erosion will occur over time. This should be prevented by compacting clay plugs around the pipe at regular intervals. Excavations for pipe installations should be inspected by a qualified geotechnical engineer. Clay plug details along mainlines and around catch basin barrels and manhole barrels in trap low areas may be required to prevent washing of fine silt soils into bedding gravels. Where fine silts and sands are encountered, M•L should be notified to provide these site specific recommendations. Geotextile placed on-top of the bedding gravel may be necessary where very silty or sandy soil is used as fill directly on-top of the bedding gravel. The geotextile will prevent migration of fine grained soil into the gravel which would result in future settlement.

5.8 Lateral Wall Pressures

Permanent and temporary walls should be designed to resist all lateral pressures including those due to soil/bedrock or backfill, surcharges, water and adjacent footings using the following expressions defined in terms of total and effective stresses:

$$P_{\text{lateral pressure}} = P'_{\text{earth+surcharge}} + P_{\text{net water}} + P'_{\text{adj ft}}$$

where $P_{\text{lateral pressure}}$ = total lateral pressure at a given depth (kN/m^2)

$P'_{\text{earth+surcharge}}$ = lateral earth pressure due to soil/bedrock or fill and surcharges at a given depth (kN/m^2)
= $K(\gamma h + q)$ above water table or phreatic surface
= $K(\gamma' h + q)$ below water table or phreatic surface

$P_{\text{net water}}$ = net water pressure on wall at a given depth (kN/m^2), calculated by hand drawn flow net or computer solution based on drainage conditions

$P'_{\text{adj ft}}$ = lateral earth pressure due to adjacent footings at given depth (kN/m^2)

K = coefficient of lateral earth pressure, K_a, K_o, K_p or combination of as noted below

K_a = coefficient of active earth pressure

K_o = coefficient of at-rest earth pressure

K_p = coefficient of passive earth pressure

γ' = submerged unit weight of backfill or natural soil or bedrock (kN/m^3)

$\gamma' = \gamma - \gamma_w$

γ = bulk unit weight of backfill or natural soil or bedrock (kN/m^3)

γ_w = unit weight of water 9.81 kN/m^3

h = excavation depth (m)

q = surcharge load (kN/m^2)

The following table presents coefficients lateral earth pressure and unit weights.

	K_a	K_o	K_p	γ (kN/m^3)
Engineered Fill	0.38	0.58	2.66	21.5
Native Silts & Clays	0.37	0.55	2.56	21.5

5.9 Permanent Lateral Wall Pressures

The distribution of soil pressure against a permanent wall may be assumed using the general equation given above under the Section 6.11 with $K = K_o$.
Permanent walls should be designed to resist the maximum possible water pressure subject to drainage conditions determined by design.

Recommendations for permanent anchors are not included in this report. Lateral forces against permanent walls may be resisted by the wall section and top and bottom slab support.

5.10 Temporary Lateral Wall Pressures

The distribution of soil pressure against a temporary wall may be assumed using the general equation given above and values of K according to deformation restrictions as follows:

- If moderate wall movements can be permitted,
  $K=K_a$.

- If foundations of buildings or services exist at a shallow depth, at a distance less than H (height of the wall) behind the top of the wall and not closer than 0.5H,
  $K= 0.5 (K_a + K_o)$.

- If foundations or services exist at a shallow depth, at a distance less than 0.5H,
  $K=K_o$.

5.11 Temporary Passive Wall Resistance

Passive resistance at the base of a temporary wall may be calculated as follows:

$P'_p = K_p (\gamma' d/1.5)$

where P'_p = passive resistance at depth below excavation (kN/m^2)
K_p = coefficient of passive earth pressure
γ' = submerged unit weight (kN/m^3)
d = depth below excavation level (m)

The passive resistance should be taken to act on an area twice the pile diameter below grade.

5.12 Concrete Type

Laboratory testing of a soil sample recovered from the above noted site has been completed. The result indicates a negligible soluble sulphate concentration of up to 0.014 percent. Therefore, the use of Type GU (Normal Portland) cement concrete in accordance with CSA A23.1, Table 2 for F-2 exposure is suitable for all concrete in contact with the soil which these samples represent. The F-2 exposure class requires minimum 25 MPa strength at 28 days, a maximum water to cementing materials ratio of 0.55 and 4-7 percent entrained air by volume based on 14-20 mm aggregate.

It is recommended that all imported soils to be utilized on site be tested for soluble sulphate concentrations.

6.0 BACKFILL MATERIALS AND COMPACTION

Portions of existing on-site materials may be suitable for use as general engineered or structural fill subject to material evaluation and removal of deleterious materials. Imported fill should be approved for use as structural or general engineered fills. Areas where fill soils have been identified will require further inspection by a qualified geotechnical engineering firm before additional backfilling activities begin.

Recommended compaction specifications and materials are as follows:

- Structural fill - 100 percent Standard Proctor Maximum Dry Density (SPMDD), maximum compacted lift thickness 250 mm, maximum grain size 200 mm. Structural fill materials should comprise clean, well-graded inorganic granular soils.
- General engineered fill - 98 percent SPMDD, 0 to +3 percent of optimum moisture content, maximum compacted lift thickness 300 mm. General engineered fill materials should comprise clean, well-graded granular soils, or inorganic medium to low plastic cohesive soils.

Where washing of fines is possible, fill material placed should be separated from coarser or finer material by a suitable geotextile.

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

7.0 REVIEW OF DESIGN AND CONSTRUCTION GUIDELINES

M•L should review details of design and specifications related to geotechnical aspects prior to construction. Adequate monitoring during construction will be required. All construction should be carried out by a qualified contractor experienced in foundation and earthworks construction. Adequate monitoring includes:

- Shallow Foundations - Inspection by a qualified geotechnical engineer prior to placement of footings.
- Earthworks - Full-time monitoring and compaction testing.
- Utility Installation - Full-time monitoring and compaction testing.

All monitoring should be carried out by a qualified person, independent of the contractor. M•L will provide these services if requested. Failure to provide an adequate level of foundation monitoring may be in contravention of building code requirements.

7.1 Design and Construction Guidelines

Recommended general design and construction guidelines are provided in Appendix B under the following headings:

- Backfill Materials and Compaction
- Proof-Rolling
- Construction Excavations
- Floor Slabs-On-Grade
- Shallow Foundations

These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the work, although they prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix B, the main text should govern.

8.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings in seventeen boreholes. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, M•L should be notified and given the opportunity to review our current recommendations in light of new findings. This report does not include any recommendations related to contaminants in soil or groundwater.

Should documentation of previous Phase 1 or 2 assessments, of previous fill and grading operations, or other historical land use exist for the site, M•L should be notified and supplied with this information for review.

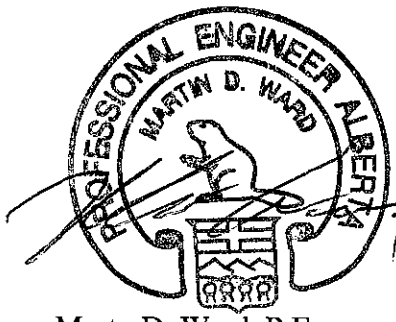
This report has been prepared for the exclusive use of Carefree Communities and its agents for specific application to the development described in this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No warranty is expressed or implied.

9.0 CLOSURE

We trust information presented herein meets with your present requirements. If you have questions or require additional geotechnical services please contact our office.

Respectfully submitted,

McIntosh•Lalani Engineering Ltd.



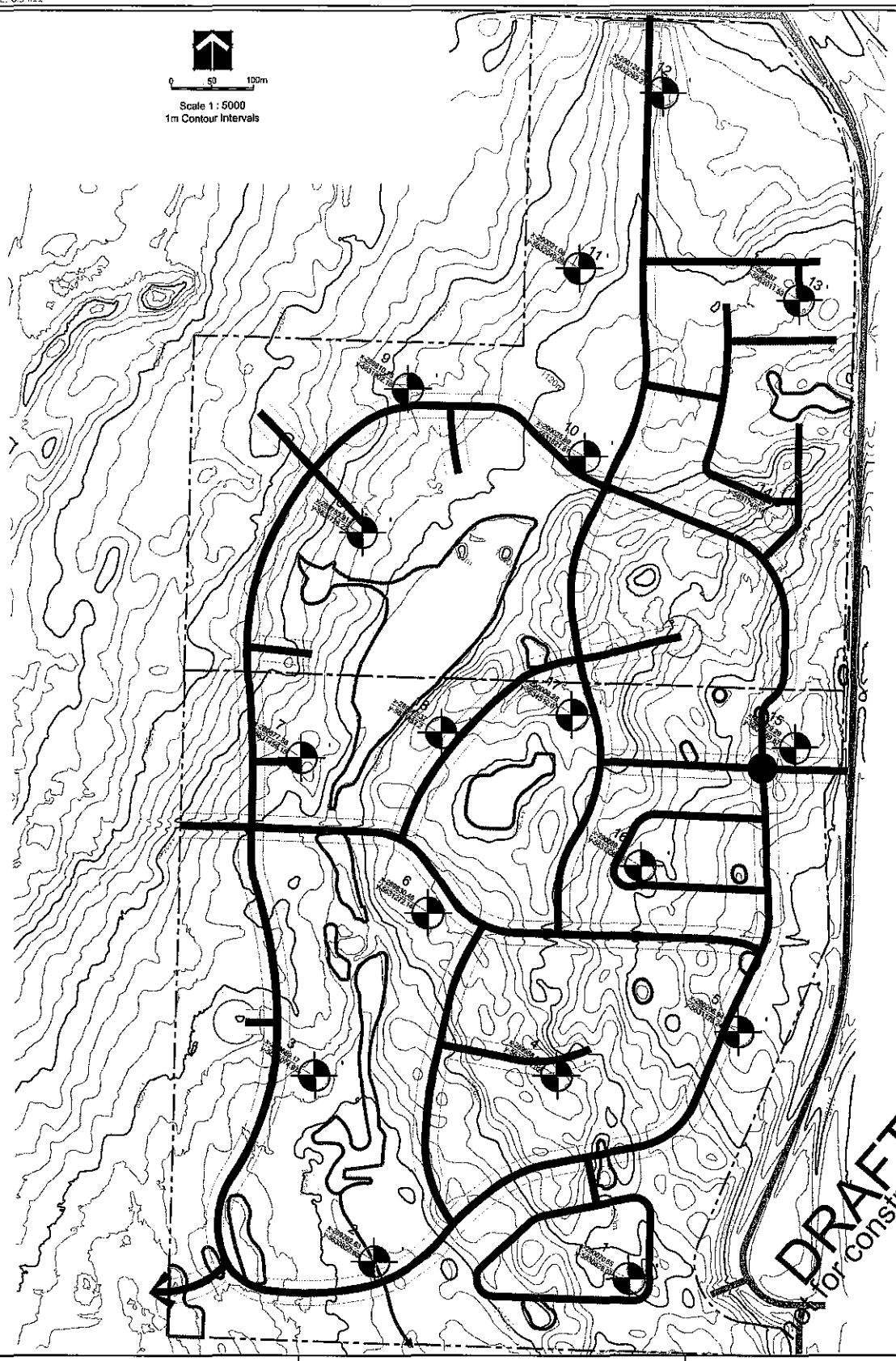
May 6 2014

Neil Klassen, P.Eng.

Marty D. Ward, P.Eng.
Senior Project Engineer
APEGA Permit #P6482

FIGURES

ORIGINAL PAPER SIZE: 8.5 x11



Client:	Project:	Title:
Carefree Communities	Carefree Estates ASP	Borehole Locations

Directional Arrow:

McINTOSH•LALANI ENGINEERING LTD.

Job Number:	Drawing Number:	Scale:	Date:
ML-6588	6588-1	N.T.S.	April 23, 2014

TABLES

WATER LEVELS

Borehole Number	Water Level (m)
1	5.98
2	0.64
3	1.52
4	3.23
5	1.5
6	4.61
7	Dry
8	5.25
9	2.88
10	Dry
11	Dry
12	Dry
13	Dry
15	2.86
16	1.03
17	Dry
18	2.05

APPENDIX A

BOREHOLE LOGS

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:1
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Silty Clay (Till) - stiff, dry to damp, low plasticity, some sands, light brown.									
				1-1			17.7				
1		- damp, medium to low plasticity, trace gravels and oxides, medium brown.									
				1-2		4-4-4					
2		- very stiff.									
				1-3			14.0		[SO_4] = 0.007%		
3				1-4		7-9-10					
				1-5			14.5				
4											
				1-6	CL-ML	6-9-11					
5											
				1-7			14.6				
6 ▼											
				1-8		6-9-13					
7		- no oxides, grey.		1-9							
		- stiff.									
				1-10		5-7-8					
8		- medium plasticity.									
				1-11							
9											
		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 5.98m									

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 5.98 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:2
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 100mm thick.			TPSL						
0.5		Silty Clay (Till) - firm, moist, medium plasticity, some sands, medium brown.		2-1							
1		- stiff, damp.									
1.5				2-2		5-7-8					
2		- very stiff, medium to low plasticity, trace sands and gravels, oxides.		2-3							
3				2-4		8-12-16					
3.5				2-5							
4		- hard.									
4.5				2-6	CL-ML	9-12-23					
5				2-7							
6		- no oxides, grey.		2-8		11-18-23					
7				2-9							
7.5				2-10		10-14-16					
8				2-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 0.64m									

ML STANDARD AUGER 6588 CAREFREE ESTATES ASP.GPJ M-L STANDARD.GDT 7/4/14

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 0.64 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:3
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 300mm thick.			TPSL						
		Silty Clay (Till) - firm, moist, medium plasticity, some sands, medium brown.		3-1			20.6		$[SO_4]$ = 0.010%		
1											
				3-2		2-2-3					
2		- stiff, water seepage.		3-3			19.8				
		- very stiff, damp, medium to low plasticity, trace sands and gravels, oxides.									
3				3-4		5-7-8					
				3-5			13.5				
4											
				3-6	CL-ML	13-19-22					
5				3-7							
6		- no oxides, brown grey.		3-8		9-13-20					
				3-9			13.9				
7											
				3-10		13-17-20					
8				3-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 3.0m with 1.5m slotted. Wet upon completion.									
10		Water Levels: March 18, 2014 - 1.52m									

ML STANDARD AUGER 6588. CAREFREE ESTATES ASP.GPJ M-L STANDARD.GDT 30/4/14

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Calgary, AB
(403) 291-2345

Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 1.52 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:4
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) / Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 120mm thick.			TPSL						
1		Silty Clay (Till) - stiff, damp, medium to low plasticity, some sands, trace gravels, oxides, medium brown with trace greys.		4-1							
2		- no greys.		4-2		3-4-5					
				4-3							
3				4-4		6-6-7					
4				4-5							
5		- trace coals.		4-6	CL-ML	5-7-9					
		- no oxides, brown with greys.		4-7							
6		- no oxides, brown grey.		4-8		5-6-9					
7				4-9							
8		- grey.		4-10		4-6-7					
				4-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 3.0m with 1.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 3.23m									

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 3.23 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:5
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 100mm thick.			TPSL						
		Silty Clay (Till) - firm, moist, medium plasticity, some sands, medium brown.		5-1							
1											
				5-2		3-2-3					
2		- stiff, damp, medium to low plasticity, trace sands and gravels, coals, oxides.		5-3							
3											
				5-4		4-8-10					
				5-5							
4											
				5-6	CL-ML	9-9-12					
5											
				5-7							
		- hard.									
6											
		- no oxides, grey. Spoon wet.		5-8		10-15-20					
				5-9							
7											
				5-10		9-12-14					
8											
				5-11							
9											
		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Wet upon completion.									
10		Water Levels: March 18, 2014 - 1.50m									

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 1.5 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:6
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Silty Clay (Till) - stiff, damp, trace sand and gravel, low plastic, trace oxides and coal, medium brown.									
1				6-1							
2				6-2		4-5-7					
				6-3							
3				6-4		4-5-6					
4				6-5							
				6-6	CL-ML	3-5-8					
5				6-7							
6				6-8		9-12-16					
		- medium grey.		6-9							
7				6-10		4-5-7					
8				6-11							
9		END OF HOLE at a depth of 9.1 m. 25 mm PVC standpipe installed to a depth of 9.1 m with 4.6 m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 4.61 m									

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Logged By: Scott Bryan	Completion Depth: 30 ft
Reviewed By:	Drilled on: 05/03/2014
Groundwater Depth: 4.61 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:7
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 300mm thick.			TPSL						
		Silty Clay (Till) - stiff, damp, low plasticity, trace sands and gravels, oxides, medium brown.		7-1							
1		- very stiff.									
				7-2		7-8-10					
2				7-3							
				7-4		7-11-13					
3											
		- hard, some gravels.		7-5							
4											
				7-6	CL	11-14-21					
5				7-7							
6				7-8		9-20-20					
				7-9							
7											
				7-10		14-13-19					
8				7-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 8.8m with 4.5m slotted. Dry upon completion.									
		Water Levels: April 2, 2014 - Dry.									
10											

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 26/03/2014
Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:8
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) / Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, damp, compact.									
				8-1	TPSL						
1											
		Silty Clay (Till) - stiff, damp, low plasticity, some sands, trace gravels, oxides, medium brown.		8-2		4-6-8					
2				8-3							
		- very stiff.									
3					CL						
				8-4		9-11-15					
		- damp to moist, some gravels.									
4				8-5							
		Gravel - dense, wet, trace sands, cobbles, medium brown.		8-6		28-40-50					
5											
				8-7							
6					GP						
				8-8							
7		Refusal - END OF HOLE at a depth of 6.7m. 25mm PVC stand pipe installed to a depth of 4.7m with 3.0m slotted. Wet upon completion.									
		Water Levels: April 2, 2014 - 5.25m									
8											
9											

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Logged By: TW	Completion Depth: 22.5 ft
Reviewed By:	Drilled on: 26/03/2014
Groundwater Depth: 5.25 m	Page 1 of 1

ML STANDARD AUGER 6588 CAREFREE ESTATES ASP.GPJ ML STANDARD.GDT 7/4/14

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:9
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) / Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 100mm thick.			TPSL						
1		Silty Clay (Till) - very stiff, dry to damp, low plasticity, some sands, trace gravels, oxides, medium brown.		9-1	CL		14.0				
				9-2		7-9-13					
2		Silt (Till) - dense, damp, yellow brown.		9-3			9.1		$[SO_4]$ = 0.014%		
3				9-4	ML	10-14-24					
4		Bedrock (Siltstone) - weak, damp, yellow brown.		9-5			14.8				
		- medium strong, grinding.									
5				9-6			15.1				
6					BE						
7		- dark grey, water seepage.		9-7							
8		- medium grey.		9-8							
9											
		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Wet upon completion.									
10		Water Levels: April 2, 2014 - 2.88m									

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 26/03/2014
Groundwater Depth: 2.88 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:10
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 80mm thick.			TPSL						
		Sandy Silt (Till) - compact, damp, trace clays, yellow brown.		10-1			13.0		$[SO_4]$ = 0.007%		
1		- trace oxides.									
				10-2	MLS	5-5-5					
2				10-3			12.2				
				10-4		50@3"					
3		Bedrock (Siltstone) - medium strong, damp, yellow brown.									
				10-5			15.5				
4											
		- alternating medium strong and strong layers.									
5				10-6			8.4				
6					BE						
		- strong, brown.									
7				10-7							
8				10-8							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 8.5m with 4.5m slotted. Dry upon completion.									
10		Water Levels: April 2, 2014 - Dry.									

ML STANDARD AUGER 6588. CAREFREE ESTATES ASP.GPJ M-L STANDARD.GDT 30/4/14

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Logged By: TW	Completion Depth: 30 ft
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Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:11
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics approx. 80mm thick, organic browns approx. 80mm thick.			TPSL						
1		Sandy Silt (Till) - compac,t damp, trace clays, medium brown.		11-1	MLS						
				11-2		5-8-9					
2		Silty Clay (Till) - very stiff, damp, medium to low plasticity, trace sands and gravels, oxides, medium brown.		11-3							
3		- hard, low plasticity.		11-4	CL-ML	7-15-16					
		- dry to damp, some sands.		11-5							
4											
		Bedrock (Siltstone) - weak, damp, yellow brown.		11-6		14-27-50@5"					
5		- medium strong, light brown.		11-7							
6											
7				11-8	BE						
		- strong, light grey.									
8											
				11-9							
9											
		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: April 2, 2014 - Dry.									

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Logged By: TW	Completion Depth: 30 ft
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Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:12
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 50mm thick, organic browns approx. 50mm thick.			TPSL						
1		Silt (Till) - compact, damp, trace sands and gravels, medium brown.		12-1			14.9		$[SO_4]$ = 0.007%		
2		- dense.		12-2	ML	8-14-16					
				12-3			14.0				
3		Bedrock (Sandstone) - strong, damp, dark brown. (Siltstone) - medium strong.		12-4		50@5"					
4				12-5			8.1				
5		- strong, light brown. Auger grinding.		12-6	BE		6.5				
6		- very strong.		12-7							
		Refusal - END OF HOLE at a depth of 6.1m. 25mm PVC stand pipe installed at a depth of 6.0m with 3.0m slotted. Dry upon completion.									
7		Water Levels: April 2, 2014 - Dry.									
8											
9											
10											

ML STANDARD AUGER 6588. CAREFREE ESTATES ASP.GPJ M-L STANDARD.GDT 30/4/14

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Logged By: TW	Completion Depth: 20.5 ft
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Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:13
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 80mm thick.			TPSL						
1		Silty Clay (Till) - hard, dry, low plasticity, trace sands and gravels, oxides, coals, medium brown.		13-1							
2				13-2		14-20-31					
				13-3	CL						
3				13-4		8-16-21					
4				13-5							
5				13-6		14-21-28					
		Bedrock (Siltstone) - medium strong, damp, yellow brown.		13-7							
6		- brown.									
7				13-8	BE						
		- strong, grey brown.									
8											
				13-9							
9											
		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 8.8m with 4.5m slotted. Dry upon completion.									
10		Water Levels: April 2, 2014 - Dry.									

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Logged By: TW	Completion Depth: 30 ft
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Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:15
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 300mm thick, organic browns approx. 600mm thick.		15-1	TPSL						
1		Silty Clay (Till) - stiff, damp to moist, medium plasticity, some sands, medium brown.		15-2		4-5-6		■			
2		- very stiff, damp, medium to low plasticity, trace sands and gravels, oxides.		15-3							
3				15-4		6-10-8		■			
4				15-5							
5				15-6	CL-ML	5-8-12		■			
6				15-7							
7		- some sands, increase in silt content.		15-8		7-8-12		■			
8		- no oxides, grey.		15-9							
9				15-10		8-12-14		■			
10		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 3.0m with 1.5m slotted. Dry upon completion. Water Levels: March 18, 2014 - 2.86m		15-11							

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 2.86 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:16
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 450mm thick.			TPSL						
1		Silty Clay (Till) - stiff, moist, medium plasticity, some sands, medium brown.		16-1	CI						
2		Sandy Silt (Till) - compact, moist, trace clays, coals, water lenses, medium brown.		16-2	MLS	3-5-6					
				16-3							
3		Silty Clay (Till) - stiff, damp, medium to low plasticity, trace sands and gravels, oxides, coals, medium brown. - very stiff.		16-4		4-7-9					
4				16-5							
5				16-6		7-9-11					
				16-7							
6		- no oxides or coals, grey.		16-8	CL-ML	7-10-13					
7				16-9							
8		- dry to damp.		16-10		7-11-18					
				16-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 1.03m									

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Logged By: TW	Completion Depth: 30 ft
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Groundwater Depth: 1.03 m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.: 17
Client: Carefree Communities	All Service Drilling Inc.	Project No.: 6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 100mm thick.			TPSL						
		Silty Clay (Till) - stiff, dry to damp, low plasticity, some sands, trace gravels, medium brown.		17-1			15.1		$[SO_4]$ = 0.007%		
1		- damp, medium to low plsticity.									
				17-2		4-5-6					
2		- very stiff, trace sands and gravels, oxides.									
				17-3			14.5				
3				17-4		5-7-9					
				17-5			15.8				
4											
				17-6	CL-ML	7-9-12					
5				17-7			14.2				
6				17-8		6-7-9					
				17-9							
7											
				17-10		7-12-12					
8		- no oxides, grey.									
				17-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - Dry.									

ML STANDARD AUGER 6588 CAREFREE ESTATES ASP.GPJ M-L STANDARD.GDT 30/4/14

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: m	Page 1 of 1

Project: Carefree Estates ASP	Drilling Information:	Borehole No.:18
Client: Carefree Communities	All Service Drilling Inc.	Project No.:6588
	M10 SS-Auger	Elevation:

SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | AUGER SAMPLE | NO RECOVERY

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m) Water Level	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		Topsoil - black organics, approx. 100mm thick.			TPSL						
		Silty Clay (Till) - stiff, damp, medium plasticity, some trace sands and gravels, oxides, coals, light brown.		18-1							
1		- medium to low plsticity, medium brown.									
				18-2		4-4-7					
2 ▼				18-3							
3				18-4		5-7-9					
				18-5							
4				18-6	CL-ML	5-8-10					
5				18-7							
6				18-8		8-10-12					
				18-9							
7				18-10		6-15-13					
8		- no oxides, grey.		18-11							
9		END OF HOLE at a depth of 9.1m. 25mm PVC stand pipe installed to a depth of 9.1m with 4.5m slotted. Dry upon completion.									
10		Water Levels: March 18, 2014 - 2.05m									

ML STANDARD AUGER 6588 CAREFREE ESTATES ASP.GPJ ML STANDARD.GDT 7/4/14

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Logged By: TW	Completion Depth: 30 ft
Reviewed By:	Drilled on: 04/03/2014
Groundwater Depth: 2.05 m	Page 1 of 1

APPENDIX B

DESIGN AND CONSTRUCTION GUIDELINES

BACKFILL MATERIALS AND COMPACTION

Maximum density, as used in this section, means Standard Proctor Maximum Dry Density (ASTM Test D698) unless specified noted otherwise. Optimum moisture content is as defined in this text.

"General engineered fill" materials should comprise clean, well-graded granular soils or inorganic, low-plastic cohesive soils. Such material should be placed in compacted lifts not exceeding 200 mm and compacted to not less than 98 percent of maximum density, at a moisture content at or slightly above optimum.

"Structural fill" materials should comprise clean, well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 98 percent of maximum density, at a moisture content at or slightly (0 to 3 percent) above optimum.

"Landscape fill" material may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90 percent of maximum density.

Backfill adjacent to and above footings, abutment walls, basement walls, grade beams and pile caps or below highway, street or parking lot pavement sections should comprise general engineered fill materials as defined above.

Backfill supporting structural loads should comprise structural fill materials as defined above.

Backfill adjacent to exterior footings, foundation walls, grade beams and pile caps and within 300 mm of final grade should comprise low-plastic cohesive general engineered fill as defined above. Such backfill should provide a relatively impervious surface layer to reduce seepage in the sub-soil.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflection is apparent, the compactive effort should be reduced accordingly. In order to reduce potential compaction induced stresses, only hand held compaction equipment should be used in the compaction of fill within 500 mm of retaining walls or basement walls.

Backfill materials should not be placed in a frozen state or placed on a frozen subgrade. All lumps of materials should be broken down during placement.

"Crushed gravel", should conform to the following grading:

PERCENT PASSING BY WEIGHT
(NOMINAL GRAVEL SIZE)

SIEVE SIZES (SQUARE OPENINGS)	100 mm	50 mm	25 mm
100 mm	100	---	---
75 mm	90 - 100	---	---
50 mm	---	100	---
40 mm	60 - 80	90 – 100	---
25 mm	---	---	100
20 mm	40 - 66	50 – 75	95 - 100
10 mm	25 - 54	25 - 52	60 - 80
4.75 mm	15 - 43	15 - 40	40 - 60
2.36 mm	10 - 35	10 - 33	28 - 48
0.60 mm	5 - 23	5 - 23	13 - 29
0.30 mm	---	---	9 - 21
0.15 mm	3 - 12	2 - 14	6 - 15
0.075 mm	2 - 10	1 - 10	4 - 10

Gravel:

100 mm Crushed Gravel: At least 13 percent by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

50 mm Crushed Gravel: At least 13 percent by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

25 mm Crushed Gravel: At least 50 percent by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

Any gravel containing deleterious material should be rejected.
"Coarse gravel" for bedding and drainage should conform to the following grading:

Where the maximum-sized particles in any backfill material exceed 50 percent of the lift thickness or minimum dimension of the cross-section to be backfilled, such particles should be removed and placed at other more suitable locations on site or screened-off to delivery to site.

Bonding should be provided between backfill lifts, if the previous life has become desiccated. For fine-grained materials, the previous lift should be scarified to 75 mm in depth followed by proper moisture conditioning and recompaction.

Recommendations for the specifications for various backfill types are presented below.

"Pit-run gravel" should conform to the following grading:

SIEVE SIZES (SQUARE OPENINGS)	PERCENT PASSING BY WEIGHT
200 mm	100 of Total Sample
150 mm	96 - 100 of Total Sample
75 mm	60 - 80 of Total Sample
25 mm	70 - 100 of Material Passing 75 mm Sieve
4.75 mm	25 - 63 of Material Passing 75 mm Sieve
1.18 mm	14 - 41 of Material Passing 75 mm Sieve
0.60 mm	7 - 30 of Material Passing 75 mm Sieve
0.15 mm	3 - 18 of Material Passing 75 mm Sieve
0.075 mm	2 - 9 of Material Passing 75 mm Sieve

Any grading variation from the above should be at the discretion of the Engineer; however, the percent of material passing the 0.075 mm sieve size should not exceed of the material passing the 0.6 mm sieve. The pit-run gravel should be free of any form of coating and any gravel containing clay, loam or other deleterious materials should be rejected. No oversized material should be tolerated.

PERCENT PASSING BY WEIGHT
(NOMINAL GRAVEL SIZE)

SIEVE SIZES (SQUARE OPENINGS)	50 mm	40 mm
50 mm	100	---
40 mm	90 - 100	100
25 mm	---	95 - 100
20 mm	35 - 70	---
15 mm	---	25 - 60
10 mm	10 - 30	---
4.75 mm	0 - 5	0 - 10
2.36 mm	---	0 - 5

"Coarse sand" for bedding and drainage should conform to the following grading:

SIEVE SIZES (SQUARE OPENINGS)	PERCENT PASSING BY WEIGHT
10 mm	100
4.75 mm	95 - 100
2.36 mm	80 - 100
1.18 mm	50 - 85
0.60 mm	25 - 60
0.30 mm	10 - 30
0.15 mm	2 - 10

"Lean-mix concrete" should be low strength concrete having a minimum 28 days compressive strength of 3.5 MPa.

FLOOR SLABS-ON-GRADE

All soft, loose or organic material should be removed from beneath slab areas. If any local hard spots such as old basement walls are revealed beneath the slab area, these should be over-excavated and removed to not less than 0.9 m below underside of slab level. The exposed soil should be proof-rolled and the final grade restored by general engineered fill placement. If proof-rolling reveals any soft or loose spots, these should be excavated and the desired grade restored by general engineered fill placement. Proof-rolling should be carried out in accordance with the recommendations given elsewhere in this Appendix. The subgrade should be compacted to a depth of not less than 0.3 m to density of not less than 95 percent Standard Proctor Maximum Dry Density (ASTM Test Method D698).

If for economic reasons, it is considered desirable to leave low quality material in place beneath a slab-on-grade, special ground treatment procedures may be considered. McIntosh•Lalani Engineering Ltd. could provide additional advice on this aspect, if required.

A leveling course of structural fill at least 150 mm in compacted thickness is recommended directly beneath all slabs-on-grade. Alternatively, a minimum thickness of 150 mm of pit-run gravel overlain by a minimum thickness of 50 mm of crushed gravel may be used. Very coarse material (larger than 25 mm diameter) should be avoided directly beneath the slabs-on-grade to limit potential stress concentrations within the slab.

General engineered fill, structural fill, pit-run gravel and crushed gravel are defined under the heading "Backfill Materials and Compaction" elsewhere in this Appendix.

If the slab will receive a vapor sensitive floor covering, or the project will include a humidity controlled area, the use of a vapor retarder beneath the slab is recommended. Without a vapour retarder, moisture can build up beneath resilient floor covering over time resulting in delamination, even if the concrete has dried sufficiently prior to flooring application. Vapour retarders are generally plastic, in sheet or roll form, and should conform to ASTM E1745, "Standard Specification for Water Vapour Retarders used in Contact with Soil or Granular Fill under Concrete Slabs". They should be located either directly beneath the concrete or beneath a granular blotter layer, depending upon project specific schedule and requirements. ACI 302.2R, "Guide for Concrete Slabs that Receive Moisture – Sensitive Flooring Materials', providing an extensive discussion on concrete moisture and guidance on the use of vapour retarders.

The slab should be structurally independent from walls and columns supported on foundations. This is to reduce any structurally distress that may occur as a result of differential soil movements. If it is intended to place internal non-load bearing partition walls directly on a slab-on-grade, such walls should be structurally independent from other elements of the building founded on a conventional foundation system so that some relative vertical movement of the walls can occur freely.

The excavated subgrade beneath slabs-on-grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of free water. This applies during and after the construction period.

A minimum slab concrete thickness of 100 mm is recommended. Control joints should be provided in all slabs. Typically for a 125 mm slab thickness, control joints should be placed on a 3 m square grid, should be sawn to a depth of one-quarter the slab thickness and have a width of approximately 3 mm.

Wire mesh reinforcement, 150 mm square grid, should be provided to reduce the possibility of uncontrolled slab cracking. The mesh should be adequately supported and should be located at or above mid-height of the slab with adequate cover.

PROOF-ROLLING

Proof-rolling is method of detecting soft areas in an "as-excavated" subgrade for fill, pavement, floor or foundations or detecting non-uniformity of compacted embankment. The intent is to detect soft areas or areas of low shear strength not otherwise revealed by means of test holes, density testing or visual examination of the site surface and to check that any fill placed or subgrade meets the necessary design strength requirements.

Proof-rolling should be observed by qualified geotechnical personnel.

Proof-rolling is generally accomplished by the use of a heavy (15-60 tonne) rubber-tired roller having found wheels abreast on independent axles with high contact wheel pressures [inflation pressures ranging from 550 kPa (80 psi) up to 1,030 kPa (150 psi)].

A heavily-loaded truck may
be used in lieu of the equipment described in the paragraph above. The truck should be loaded to approximately 10 tonnes (22,000 lbs) per axle and a minimum tire pressure of 550 kPa (80 psi).

Ground speed to be maximum of 8 km/hr (133 m/min) (5 mph)(400 ft/min). Recommended speed is 4 km/hr (65 m/min) (2.5 mph) (200 ft/min).

The recommended procedures is two complete coverages with the Proof-rolling equipment in one direction and a second series of two coverages made at right angles to the first series; one "coverage" means that every point of the proof-rolled surface has been subjected to the tire pressure of a loaded wheel. Less rigorous procedures may be acceptable under certain conditions subject to the approval of an engineer.

Any soft areas rutted or displaced materials detected should be either recompacted with additional fill or the existing material removed and replaced with general engineered fill or properly moisture conditioned as necessary.

The surface of the grade under the action of the proof-rolled should be observed, noting visible deflection and rebound of the surface or shear failure in the surface of granular soils as ridging between wheel tracks.

If any part of an area indicates significantly more distress than other parts, the cause should be investigated, by, for example, shallow auger holes.

In the case of granular subgrades, distress will generally consist of either compression due to insufficient compaction or shearing under the tires. In the first case, proof-rolling should be continued until no further compression occurs. In the second case, the tire pressure should be reduced to a point where the subgrade can carry the load without significant deflection and subsequently, gradually increased to its specified pressure as the subgrade increases in shear strength under this compaction.

CONSTRUCTION EXCAVATIONS

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

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

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

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

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

The construction of a temporary support system should be monitored. Detailed records should be taken of installation methods, materials, in situ conditions and the movement of the system. If anchors are used, they should be load tested. McIntosh•Lalani Engineering Ltd. can provide further information on monitoring and testing procedures, if required.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down at 45^0 from a horizontal, from the base of foundations of adjacent structures, intersects the extent of the proposed excavation, then these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

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

SHALLOW FOUNDATIONS

Design and construction of shallow foundations should comply with relevant Building Code requirements.

The term "shallow foundations" includes strip and spread footings, mat slab and raft foundations.

Minimum footing dimensions in plan should be 0.45 m and 0.9 m for strip and square footings, respectively.

No loose, disturbed or sloughed material should be allowed to remain in open foundation excavations. Hand cleaning should be undertaken to prepare an acceptable bearing surface. Recompaction of disturbed or loosened bearing surface may be required.

Foundation excavation and bearing surfaces should be protected from rain, snow, freezing temperatures, drying and the ingress of free water, during and after footing construction.

Footing excavations should be carried down into the designated bearing stratum.

After the bearing surface is approved, a mud slab should be poured to protect the soil and provide a working surface for construction, should immediate foundation construction not be intended.

All constructed foundations should be placed on unfrozen soils, which should be at all times protected from frost penetration.

All foundation excavations and bearing surface should be observed by a qualified geotechnical engineer to confirm that the recommendations contained in this report have been followed and that soil conditions are consistent with those assumed in the design.

Where over-excavation has been carried out through a weak or unsuitable stratum to reach into a suitable bearing stratum or where a foundation pad is to be placed above stripped natural ground surface, such over-excavation may be backfilled to subgrade elevation utilizing either structural fill or lean-mix concrete. These materials are defined under the separate heading "Backfill Materials and Compaction."