PRELIMINARY SERVICING REPORT

Southwest Park Subdivision

Prepared for:
Russell Township
717 Notre Dame Street
Embrun, Ontario
K0A 1W1

Prescott Russell County
59 Court Street
L’Original, Ontario
K0B 1K0

Prepared by:
McIntosh Perry Consulting Engineers Ltd.
115 Walgreen Road
Carp, ON
K0A 1L0

April 27, 2015
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1.0 INTRODUCTION

McIntosh Perry has been retained by Melanie Construction Inc. to complete a Preliminary Servicing Report as part of the Draft Plan Application for the subject property. This Preliminary Servicing Report will discuss municipal water, sewer and stormwater management options associated with the development of the proposed Southwest Park Subdivision located in the Village of Russell, Ontario. It is the intent of this report to address servicing of the entire site, so that a complete view of the overall development scheme can be presented.

The South Nation Conservation Authority (SNCA) and the Township of Russell have been pre-consulted on this project. Several meetings have been held with the Township and the SNCA to review items such as the overall concept, servicing options, floodplain limitations, slope stability issues, and future considerations for adjacent properties.

2.0 SITE DESCRIPTION

The proposed Southwest Park Subdivision covers approximately 50 hectares of land and is located at the southwest edge of the Village of Russell, described as Part of Lots 11 and 12, Concession 2, Village of Russell in the geographic Township of Russell. The site is bounded by the Castor River to the north, Macdonald Road to the west, existing units fronting Bols Street to the east, and Church Street (Route 300) to the south (see Figure 1).

The proposed subdivision consists of two major development phases – Phase 1 within the current village limits and Phase 2 outside the western boundary of the current village limits. In total, the plan is made up of 417 single family homes, 108 semi-detached homes, 88 townhouse units and a stormwater management facility. The subdivision will be developed in several sub-phases, as servicing constraints and market demand allows.

The proposed subdivision will be developed on mostly agricultural farm land with a previously forested area in the north east corner of the site. The site is relatively flat with the majority of the runoff sheet draining to the north. An existing ditch along the east side of MacDonald Road collects some of the runoff from the west portion of the site, while a swale/ditch located in the previously forested area collects drainage from the northeast corner before directing it to the Castor River.
3.0 BACKGROUND STUDIES

A Geotechnical Investigation prepared by Inspec-Sol (dated January 5th, 2011) was reviewed to evaluate the subsoil stratigraphy of the site and to review any recommendations pertaining to the design of the subdivision. The report covers only the eastern half of the site that is currently within the village limits. The results of the investigation indicate that the subsoil conditions vary significantly across the site; however the majority of cases showed the existence of surficial topsoil underlain by native silty sand, followed by silty clay and finally sandy silt till. The geotechnical report is available under Appendix A.

A Fisheries and Aquatic Ecosystems Assessment Report was completed by McIntosh Perry Consulting Engineers Ltd. (dated October, 2009) to identify the existing fisheries, assess fish, and fish habitat sensitivity within the proposed development area. No fish were observed within any of the watercourses on the subject property, and the watercourse/drainage channel on site was noted to be ephemeral. It is anticipated that no significant negative impacts to the study area will occur, however appropriate sediment and erosion control
measures should be installed prior to the commencement of construction. This report is also available under Appendix A.

As-builts for the surrounding streets, completed by Lecompte Engineering Ltd. (dated May, 1988) were reviewed in order to determine the available servicing and stormwater management options for the site.

A slope stability evaluation was performed by Houle Chevrier Engineering (dated September 12, 2014) to review the current condition of the slope alongside the Castor River. In summary, this report states that the soils at the site consist of marine deposited sensitive clay which may be overlain by a thin sand layer. The slopes of the Castor River at the site consist of silty clay and no signs of deep seated instability, surficial tension cracks or other obvious indications of slope movement are visible at the site. Minor erosion was noted along the toe of the slope at the Castor River and therefore set back limitations were calculated. This report is also available under Appendix A.

4.0 EXISTING SERVICES

Existing services within close proximity to the site include a 300mm diameter watermain located along Church Street which allows for servicing of the site. Stormwater runoff from the site either sheet drains directly to the Castor River or is picked up in ditches located along the east and west limits of the site and also outlet to the Castor River. There are no gravity sanitary sewers in close proximity to the site, although municipal sanitary services are available on Concession Street in the Village.

Gas, hydro, and telephone utilities are available nearby and can be extended from Church Street.

5.0 SERVICING PLAN

A pre-consultation with the Township has confirmed that downstream sanitary capacity and watermain capacity exists for this site. No significant restrictions on existing servicing capacities are known at this time.

5.1 Watermain Design

Water servicing for the site will be drawn from the existing 300mm watermain located on Church Street. Servicing through the Southwest Park Subdivision site will be accomplished with 200 mm diameter mains, pending confirmation with a hydraulic model. Fire hydrants will be located throughout the subdivision as required by Municipal Standards and individual water services are to be installed as per OPSS and Russell Township Standards.
5.2 Sanitary Sewer Design

A new sanitary sewer system for this development will be constructed and will drain via gravity into a new pumping station to be located in the same block as the proposed SWM pond.

Within the site, gravity sanitary mains will be installed as required with a target velocity of 0.6m/s within the pipe. A target velocity of 0.6m/s in the pipe may not be feasible on every length of pipe, as the capture area for the uppermost mains in the system is relatively small. As is typical in these situations, this issue will be reviewed with the Township prior to final design.

From the proposed pumping station, the effluent will then be diverted from the site via a proposed force main eastward along Church Street to an existing municipal pumping station located near the Church Street/Concession Street intersection – a distance of approximately 1,200 meters.

It should be noted that the Township of Russell is currently investigating options to provide gravity service to several existing residential streets to the east of the Southwest Park development. Houses within these existing areas are currently serviced via septic.

The proponent has indicated a willingness to work with the Township to develop a mutually beneficial sanitary collection system.

5.3 Storm Sewer Design

Stormwater runoff will be conveyed through curb and gutter and rearyard swales towards catchbasins, where it will be captured and drained into the new storm sewer network. The storm sewer network within the subdivision will be designed to accommodate a storm event with a 5-year return period. Storms in excess of this event will result in surcharging at catchbasins and manholes. However, stormwater runoff during these major events will be conveyed via overland flow routes within rear-yard swales and along the roadway, as is typical in subdivisions of this nature.

5.4 Stormwater Management Design

A stormwater management (SWM) pond is being proposed for the subdivision, which will eventually outlet into the Castor River. At this time, the SWM pond is to be located at the northern end of the site, just west of the Phase 1 property line. The intent of the overall stormwater management design will be to provide both quantity and quality treatment in accordance with current best practices for the proposed development. This will be more fully explored in Section 6.0.
5.5 Site Utilities

All relevant utility companies (gas, telephone, cable, and hydro) will be contacted throughout the design process in order to provide proper utility servicing for the subdivision. Our intent is to provide for four party trench with Gas, Hydro, telephone and cable services all included.

5.6 Service Location/Cover

The storm, sanitary and water services will be placed in a common service trench. The watermain will have the equivalent of 2.2 m of cover. The sanitary and storm mains and services will have an equivalent of at least 1.5 m of cover.

6.0 STORMWATER MANAGEMENT

Stormwater management for this site will be maintained through positive drainage away from the proposed dwellings. The storm runoff will enter the proposed pipe system through catchbasins (CBs) and catchbasin manholes (CBMHs) located throughout the subdivision. The minor system storm runoff as well as the major system overland flow will be directed towards the proposed stormwater management facility. The SWM facility will be a “Wet Pond” that will treat quantity and quality of surface runoff. The stormwater pond will provide a total suspended solids (TSS) removal rate of 80% for the proposed development. The pond will provide a level of storage to ensure that post-development flows to the Castor River will be restricted to pre-development levels to ensure that there are no negative downstream impacts.

6.1 Design Methodology

Runoff calculations presented in this preliminary report are derived using the Rational Method, given as:

\[ Q = 2.78 \times CIA \ (l/s) \]

Where:
- \( Q \) = peak flow discharge \( (l/s) \)
- \( C \) = dimensionless runoff coefficient
- \( I \) = rainfall intensity \( (mm/hr) \)
- \( A \) = drainage area \( (ha) \)

It is recognized that the Rational Method tends to overestimate runoff rates as the watershed increases in size. As a by-product of using an extremely conservative prediction method, any facilities that are sized using these results will most certainly function as intended in “real world” conditions.
The following runoff coefficients were used to develop a weighted ‘C’ for each drainage area:

```
<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>C Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building roofs, Asphalt, Concrete</td>
<td>0.90</td>
</tr>
<tr>
<td>Grass, undeveloped areas</td>
<td>0.20</td>
</tr>
<tr>
<td>Gravel</td>
<td>0.60</td>
</tr>
</tbody>
</table>
```

The runoff coefficient is increased by 25% to a maximum of 1.0 for 100-year storm event, to appropriately simulate saturated conditions.

Rainfall intensities are derived from the IDF curves for the City of Ottawa. The time of concentration ($T_c$) for the drainage area was derived using the TR-55 Method within the WIN TR-55 modelling program by the USDA National Research Conservation Service.

Although the rational method is adequate for preliminary stormwater management design, further accuracy will be placed within the detailed design in order to properly size the storm sewer and stormwater management components. Bentley’s storm sewer and pond modelling software (CivilStorm) as well as Visual Otthymo will be used during the final stormwater management design of the proposed development.

**6.2 Pre-Development Drainage Area**

Drawing CP-08-512-PRE (Appendix B) illustrates the pre-development drainage area in the vicinity of the site.

Drainage Area A1 covers 50 hectares and encompasses the entire proposed development. The area drains north into Castor River either via overland flow or via drainage ditches located northeast or northwest of A1. A runoff coefficient (‘C’) value of 0.21 was calculated for the 5-year storm event and this value was increased to 0.26 for the 100-year storm event. Estimates of maximum runoff rates for typical 5 and 100-year rainfall events are 800 L/s and 1,700 L/s, respectively based on a time of concentration of 77min.

It should be noted that there is a small amount of “offsite” drainage that makes its way through the site towards the Castor River. This drainage is largely generated from roadway drainage, which is collected in roadside ditches running along the south side of Church Street and conveyed to the site via existing culverts crossing Church Street. This area has been accounted for in the pre-development drainage area and has also been included when sizing the pond.

Pre-development time of concentration calculations and stormwater runoff results for the 5 and 100-year storm events are found in Appendix D.

**6.3 Post-Development Drainage Area**

Drawing CP-08-512-POST (Appendix C) shows the anticipated post development drainage area for the proposed development.
Drainage area B1 covers 50 hectares and encompasses the entire proposed development. The ground cover will be made up of mainly asphalt, roofs and grass. The proposed area will drain through a curb and gutter system with minor flow (5-year flow) being captured within the newly constructed storm pipe network. This flow will then be directed into the proposed stormwater management pond. Runoff during a major storm event will be conveyed via overland flow routes within rear-yard swales and along roadways to the stormwater management pond. The pond’s release rate to the Castor River will be restricted to match the pre-development runoff rates.

A runoff coefficient (‘C’) value of 0.45 was calculated for the 5-year storm event and this value was increased to 0.52 for the 100-year storm event. Estimates of maximum unrestricted runoff rates for typical 5- and 100-year storm events are 6,600 L/s and 13,000 L/s, respectively based on a time of concentration of 10min.

Post-development time of concentration calculations and stormwater runoff results for the 5 and 100-year storm events are found in Appendix D.

6.4 Major Drainage Route

The pipe network within the subdivision will be designed to accommodate the 5-year storm event. The grading plan will be designed to make use of the roadway as the major drainage route for any storm event exceeding the design capacity of the storm sewer system. The grading of the roadway will be designed in a way to ensure that the major flows are directed towards the SWM Pond. Rear yard drainage swales and easements will be incorporated to provide additional overflow capacity.

6.5 On-Site Quality Control

The Southwest Park Subdivision will employ Best Management Practices (BMP’s) wherever possible. The intent of implementing stormwater BMP’s throughout the development is to ensure that water quality and quantity concerns are addressed at all stages of development. BMP’s will be implemented at the lot, conveyance and end-of-pipe levels.

Lot level BMP’s include the direction of roof leaders onto grassed areas, minimizing ground slopes and maintaining as much of the lot as possible in a natural state, which will provide an opportunity for initial filtration of any sediment, and provide an opportunity for absorption and ground water recharge. Recent recommendations by a number of Conservation Authorities and the MOE suggest that yard grading as flat as 0.5% be implemented to promote infiltration. Our experience has been that slopes less than 1% result in unsightly ponding due to settlement. The target range for finished ground slopes will be 1.5% - 3.0% where possible. This range of slope will still provide a significant opportunity for the absorption and filtration process.

The conveyance system to be used within the subdivision is a combination of rear yard swales, roadside curbs, gutters and storm sewer systems. Swales will be constructed at minimal gradient where possible, thus
promoting absorption and infiltration, as well as providing some opportunity for particle filtration. A perforated sub-drain tile will be installed under low gradient (less than 1.0%) rear yard swales in order to ensure that standing water is not a problem. Riprap will be placed at erosion-prone areas, and all disturbed areas shall be re-vegetated as soon as possible following construction.

The new stormwater management facility will implement end-of-pipe BMP’s.

### 6.6 Stormwater Management Facility (SWMF)

The South Nation Conservation Authority now relies on the MOE Stormwater Management (SWM) Practices Planning & Design Manual, 2003, as the current guideline applicable to the stormwater component of this project. The ultimate goal of the SWM facility is to manage both quantity and quality of effluent released to the receiving stream.

Section 3.3.2 of the relevant MOE Manual identifies wet ponds as the accepted facility that meets the basic and enhanced protection criteria respectively. A wet pond is planned to be located within the northwest side of the property and will outlet to the Castor River.

The SWM pond will be designed with mild side slopes above the waterline, and will be landscaped to become an attractive feature in the community.

### 6.7 SWMF Quantity Control

Quantity control for the developed site will be achieved at the stormwater management pond by matching pre to post development flows.

The pond will be sized in accordance with the MOE Design Manual. Quantity control will be provided via an outlet structure complete with orifice and weir controls. It is important to note that the total volume of water entering the Castor River will not be restricted, but instead the rate at which it enters will be controlled. A preliminary estimation of the stormwater management dry pond storage volume was computed using the Modified Rational Method (*Appendix D*). An approximate volume of 9,100 m$^3$ for the 100-year storm event was calculated when restricting the post-development flow to a pre-development level for the worst case storm event.

Detailed quantity calculations (stage-storage tables, stage-discharge tables, etc.) will be provided within the final servicing report at the detailed design stage.

### 6.8 SWMF Quality Control

The main measure of quality control success in a SWM pond is the sediment removal rate. The targeted total suspended solids (TSS) removal rate for a pond providing enhanced levels of protection is 80%. It is acknowledged that the *MOE Design Manual* targets a minimum 24-hour retention time in the pond for the
required 40 m³/ha extended detention. This is primarily to allow for particle settling to occur. Meeting and/or exceeding the MOE Guidelines for SWM pond sizing will, in itself, provide a good level of quality control for the end-of-pipe facility. We expect that our facility will meet or exceed these requirements.

The suggested quality treatment storage volume for a wet pond at enhanced protection level is approximately 140 m³/ha, based on an impervious level of 35%. This yields an extended detention volume of 2,000 m³ and a minimum permanent pool volume of 5,000 m³.

Any new SWM facility will include construction of a proper sediment forebay. The forebay will be designed to meet the desired 2:1 minimum length to width ratio as suggested in the MOE Design Manual. Access for future cleanout will also be provided.

Detailed pond design information will be submitted with the detailed engineering package after Draft Plan approval.

**6.9 SWMF Maintenance**

Periodic removal of sediment or debris build-up in the forebay may be required from time to time. A 3 m wide stone pathway will be constructed from the subdivision roadways leading to the sediment forebay area of the pond to allow maintenance equipment access to the site for periodic removal of built-up sediment and general maintenance. The surface will likely be a granular “B” type stone material.

It is assumed that the pond will be turned over to the Municipality upon registration. In recognition of the fact that development may be on-going for a few years, it is suggested that pond maintenance be completed by the developer for a period of three years from the date of registration. This discussion needs to be clarified through negotiation, but the intent is that the developer would provide the Township with a clean pond when it assumes the full road network.

Once transferred to the Municipality, it is suggested that the Municipality carry out routine visual inspections of the pond on a quarterly basis as well as after major storm events, until all vegetation is well rooted. This will aid in the long-term performance of the stormwater management facility.

**7.0 SEDIMENT AND EROSION CONTROL**

Before construction begins, straw bales or rock flow check dams will be installed at all natural runoff outlets from the property. These controls will be inspected and maintained throughout construction.

Silt fences will be installed where shown on the final engineering plans. Every effort will be made to ensure that all disturbed areas are top soiled and sodded as soon as it is reasonably possible. The rock flows, straw bales and silt fences shall be inspected weekly and after rainfall events. Care will be taken to properly remove sediment from the fences as required.
Work through winter months shall be closely monitored for erosion, and whatever steps necessary shall be taken to address the situation. Silt fences shall be installed at the appropriate locations as soon as ground conditions both warrant and permit, as shown on the final plans.

As each lot is developed, proper sediment and erosion controls will need to be installed and maintained. Sediment controls shall consist of, at minimum, straw bales at the down gradient property line. Grass shall be established as soon as possible and excess fill shall be removed or levelled promptly.

All manholes, catchbasins and other drainage structures shall be covered in geotextile cloth when installed. This sediment trap will need to be monitored weekly and cleaned out as required.

**8.0 SUMMARY**

- The proposed *Southwest Park* Subdivision covers approximately 50 hectares, and is located in part of Lots 11 & 12, Concession 2 in the Village of Russell.
- At this time approval is being sought only for the lands within the current village boundaries. This report provides a larger scale view of the ultimate project to aide in the planning exercise.
- A new watermain distribution system will be extended throughout the development from the existing 300 mm diameter watermain along Church Street.
- A new gravity sanitary sewer system will be extended throughout the development and into a new pump station located on site. Outlet will be via Forcemain along Church Street to existing services on Concession Street.
- Telephone, gas and hydro utilities will be extended from Church Street.
- A new stormwater management pond will be constructed to control flows (match post to pre-development levels) and achieve an 80% TSS removal rate. The pond will be located within the northwest quadrant of the site and will outlet into the Castor River.
- Storm water runoff will be directed into the new storm pipe system via a curb and gutter system and will be directed to the new stormwater management pond for quantity and quality control purposes.
- Lot Level, conveyance and end-of pipe controls will be used for stormwater Best Management Practices. Minor re-grading will be required to ensure proper drainage.
- Sediment and erosion protection measures will be installed as soon as ground conditions warrant and permit, and shall remain in place until construction is complete.
9.0 RECOMMENDATIONS

Based on the information presented in this Report, we recommend that the Township of Russell approve this Preliminary Servicing Report in support of the Draft Plan application for the development of the Southwest Park Subdivision.

Ryan Kennedy, P. Eng.
PRACTICE AREA LEAD | LAND DEVELOPMENT
McIntosh Perry Consulting Engineers
613.836.2184 Ext. 2243
r.kennedy@mcintoshperry.com

Bader Alnabelseya, E.I.T
LAND DEVELOPMENT
McIntosh Perry Consulting Engineers
613.836.2184 Ext. 2268
b.alnabelseya@mcintoshperry.com
APPENDIX A
SUPPORTING DOCUMENTS
Geotechnical Investigation
GEOTECHNICAL INVESTIGATION
SOUTHWEST RUSSELL SUBDIVISION
PART OF LOTS 11 AND 12, CONCESSION 2
RUSSELL, ONTARIO

Date: January 5, 2011
Reference No. T020624-A1
Reference No.: T020624-A1

January 5, 2011

Mr. Reynald Patenaude
Melanie Construction
900 Route 500
Russell, Ontario
K4R 1E5

Re: Geotechnical Investigation
Southwest Russell Subdivision
Part of Lots 11 and 12, Concession 2
Russell, Ontario

Dear Mr. Patenaude,

In accordance with your instructions, Inspec-Sol Inc. (Inspec-Sol) completed a Geotechnical Investigation at the above-mentioned site, and is pleased to present the findings.

We trust this information meets with your approval. Please do not hesitate to contact us, should any questions arise.

Yours very truly,

INSPEC-SOL INC.

Joseph B. Bennett, P. Eng.
Vice President

SD/vl

Dist: Mr. Reynald Patenaude – email – melconst@explornet.com Mail (3); and
Mr. Todd Perry – email – t.perry@mcintoshperry.com
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ENCLOSURES

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NOTES ON BOREHOLE LOGS APPENDIX A
1.0 INTRODUCTION

Inspec-Sol Inc. (Inspec-Sol) was authorized to carry out a Geotechnical Investigation for the proposed residential subdivision development located on the north side of Route 300 in Russell, Ontario. The authorization to proceed with this study was provided by Mr. Reynald Patenaude of Melanie Construction.

The purpose of the investigation was to evaluate the subsoil stratigraphy at ten (10) borehole locations in order to provide recommendations pertaining to foundation type, bearing pressure, seismic site class, and pavement design. We have also provided comments on groundwater conditions, and other pertinent subsurface conditions that may affect the construction of the proposed residential buildings. The scope of work for this Geotechnical Investigation was agreed to in our proposal, Ref No: FP3028

2.0 SITE DESCRIPTION

The Site is approximately 200 m north-west of the intersection of Church Street and Bols Street in the Russell, Ontario. The Site consists of undeveloped land which is currently being used for agricultural purposes. The Site is bounded on the north by the Castor River, and bounded on the west by neighbouring agricultural properties. The south and east sides of the Site are bounded by the residential properties along Church Street and Bols Street. The detached residential lots running along both Bols Street and Church Street are not included within the scope of this investigation. The Site is defined as “Part of Lots 11 and 12, Concession 2, Township of Russell, County of Russell” on the Plan of survey provided by the Client.

The investigated Site is approximately 27 Ha in area. The Site has a generally flat topography, with a slight downward slope from the south to the north, towards the Castor River.

The location of the site is shown on the Site Location Map, Dwg. No. T020624-A1-1.
3.0 FIELD WORK

The Geotechnical Investigation consisted of advancing ten (10) boreholes strategically placed across the site. Nine (9) of these boreholes were advanced to an approximate depth of 6 m. The remaining (1) borehole was advanced to approximately 6.5 m and continued to approximately 12 m with a standard penetration test (SPT).

The drilling was undertaken on May 4th through May 13th, 2009. Drilling was carried out by means of a track mounted drill rig with hollow-stem continuous-flight auger equipment, under the supervision of Inspec-Sol field staff. SPTs were performed at regular intervals throughout the overburden, using a conventional 50 mm split-spoon sampler and a 63.5 kg hammer free falling from a distance of 760 mm, to collect soil samples for laboratory testing. The number of drops required to drive the sampler 0.3 m was recorded as “N” value. Field Vane Tests (FVTs) were also performed at regular intervals to determine the in-situ and remoulded undrained shear strength of the cohesive soil. One (1) thin walled Shelby tube sampler was used in borehole (BH-9) to collect additional undisturbed samples for further laboratory testing, if necessary. All boreholes were backfilled with native materials upon the completion of the drilling.

The elevations of all boreholes were surveyed by Inspec-Sol personnel. The job benchmark used for surveying was located at the north east corner of the intersection of MacDonald Road and Church Street. It was noted that this benchmark has a geodetic elevation of 71.43 m, as reported by Annis, O’Sullivan, and Vollebekk Ltd. The location of the boreholes and the benchmark are shown on the Borehole Location Plan, Dwg No. T020624-A1-2.

4.0 SUBSOIL

The results of the Geotechnical Investigation indicate that the subsoil conditions vary significantly across the Site. However, in the majority of cases, a surficial topsoil was found to be underlain by a native silty sand. This sand was followed by a silty clay and finally a sandy silt till. In BH-5, the silty sand was found to be directly overlying the till, and no silty clay was observed. A graphical representation of the soils found at the borehole locations can be found in the Borehole Logs, Enclosures No. 1-10.
4.1 Topsoil

The surficial topsoil layer varies in thickness from approximately 0.2 m to 0.3 m. It was predominantly silt, dark brown, and contained some organics. It was recovered in a moist condition. The topsoil depths and descriptions contained within this report and on the borehole logs should not be used for quantity take-offs or quality assessments.

4.2 Silty Sand

The native silty sand was found to be loose near the surface and becoming compact with depth. It was medium brown and was recovered in a moist condition. The thickness of this sand layer was found to range from approximately 1.3 m in BH-10 to approximately 2.2 m in BH-8. No consistent trend in the thickness of the Sand layer was found across the Site.

4.3 Silty Clay

In all the boreholes except BH-5, a silty clay was found to be underlying the silty sand. This clay was found to be of a stiff consistency in the upper level, and becoming firm with depth. The clay was medium grey in colour and was recovered in a wet condition. Additional laboratory testing on selected samples of this clay confirmed it to have a moisture content ranging from approximately 50% to 80%. Atterberg Limits testing on the same samples showed the liquid limit to range from approximately 28% to 76% and plasticity indices to range from approximately 11% to 43%. Despite the significant variances in the clay samples tested, in all cases the natural moisture content was found to be near or exceed the liquid limit for each sample. This silty clay could be considered to be a high plasticity fat clay. In-situ FVT data showed this clay to have a maximum sensitivity of 8. This clay would therefore be considered very sensitive to disturbance.

4.4 Sandy Silt Till

In boreholes BH-1, BH-2, BH-3, BH-5, BH-6, and BH-7, a sandy silt with frequent gravel sizes was encountered. In such cases, where a soil containing a wide variation of particle sizes is found to be overlying bedrock, this is typically an indication of a Glacial Till deposit. This till was found to be dense, was medium grey, and was recovered in a moist condition. The depth to this till layer was found to vary significantly across the Site.
4.5 **Bedrock**

Bedrock was not penetrated as part of the scope of this Geotechnical Investigation. In several cases, split spoon refusal was encountered within the boreholes. This occurred in boreholes BH-3, BH-6, and BH-7, at depths of approximately 6.7 m, 6.6 m, 5.7 m, respectively. Due to the gravel and probable cobble or boulder content of the till, it is likely that these refusals do not represent the bedrock surface. Furthermore, in borehole BH-9, an SPT was advanced through this till and finally encountered refusal at a much deeper depth of approximately 12.2 m which corresponds to an elevation of approximately 58.2 m.

5.0 **GROUNDWATER**

No standpipes were installed as part of this scope of work. Groundwater levels at the time of the investigation were estimated based on the sample appearance and was found to be ranging in depth from approximately 1.0 m in BH-4 to approximately 1.5 m BH-8. Generally, this would correspond to ground water levels near an elevation 69 m to 70 m.

The surficial sandy soils found on Site would be expected to collect infiltration waters, especially during wet seasons. Also, it should be noted that the groundwater levels vary considerably with seasonal affects as well as significant precipitation events. They will likely be at their highest level during the spring thaw.

6.0 **DISCUSSION AND RECOMMENDATIONS**

6.1 **Description of Project**

It is understood that the proposed subdivision development will include construction of residential houses, roadways, and landscaped areas only. Such work would include site preparation, shallow excavation for basements, footings and floor slabs, service trench excavations, backfill, permanent drainage, and roadways. It is also our understanding that no significant grade raises (> 1.0 m) are planned for this Site. At this time it is understood that no commercial developments are planned for this Site.
Based upon the results of this Geotechnical Investigation and assuming that they are representative of subsoil conditions across the entire site, the following comments and recommendations are offered for the foundations and floor slabs of the proposed structures as well as road bases and asphalt courses.

6.2 Site Preparation

The surficial topsoil and organic layers should be stripped down to the native sand prior to the construction of roadways and houses. These soils will not be acceptable for use as structural fill. However, with proper handling, sorting and on site storage, it may be possible to re-use this material for non-structural landscaping purposes.

Due to the nature of the sand and clay layers observed at this site, grade raises in excess of 1.0 m (with a 100 mm tolerance) are not to be permitted. Such grade raises have the potential to cause settlement due to additional footing surcharges. If larger grades immediately around a house structure become necessary for grading or other issues then options will need to be considered by the Designers. The use of light weight fill materials such as Plasti-Fab’s GeoSpec products may be one option. However, Inspec-Sol should be retained to provide input into the design and to review this type of work if it is deemed necessary.

Infiltration into excavations from the overburden material should be anticipated especially in wet seasonal periods. These waters can likely be handled through standard ditching and trenching operations combined with conventional sump and pump operations. However, a detailed formal water management plan should be developed at the outset of this project.

It is anticipated that the native soils, especially the silty clay at lower depths, will be very sensitive to disturbance both under heavy construction traffic as well as changes in moisture condition. Therefore earth-moving operations will have to be carried out properly to avoid any remoulding of the subsoils and minimize the necessity of over-excavation. The site should also be graded in the early stages of construction to provide for positive run-off of all surface water.
6.3 Foundations

If there are any commercial developments planned on this Site in the future, they will require a separate investigation to evaluate available soil bearing capacities; this would be based on the column loads, floor loads, and proximity of the footings to the underlying clay layer.

For typical domestic dwellings, it is expected that the footings will be supported on the silty sand layer, with a minimum of 0.6 m of native compact sand present below the underside of the footings. This constraint will help to spread out the footing loads and lower their influence on the underlying soft clay layers. Additionally, this will minimize the risk of accidentally over excavating the footings and exposing the soft clays. Furthermore, this constraint may assist in the control of water infiltration into footing excavations during construction.

Based on the subsoil conditions encountered at this site, and the lab testing performed, the design bearing capacity for dwellings should be limited to 50 kPa, under Serviceability Limit States (SLS) conditions. This assumes standard settlement tolerances of 25 mm total settlement and 12 mm of differential settlement. The corresponding unfactored bearing capacity under Ultimate Limit States (ULS) conditions is 100 kPa. For these design bearing capacities, the strip footing widths at this Site are limited to a maximum of 1.0 m, and interior pad footings are limited to 1.2 m by 1.2 m in dimension. If footings larger than this are required to achieve 50 kPa from a structural standpoint, Inspec-Sol will need to be retained to provide settlement estimates on a case by case basis. Again, these bearing capacities are based on a maximum grade raise of 1.0 m (with a 100 mm tolerance).

With the soil conditions existing at this Site (i.e. silty sand over silty clay) it is recommended that only trees with shallow root systems be planted near the dwellings, such that root systems do not penetrate below the footings. Trees that develop a large and deep root system will dewater the wet silty clay and cause settlement of the foundations in the long term.
Footings, for heated structures should be provided with a minimum of 1.5 m of earth cover or its equivalent in insulation to protect against detrimental frost action. Isolated foundations for signage, lighting, and canopies require 1.8 m of earth cover (or its equivalent) for frost protection. If such soil cover is not possible due to the required founding elevations of the footings, and the grade raise constraints noted above, Inspec-Sol should be retained to review or design a specific insulation detail which meets these requirements. Such an insulation detail may require structural load bearing insulation below the footings such as Dow HI or equivalent type product.

6.4 Slab on Grade Floor Slabs

Slab-on-grade construction of the basement floors are anticipated across this Site. Floor slabs are recommended to be underlain by a minimum 200 mm layer of 19 mm clear stone (OPSS 1004) compacted by vibration to a dense state. Some architects/contractors prefer this material be specified as a Granular A (OPSS 1010) product which would also be considered acceptable, providing it is adequately compacted to achieve 100% of its standard Proctor maximum dry density (SPMDD).

The slabs should be free floating, and should not be tied into the foundation walls or grade beams. The placement of construction and control joints in the concrete should be in accordance with generally accepted practice.

Floor toppings may be impacted by curing and moisture conditions of the concrete. Floor finish manufacturer’s specifications and requirements should be consulted and designers should decide on whether vapour barriers are required. The impact of vapour barriers relative to intended floor finishes and the impact of such on concrete placement and curing should be taken into account.

It is recommended that vapour barriers be incorporated beneath the slab if floor coverings/finishes of impermeable or low permeable type and/or where adhesive products are used. Sheet type flooring systems are very sensitive to vapour/moisture pressures and must be used, specified, and constructed with extreme caution and care.
6.5 Seismic Classification

Buildings and their structural elements must be designed to resist a minimum earthquake force in accordance with the Ontario Building Code (OBC-2006). Typically, residential structures governed by “Part 9” of OBC-2006 are inherently stiff structures. However if there are large spans or large window walls then specific seismic design may be necessary. The subsoil at this site is considered to have a Site Classification ‘E’, with respect to Table 4.1.8.4.A of OBC-2006.

6.6 Drainage Systems and Lateral Earth Pressures

The earth pressure acting on the basement walls can be estimated using an earth pressure coefficient $K_a=0.35$, and no hydrostatic pressure distribution, which is based on the assumption of an adequate perimeter drainage system. The earth pressure distribution recommended is shown on Dwg. No. T020624-A1-3.

Foundation wall backfill and drainage should be in accordance with the Ontario Building Code (OBC-2006) requirements and should include free draining backfill, even if a composite drainage membrane is employed. Recommended perimeter drainage options are shown attached, as Dwg. No. T020624-A1-4. Perimeter drains are to be considered necessary for the homes on this Site. Drainage systems must be connected to a frost free outlet to allow for year-round drainage. The systems should be compliant with the OBC-2006.

Under-floor drainage is also recommended under the basement floors based on the groundwater observations and the anticipated founding elevations. These will require connection to a sump pit and in turn, connection to a frost free outlet to allow for year-round drainage.

6.7 Foundation Excavation

All excavations should be completed and maintained in accordance with the Occupational Health and Safety Act (OHSA) requirements. The following recommendations for excavations should be considered to be a supplement to, not a replacement of, the OHSA requirements.
The sand expected within the excavations for footings and basements are considered to be “Type 3” soil as defined by the OHSA Regulations for Construction. If the silty clay is encountered during excavation, it will be considered to be a “Type 4” soil. It is important to note that if an excavation extends through two separate soil types, the entire excavation shall be considered as being of the higher number of soil type.

It is expected that the deepest excavations on this Site will be associated with the installation of the site services. Please see the comments in Section 6.9.1.

### 6.8 Foundation Wall and Garage Backfill

The materials to be used for backfill will depend upon their end use. It is important to note that the fill height required for grade raise should not exceed 1.0 m above the current existing grade in order to limit the potential settlement due to the backfill loading on site.

Foundation and garage backfill should be placed and compacted as outlined below:

- To minimize heaving and cracking of garage slabs, we recommend that the at least 1.0 m of soils below the garage slab be excavated and backfilled with free-draining materials.
- Backfill should be placed and compacted in uniform lift thickness compatible with the selected construction equipment but not thicker than 200 mm.
- Backfill should be placed uniformly on both sides of the foundation walls to avoid build-up of unbalanced lateral pressures, or until walls are structurally braced.
- Backfill should not be placed in a frozen condition, or placed on a frozen subgrade.
- Compaction equipment must be of size and distance away to prevent damage to the walls during the time of placement.
- For backfill that would underlie paved areas or sidewalks each lift should be uniformly compacted to at least 98% of its SPMDD.
- For backfill on the building exterior that would underlie landscaped areas, each lift should be uniformly compacted to at least 95% of its SPMDD.
- Any fill used to raise the grade beneath floor slabs should be compacted to 100% of its SPMDD.
- In areas on the building exterior where an asphalt or concrete pavement will not be present adjacent to the foundation wall, the upper 0.3 m of the exterior foundation wall backfill should be a low permeable soil to reduce surface water infiltration.
- Exterior grades should be sloped away from the foundation wall, and roof drainage downspouts should be placed so that water flows away from the foundation wall.

### 6.9 Service Trenches

#### 6.9.1 Excavation

Although the underground services along the Site are expected to be generally shallow, they are expected to be some of the deepest excavations anticipated in the proposed development. It is anticipated that these services will be installed using standard open-cut techniques, however with the soft clays present in the area it will prove very challenging. A combination of trench box shoring and benched excavation methods will be absolutely necessary.

All excavations should be performed in accordance with the current OHSA requirements. Because of the soft soils present at the site, and the ground water levels observed during the fieldwork, it is recommended that contractors installing the sewers confirm the possible base heaving behaviors of the subsoils with test pits prior to undertaking the sewer installation. It is anticipated that continuous pumping of infiltration waters will be required throughout the installation process. Wider than normal excavations may be required to obtain stable working conditions. Additional crusher-run stone acting as ballast may be required to achieve a stable base condition on which to place the specified pipe bedding material.

#### 6.9.2 Bedding and Cover

The following are recommendations for service trench bedding and cover materials:
• Bedding for buried utilities should be OPSS Granular A or B Type II as applicable, and placed in accordance with pertinent Ontario Provincial Standard Drawings (OPSD).

• Use of clear 19 mm stone is not recommended for use as bedding. The voids in the stone may result in a low gradient water flow and infiltration of fines from the surrounding soils and cover materials, causing settlement and loss of support to pipes and structures.

• The cover material should be a sand material or others approved by pipe manufacturer or designer. The dimensions should comply with pertinent OPSD standards.

• The bedding material and cover materials should be compacted as per OPSS 501 and 514 and to at least 95% of its SPMDD.

• Compaction equipment should be used in such a way that the utility pipes are not damaged during construction.

6.9.3 Backfill

Backfill above the cover for buried utilities should be in accordance with the following recommendations:

• For service trenches under pavement areas, the backfill should be placed and compacted in uniform thickness compatible with the selected compaction equipment and not thicker than 200 mm. Each lift should be compacted to a minimum of 95% of its SPMDD.

• The backfill placed in the upper 300 mm below the top of the pavement sub-base course should be compacted to a minimum of 100% SPMDD.

• To reduce the potential for differential settlement and frost heave, the selected backfill materials should reasonably match the original soil profile within the frost penetration zone (1.5 m below finished grade). Alternatively, if imported backfill, including granular materials, are used then the excavation sides should have frost tapers as per OPSD 800 series which essentially indicates that there should be a slope of 10:1 (H:V) from the bedding grade to the finished grade.
Excavated soils that are too wet (i.e. greater than 5% above the optimum moisture content based upon a Standard Proctor Test) will become problematic to compact and may not perform properly during construction period. If such conditions occur, the options include drying of the soils; compacting and leaving the area un-travelled for a period of time; importation of a more suitable material; or a combination of above and the use of geotextiles at the base and possibly additional layers within the pavement structure’s granular base courses. The appropriate measures will need to be discussed during construction period and be such to achieve adequate performance from the pavement structure.

6.10 Pavement Structures

It is expected that the roadways and driveways will be constructed over the existing silty sand subgrade. In order to prepare the site for pavement areas, it is necessary that the topsoil be stripped and the subgrade proof-rolled with loaded dump trucks or heavy duty steel drum rollers. Any areas exhibiting rutting, significant deflection, deeper organics, or local anomalies should be sub-excavated and replaced with appropriate fill. The fill should be compacted to at least 95% of its SPMDD. The recommended minimum pavement sections are described in Table 1, below.

<table>
<thead>
<tr>
<th>PAVEMENT LAYER</th>
<th>LIGHT DUTY (Driveways)</th>
<th>HEAVY DUTY (Roadways)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL3 Asphalt or SuperPave 12.5</td>
<td>50 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>HL8 Asphalt or SuperPave 19.0</td>
<td>n/a</td>
<td>50 mm</td>
</tr>
<tr>
<td>Granular A [BASE] (Crushed Limestone)</td>
<td>150 mm</td>
<td>150 mm</td>
</tr>
<tr>
<td>Granular B, Type II [SUB-BASE] (Crushed Limestone)</td>
<td>300 mm</td>
<td>400 mm</td>
</tr>
</tbody>
</table>
Drainage of pavement structures is important. The surface of the subgrade, granular courses, and each layer of the pavement section should be provided with a suitable cross fall shaping to prevent water from ponding on the pavement surface and beneath the pavement layers. Surface water runoff should be directed to storm sewers, or allowed to flow into ditches.

Following discussions with the Client and their Civil Engineer, it was agreed that a granular sub-base thickness of 400 mm would be permissible rather than the originally recommended 450 mm. This will increase the importance of good subgrade preparation. Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the sub-base in a dry condition. Failure to provide drained conditions under heavy wheel loading can result in the fine subgrade soil pumping into the voids in the coarse sub-base. The most severe loading conditions on the pavement structure are throughout construction. Special provisions, such as restricted access lanes and half loading may be required, especially for wet weather construction. The pavement thicknesses described within this report are for the end-use conditions only (ie. residential traffic and occasional garbage and service vehicles). It may be necessary to over-build these sections if heave equipment traffic is envisioned during construction.

Sufficient field-testing should be carried out during construction to assess compaction of each lift of the pavement layers. This should be accompanied by laboratory testing of the granular and asphalt materials. All granular base course materials should be compacted to 98% of its SPMDD.

The asphalt materials should be compacted as per OPSS 310. In general the HL8 binder course should be compacted to a minimum of 97% of its Marshall Bulk Relative Density or 91% to 96.5% of its Marshall Maximum Relative Density as per OPSS “Table 9”. The surface coarse HL3 should be 92% to 96.5% of its Marshall Maximum Relative Density as per OPSS “Table 9”. In the case that a SuperPave system is selected, placement should be in accordance to OPS 1151, and its’ common Municipal Appendix ‘A’.

Where services are installed in the roadways, it is expected that a geotextile separation layer such as Amoco 2002 or similar will be required. However, this will be a Site decision, based on the performance of the backfill, after the services are installed.
It is recommended that pavement surface course asphalt layers not be placed for 1 to 2 years subsequent to the base course asphalt placement to allow for correction of any settlement or inadequate performing areas.

7.0 RECOMMENDED CONSTRUCTION OVERSIGHT

Once the Plans and Specifications become available, and before construction begins, Inspec-Sol requests to be retained in order to review these documents. They will be reviewed to ensure that the recommendations contained within this report are adequately addressed, and to look for other obvious problematic geotechnical conditions. The recommendations provided in this report are based on an adequate level of construction monitoring throughout the construction phase. Due to the nature of the planned project, and the soil conditions encountered in the boreholes, an adequate level of construction monitoring is considered to be as follows:

- Once footing excavations are complete for each home, the foundation subgrade should be approved by a Geotechnical Engineer, prior to pouring the footings.
- Before any soils are brought to Site, they should be sent to a geotechnical laboratory, for proctor testing and grain size analysis. To ensure they meet the requirements of the above report and applicable standards.
- Subgrades below roadways should be proof-rolled in the presence of an Engineering Technologist, prior to placement of geotextile and the sub-base course granular materials.
- Engineered Fill (if required) should be placed under the full time supervision of a qualified Engineering Technologist.
- Concrete for footings, foundation walls, and floor slabs, and cast in place site works should be periodically tested for slump, entrained air, temperature, and cylinders should be cast for compressive strength testing. This should be performed by a qualified Engineering Technician.
8.0 REPORT CONDITIONS AND LIMITATIONS

This report is intended solely for Melanie Construction and other parties explicitly identified in the report and is prohibited for use by others without Inspec-Sol’s prior written consent. This report is considered Inspec-Sol’s professional work product and shall remain the sole property of Inspec-Sol. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient’s sole risk, without liability to Inspec-Sol. Client shall defend, indemnify and hold Inspec-Sol harmless from any liability arising from or related to Client’s unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, Inspec-Sol will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, Inspec-Sol is the geotechnical engineer of record. It is recommended that Inspec-Sol be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.
It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the ten (10) borehole locations only. The subsurface conditions confirmed at these four test locations may vary at other locations. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by Inspec-Sol is completed.

INSPEC-SOL INC.

Shane Dunstan, B.A.Sc., E.I.T. 
Joseph B. Bennett, P. Eng.

SD/vl

Dist: Mr. Reynald Patenaude – email – (melconst@explornet.com) Mail (3); and
Mr. Todd Perry – email – (t.perry@mcintoshperry.com).
DRAWINGS

SITE LOCATION MAP
BOREHOLE LOCATION PLAN
EARTH PRESSURE ON BASEMENT WALLS
RECOMMENDED PERIMETER DRAINAGE ALTERNATIVES
THE EARTH PRESSURE ACTING ON BASEMENT WALLS CAN BE CALCULATED USING THE FOLLOWING EARTH PRESSURE DIAGRAM.

\[ q = \text{SURCHARGE} \]

\[ P_q = K_a q H \]

\[ P_a = \frac{1}{2} K_a \gamma H^2 \]

THE FOLLOWING NOTES ARE FOR GENERAL GUIDANCE

ASSUME:

- \( H \) = HEIGHT OF RETAINED SOIL (m).
- \( K_a = 0.35 \) WHERE SOME SLIGHT MOVEMENT IS PERMISSIBLE.
- \( K_a = 0.5 \) WHERE MINIMAL MOVEMENT IS TOLERATED.
- \( \gamma \) = ASSUME 20 kN/m³ FOR FREE DRAINING GRANULAR BACKFILL.
- \( q \) = THE VALUE OF ANY SURCHARGE LOADING WHICH MAY ACT ON THE GROUND SURFACE ADJACENT TO THE WALL.

NOTE:

WITH THE ABOVE DIAGRAM, IT HAS BEEN ASSUMED THAT AN EFFECTIVE DRAINAGE SYSTEM HAS BEEN INSTALLED AND THERE IS NO BUILD UP OF HYDROSTATIC PRESSURE.

EARTH PRESSURE ON BASEMENT WALL

GEOTECHNICAL INVESTIGATION
PATENAUDE SOUTH WEST RUSSELL SUBDIVISION
PART OF LOTS 11 AND 12, CONCESSION 2
TOWNSHIP OF RUSSELL, ONTARIO

1. DRAIN
100mm Ø MIRAPIPE c/w P50 SOCK OR EQUIVALENT SYSTEM LEADING TO FUNCTIONAL SUMP OR OUTLET. PIPE MAY BE PLACED ON FOOTING LEDGE OR BESIDE FOOTING AT LEAST 150 mm BELOW UNDERSIDE OF FLOOR SLAB AND WITH 150mm OF STONE TO ACT AS A BEDDING.

2. CRUSHED STONE
19 mm CLEAR CRUSHED STONE (OPSS 1004) OR WASHED GRAVEL TO A THICKNESS OF 150 mm ON TOP AND SIDES OF DRAIN PIPE.

3. DRAINAGE BLANKET
MIRADRAIN 6000 OR EQUIVALENT GEOTEXTILE ON PIPE MUST OVERLAP BLANKET TO PREVENT SOIL MOVEMENT INTO DRAINAGE SPACE. TOP OF DRAINAGE BLANKET TO EXTEND TO WITHIN 0.5m OF EXTERIOR GRADE.

4. GEOTEXTILE
NON-WOVEN FILTER TYPE TERRAFIX 270R OR EQUIVALENT

5. SAND BACKFILL
FREE-DRAINING SAND COMPACTED TO 90% (ASTM D-698) IN LANDSCAPED AREAS AND TO 95% IN PAVED AREAS. MINIMUM DEPTH OF SAND BACKFILL AGAINST Poured CONCRETE WALLS IS 1.2 m FROM THE BASE OF FOOTING. USE FULL-DEPTH SAND BACKFILL AGAINST CONCRETE BLOCK FOUNDATION WALLS.

6. LOCAL BACKFILL
ORGANIC FREE NATIVE SOIL FROM FOUNDATION EXCAVATION COMPACTED TO 90% (ASTM D-698) IN LANDSCAPED AREAS. USE FREE-DRAINING SAND AND COMPACT TO 95% IN SIDEWALK, FROST, SENSITIVE PAVED AREAS. SLOPE BACKFILL AWAY FROM BUILDING FOR POSITIVE DRAINAGE.

7. ENTRANCE LEVEL FLOOR
SEE PROJECT'S STRUCTURAL ENGINEER’S SPECIFICATION, BUT TYPICALLY BASEMENT WALLS MUST BE SUPPORTED AT THE ENTRANCE LEVEL AND AT ALL INTERMEDIATE LEVELS WITH THE FLOOR SYSTEM PRIOR TO BACKFILLING AND COMPACTING.

8. BASE COURSE
CLEAR CRUSHED STONE 20 mm Ø OR SIMILAR FREE-DRAINING TO PREVENT MIGRATION OF MOISTURE TO THE UNDERSIDE OF SLAB. MINIMUM RECOMMENDED THICKNESS IS 150mm.

9. VAPOUR BARRIER
DESIGNERS SHOULD MAKE AN ASSESSMENT FOR THE NEED OR DELETION OF A VAPOUR BARRIER - SEE GEOTECHNICAL REPORT.

10. FLOOR SLAB
CONCRETE FLOOR SLAB POURED ON GRADE. DESIGNED AND CONSTRUCTED AS PER PROJECT STRUCTURAL ENGINEER. PROVIDE CONTROL JOINTS AT WALLS AND AROUND INTERIOR COLUMNS.

11. BASEMENT WALL
POURED CONCRETE FOUNDATION WALL TO BE DAMP-PROOFED OR WATER-PROOFED, DEPENDING ON INTERIOR USE AND GROUNDWATER CONDITIONS. SEE GEOTECHNICAL REPORT OR CALL OFFICE FOR SPECIFIC DETAILS IF REQUIRED.

RECOMMENDED PERIMETER DRAINAGE ALTERNATIVES

GEOTECHNICAL INVESTIGATION
PATENAUDA SOUTH WEST RUSSELL SUBDIVISION
PART OF LOTS 11 AND 12, CONCESSION 2
TOWNSHIP OF RUSSELL, ONTARIO

Dwg. No. T020624-A1-4
ENCLOSURES

BOREHOLE LOGS
RESULTS OF LABORATORY TESTING
**BOREHOLE No.: BH-01**

**ELEVATION: 71.57 m**

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**DESCRIPTION OF SOIL AND BEDROCK**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Stratigraphy</th>
<th>State</th>
<th>Recovery</th>
<th>Organic Vapour ppm or %LEL</th>
<th>Shear Strength based on Field Vane</th>
<th>Shear Strength based on Lab Vane</th>
<th>Sensitivity Value of Soil</th>
<th>Atterberg limits (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>SILTY SAND - compact, brown, moist</td>
<td>SS1 58</td>
<td>3</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>1.0</td>
<td>-becoming wet by 1.2m depth</td>
<td></td>
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</tr>
<tr>
<td>1.5</td>
<td>SILTY CLAY - stiff, grey, wet</td>
<td>SS2 54</td>
<td>11</td>
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<tr>
<td>3.0</td>
<td>SANDY SILT TILL- compact to dense, grey, frequent gravel sizes, moist</td>
<td>SS3 100</td>
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<td></td>
</tr>
</tbody>
</table>

---

1. Water table estimated at 1.2m depth from sample appearance.
1. Water table estimated at 1.2m depth from sample appearance.
1. Water table estimated at 1.3m depth from sample appearance.
TOPSOIL/ROOTMAT

Silty Sand - compact, brown, moist
-becoming wet by 1m depth

Silty Clay - stiff to firm, grey, occasional sand seams, wet

End of Borehole

NOTES:
1. Water table estimated at 1m depth from sample appearance.
<table>
<thead>
<tr>
<th>Depth (meters)</th>
<th>BGS Elevation (m)</th>
<th>Stratigraphy</th>
<th>DESCRIPTION OF SOIL AND BEDROCK</th>
<th>Type and Number</th>
<th>Recovery %</th>
<th>Organic Vapour ppm</th>
<th>Sensitivity Value of Soil</th>
<th>Penetration Index / RQD</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.9</td>
<td>71.12</td>
<td>TOPSOIL/ROOTMAT</td>
<td>SILTY SAND -compact, brown, moist</td>
<td>SS1</td>
<td>54</td>
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<tr>
<td>68.8</td>
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<td>GROUND SURFACE</td>
<td>SANDY SILT TILL- compact to dense, grey, frequent gravel sizes, moist</td>
<td>SS2</td>
<td>63</td>
<td>13</td>
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<tr>
<td>64.4</td>
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<td>End of Borehole</td>
<td>SS3</td>
<td>8</td>
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<td>SS4</td>
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**LEGEND**
- **SS**: Split Spoon
- **ST**: Shelby Tube
- **RC**: Rock Core
- **Cu**: Shear Strength based on Field Vane
- **Cu**: Shear Strength based on Lab Vane
- **A**: Atterberg limits (%)
- **DI**: Dynamic Cone sample
- **N**: Penetration Index based on Split Spoon sample
- **DI**: Penetration Index based on Dynamic Cone sample

**NOTES:**
CLIENT: Melanie Construction

PROJECT: Proposed Subdivision - Patenaude South West Russell

LOCATION: Part of Lots 11 and 12 Concession 2 Township of Russell, Ontario

DESCRIBED BY: A. Meacoe

CHECKED BY: H. Krzywicki

DATE (START): May 5, 2009

DATE (FINISH): May 5, 2009

SCALE

<table>
<thead>
<tr>
<th>Depth (meters)</th>
<th>Elevation (m)</th>
<th>Stratigraphy</th>
<th>Description of Soil and Bedrock</th>
<th>Type and Number</th>
<th>Recovery</th>
<th>Organic Vapour ppm</th>
<th>Sensitivity Value of Soil</th>
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<td>- becoming wet by 1.5m</td>
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<td></td>
<td>SILTY CLAY - stiff to firm, grey, wet</td>
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<td>REFUAL to vane advancement, continued with spoon</td>
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<td>SANDY SILT TILL - dense, grey, frequent gravel sizes, wet</td>
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</table>
### STRATIGRAPHY

**DESCRIPTION OF SOIL AND BEDROCK**

**GROUND SURFACE**

<table>
<thead>
<tr>
<th>Depth (meters)</th>
<th>Stratigraphy</th>
<th>Recovery</th>
<th>Organic Vapour (ppm)</th>
<th>Penetration Index (N)</th>
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</thead>
<tbody>
<tr>
<td>70.3</td>
<td>TOPSOIL/ROOTMAT</td>
<td>SS1 63</td>
<td>8</td>
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<tr>
<td>70.0</td>
<td>SILTY SAND - compact, brown, moist</td>
<td>SS2 68</td>
<td>13</td>
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<tr>
<td>69.0</td>
<td>- becoming wet by 1.2m depth</td>
<td>SS3 79</td>
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<tr>
<td>68.9</td>
<td>SILTY CLAY - stiff to firm, grey, wet</td>
<td>SS4 2.7</td>
<td>S=2.7</td>
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</tr>
<tr>
<td>68.0</td>
<td>SANDY SILT TILL- dense, grey, frequent gravel sizes, moist</td>
<td>SS5 4.8</td>
<td>S=4.8</td>
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<tr>
<td>75.5</td>
<td>Sampling Refusal - Possible Bedrock</td>
<td>SS6 100</td>
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<tr>
<td>56.8</td>
<td>End of Borehole</td>
<td>SS7 58</td>
<td>68</td>
<td>R</td>
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</tbody>
</table>

**NOTES:**
1. Water table estimated at 1.2m depth from sample appearance.
BOREHOLE No.: BH-08
ELEVATION: 70.43 m

CLIENT: Melanie Construction
PROJECT: Proposed Subdivision - Patenaude South West Russell
LOCATION: Part of Lots 11 and 12 Concession 2 Township of Russell, Ontario

DESCRIBED BY: A. Meacoe
CHECKED BY: H. Krzywicki
DATE (START): May 4, 2009
DATE (FINISH): May 4, 2009

SCALE

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Elevation (m)</th>
<th>Stratigraphy</th>
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<tr>
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<td>68.2</td>
<td>Silty clay - stiff to firm, grey, wet</td>
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<tr>
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<tr>
<td>0</td>
<td>- becoming wet 1.5m</td>
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</tr>
</tbody>
</table>

LEGEND
- SS Split Spoon
- ST Shelby Tube
- RC Rock Core
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- Cu Penetration Index based on Dynamic Cone sample
- Cu Shear Strength based on Field Vane
- Sensitivity Value of Soil
- Shear Strength based on Pocket Penetrometer

NOTES:
1. Water table estimated at 1.5m depth from sample appearance.
**BOREHOLE LOG**

**CLIENT:** Melanie Construction  
**PROJECT:** Proposed Subdivision - Patenaude South West Russell  
**LOCATION:** Part of Lots 11 and 12 Concession 2 Township of Russell, Ontario  
**DESCRIPTION BY:** A. Meacoe  
**CHECKED BY:** H. Krzywicki  
**DATE (START):** May 4, 2009  
**DATE (FINISH):** May 4, 2009

---

### SCALE FOR TEST RESULTS

- **50 kPa**  
- **100 kPa**  
- **150 kPa**  
- **200 kPa**

---

### STRATIGRAPHY

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Ground Surface</th>
<th>Organic Vapour ppm</th>
<th>Penetration Index / RQD</th>
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### WATER TABLE ESTIMATE

Water table estimated at 1.2m depth from sample appearance.
1. Water table estimated at 1.2m depth from sample appearance.
# BOREHOLE LOG

**BOREHOLE No.:** BH-10  
**ELEVATION:** 70.18 m

## CLIENT:
Melanie Construction

## PROJECT:
Proposed Subdivision - Patenaude South West Russell

## LOCATION:
Part of Lots 11 and 12 Concession 2 Township of Russell, Ontario

## DATE (START):
May 4, 2009  
## DATE (FINISH):
May 4, 2009

## SCALE SAMPLE DATA

<table>
<thead>
<tr>
<th>Depth (meters)</th>
<th>Elevation (m)</th>
<th>Stratigraphy</th>
<th>Description of Soil and Bedrock</th>
<th>Type and Number</th>
<th>Recovery</th>
<th>Organ Vapour ppm</th>
<th>N Penetration Index / RQD</th>
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<tr>
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<td>SS6</td>
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## STRATIGRAPHY

**GROUND SURFACE**

### GROUND SURFACE

End of Borehole

### LEGEND

- **SS** Split Spoon
- **ST** Shelby Tube
- **RC** Rock Core
- **S** Sensitivity Value of Soil
- **Cu** Shear Strength based on Field Vane
- **S** Shear Strength based on Dynamic Cone sample
- **N** Penetration Index based on Split Spoon sample
- **N** Penetration Index based on Lab Vane
- **%** Water content (%)
- **Cu** Shear Strength based on Pocket Penetrometer
- **%** Atterberg limits (%)

## NOTES:

- **ENCLOSURE No.:** 10
- **REFERENCE No.:** T020624-A1
- **DATE (FINISH):** May 4, 2009
- **SCALE FOR TEST RESULTS:**

  - **50kPa**
  - **100kPa**
  - **150kPa**
  - **200kPa**

## STRATIGRAPHY DESCRIPTION

- **Shear Strength based on Field Vane**
- **Cu** Shear Strength based on Lab Vane
- **N** Penetration Index based on Dynamic Cone sample
- **%** Water content (%)
- **Cu** Shear Strength based on Pocket Penetrometer
- **%** Atterberg limits (%)

## SCALE FOR TEST RESULTS

- **50kPa**
- **100kPa**
- **150kPa**
- **200kPa**

## SCALE

- **Elevation (m)**
- **Depth (meters)**
- **Stratigraphy**
- **Description of Soil and Bedrock**
- **Type and Number**
- **Recovery**
- **Organ Vapour ppm**
- **N Penetration Index / RQD**

## END OF BOREHOLE

- **ELEVATION:** 70.18 m

## Moisture Content of Soils

**CLIENT:** Melanie Construction

**PROJECT No.:** T020624-A1  **SAMPLE No.:** 712

### Measuring Instruments Used

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### Sample Data

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<tr>
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<table>
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<table>
<thead>
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<td>Mass of Dry Soil (g)</td>
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<td>27.3</td>
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<td>Mass of Water (g)</td>
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<td>14.4</td>
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<td>80.0</td>
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<td>16.2</td>
<td>51.5</td>
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### Remarks

PREPARED BY: Tom McCarthy  **DATE:** August 5, 2009

VERIFIED BY: Dan Boateng  **DATE:** August 7, 2009
**CLIENT:**  
Melanie Construction

**PROJET No.:**  
T020624-A1  

**SAMPLE No.:**

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### Measuring Instruments Used

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<th>Oven No.</th>
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### Sample No.

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### Depth of Soil

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<tr>
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<td>1.5</td>
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### Plasticity Index

| 48.7 | 52.6 |

---

**Remarks:**

---

**Prepared By:**  
Tom McCarthy  

**Date:**  
August 5, 2009

**Verified By:**  
Dan Boateng  

**Date:**  
August 7, 2009
CLIENT: Melanie Construction

PROJET No.: T020624-A1

SAMPLE No.: 

**MEASURING INSTRUMENTS USED**

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<th>Oven No.</th>
<th>Balance No.</th>
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<tbody>
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<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE No.</th>
<th>BH7 SS9</th>
<th>BH7 SS9</th>
<th>BH7 SS9</th>
<th>BH4 SS12</th>
<th>BH4 SS12</th>
<th>BH4 SS12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LL</td>
<td>PL1</td>
<td>PL2</td>
<td>LL</td>
<td>PL1</td>
<td>PL2</td>
</tr>
</tbody>
</table>

**Depth of Soil**

| 4.6m - 5.2m | 6.1m - 6.7m |

| CONTAINER No. | 48 | 45 | 35 | 17 | 9 | 56 |

| MASS OF CONTAINER + SOIL HUMID (g) | 72.3 | 5.3 | 5.8 | 67.4 | 4.3 | 3.9 |
| MASS OF CONTAINER + SOIL DRY (g) | 57.4 | 4.8 | 5.1 | 40.2 | 3.6 | 3.4 |
| MASS OF CONTAINER | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 |
| MASS OF DRY SOIL (g) | 56.1 | 3.5 | 3.8 | 38.9 | 2.3 | 2.0 |
| MASS OF WATER (g) | 14.9 | 0.6 | 0.6 | 27.3 | 0.7 | 0.5 |
| MOISTURE CONTENT (%) | 26.5 | 16.1 | 16.9 | 70.1 | 28.4 | 24.0 |
| SWEDISH CONE PENETRATION (mm) | 7.5 | 9.5 |
| CORRECTED MOISTURE CONTENT (%) | 28.2 | 16.5 | 71.5 | 26.2 |

**PLASTICITY INDEX**

| 11.7 | 45.3 |

**REMARKS:**

**PREPARED BY:** Tom McCarthy  **DATE:** August 5, 2009

**VERIFIED BY:** Dan Boateng  **DATE:** August 7, 2009
## Client
Melanie Construction

## Project No.
T020624-A1

## Sample No.

<table>
<thead>
<tr>
<th>BH10 SS3</th>
<th>BH10 SS3</th>
<th>BH10 SS3</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>PL1</td>
<td>PL2</td>
</tr>
</tbody>
</table>

## Measuring Instruments Used
- Oven No.: 1
- Balance No.: 1

## Measurement Details

<table>
<thead>
<tr>
<th>Depth of Soil</th>
<th>Mass of Container + Soil Humid (g)</th>
<th>Mass of Container + Soil Dry (g)</th>
<th>Mass of Container</th>
<th>Mass of Dry Soil (g)</th>
<th>Mass of Water (g)</th>
<th>Moisture Content (%)</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5m - 2.1m</td>
<td>57.2</td>
<td>40.2</td>
<td>1.3</td>
<td>38.9</td>
<td>16.9</td>
<td>43.5</td>
<td>23.4</td>
</tr>
<tr>
<td></td>
<td>5.6</td>
<td>4.9</td>
<td>1.3</td>
<td>3.5</td>
<td>0.7</td>
<td>20.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.9</td>
<td>4.3</td>
<td>1.3</td>
<td>3.0</td>
<td>0.6</td>
<td>20.4</td>
<td></td>
</tr>
</tbody>
</table>

## Remarks:

## Prepared By:
Tom McCarthy

## Date:
August 5, 2009

## Verified By:
Dan Boateng

## Date:
August 7, 2009
### COMPRESSIBILITY PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s'_p$ Preconsolidation pressure (kPa)</td>
<td>110</td>
</tr>
<tr>
<td>$s'_vo$ Effective pressure</td>
<td>64</td>
</tr>
<tr>
<td>$s'_p - s'_vo$ Overconsolidation</td>
<td>46</td>
</tr>
<tr>
<td>Overconsolidation ratio (&quot;OCR&quot;)</td>
<td>1.72</td>
</tr>
<tr>
<td>$e_o$ Initial void ratio</td>
<td>2.08</td>
</tr>
<tr>
<td>$c_r$ Recompression index</td>
<td>0.08</td>
</tr>
<tr>
<td>$c_s$ Compression index</td>
<td>2.0</td>
</tr>
<tr>
<td>$c_v$ Coefficient of consolidation</td>
<td></td>
</tr>
</tbody>
</table>

### Size of Sample

- Diameter (mm): 63.5
- Height (mm): 20

### Notes

- Moisture Content (W) %: Initial: 75.530 Final: 45.324

---

**Preformed By:** Daniel Boateng  **Date:** July 20, 2009

**Checked By:** Shane Dunstan  **Date:** July 24, 2009
APPENDIX

NOTES ON BOREHOLE LOGS
SOIL DESCRIPTION:

Each subsoil stratum is described using the following terminology. The relative density of granular soils is determined by the standard penetration index ("N" value), while the consistency of clayey soils is measured by the value of the undrained shear strength (Cu).

### CLASSIFICATION (UNIFIED SYSTEM)

<table>
<thead>
<tr>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
<th>Gravel</th>
<th>Cobbles &amp; Boulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.002mm</td>
<td>0.002 to 0.075mm</td>
<td>0.075 to 4.75mm</td>
<td>4.75 to 75mm</td>
<td>75 to 300mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fine, medium, coarse</td>
<td>fine, coarse</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.075 to 0.425mm</td>
<td>0.075 to 19mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.425mm to 2.0mm</td>
<td>2.0 to 19mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0 to 4.75mm</td>
<td>4.75mm to 19mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.0 to 4.75mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19 to 75mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75 to 200mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>200 to 400mm</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>400 to 750mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>750 to 2000mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2000 to 4000mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4000 to 7500mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7500 to 10000mm</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>10000 to 20000mm</td>
<td></td>
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<td>20000 to 40000mm</td>
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<td>40000 to 75000mm</td>
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<td>75000 to 100000mm</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 100000mm</td>
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</tr>
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<td></td>
<td></td>
<td></td>
<td>&gt; 200000mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 500000mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 1000000mm</td>
<td></td>
</tr>
</tbody>
</table>

### RELATIVE DENSITY OF GRANULAR SOILS

- **Very loose**: 0 - 4
- **Loose**: 4 - 10
- **Compact**: 10 - 30
- **Dense**: 30 - 50
- **Very dense**: > 50

### STANDARD PENETRATION INDEX "N" VALUE

<table>
<thead>
<tr>
<th>Very loose</th>
<th>Loose</th>
<th>Compact</th>
<th>Dense</th>
<th>Very dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>4 - 10</td>
<td>10 - 30</td>
<td>30 - 50</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>

### CONSISTANCY OF COHESIVE SOILS

- **Very soft**: < 250
- **Soft**: 250 - 500
- **Medium**: 500 - 1000
- **Stiff**: 1000 - 2000
- **Very stiff**: 2000 - 4000
- **Hard**: > 4000

### UNDRAINED SHEAR STRENGTH (Cu)

- **Very soft**: < 12
- **Soft**: 12 - 25
- **Medium**: 25 - 50
- **Stiff**: 50 - 100
- **Very stiff**: 100 - 200
- **Hard**: > 200

### ROCK QUALITY DESIGNATION

<table>
<thead>
<tr>
<th>&quot;RQD&quot; (%) VALUE</th>
<th>QUALITATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25</td>
<td>very poor</td>
</tr>
<tr>
<td>25 - 50</td>
<td>poor</td>
</tr>
<tr>
<td>50 - 75</td>
<td>good</td>
</tr>
<tr>
<td>75 - 90</td>
<td>excellent</td>
</tr>
</tbody>
</table>

### STRATIGRAPHIC LEGEND

- **sand**
- **gravel**
- **cobbles & boulders**
- **Bedrock** (limestone)
- **silt**
- **clay**
- **organic soil**
- **fill**

### SAMPLES:

**TYPE AND NUMBER**

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

- **SS**: Split spoon
- **SSE, GSE, AGE**: Environnemental sampling
- **ST**: Shelby tube
- **PS**: Piston sample (Osterberg)
- **AG**: Auger
- **RC**: Rock core
- **GS**: Grab sample

### RECOVERY

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil.

### RQD

The "Rock Quality Designation" or "RQD" value, expressed as a percentage, is the ratio of the total length of all core fragments of 4 inches (10cm) or more to the total length of the run.

### IN-SITU TESTS:

- **N**: Standard penetration index
- **R**: Refusal to penetration
- **Cu**: Undrained shear strength
- **k**: Permeability
- **ABS**: Absorption (Packer test)

### LABORATORY TESTS:

- **Ip**: Plasticity index
- **Wt**: Liquid limit
- **WP**: Plastic limit
- **H**: Hydrometer analysis
- **GSA**: Grain size analysis
- **A**: Atterberg limits
- **w**: Water content
- **g**: Unit weight
- **C**: Consolidation
- **O.V.**: Organic vapor
- **CS**: Swedish fall cone
- **CHEM**: Chemical analysis
A- Soil Sampling

Soil samples are normally recovered with a split-spoon sampler or a thin-walled Shelby tube. The split spoon is dynamically driven into the ground and takes a remoulded sample of the soil found at depth. A standard penetration test is thereby obtained, and is described in the following paragraph. The Shelby tube is pushed into the ground to obtain undisturbed samples of clay or clayey soils. Rock samples are obtained by drilling a core barrel into the rock formation; the diameter of the recovered sample varies with the size of the drilling bit used.

B- Standard Penetration Test (SPT)

A standard penetration test consists of driving a standard split-spoon sampler into the soil by dropping a 140 lb. weight (63.5 kg) from a height of 30 inches (76 cm). The sampler is driven 18 inches (45 cm) into the soil and the number of blows of the drop weight is recorded for every 6 inches (15 cm) of penetration. The total number of blows for the last 12 inches (30 cm) of penetration is the standard penetration index ("N" value). This value obtained at regular intervals provides vital information from which the density, compressibility and bearing capacity of the various soil horizons can be estimated. The test is however seldom used in clayey soils.

C- Dynamic Penetration Test

A dynamic penetration test (or cone penetration test) is similar to a standard penetration test with the difference that the split-spoon sampler is replaced by a conical point 10 cm² in area. The number of blows is recorded continuously for every foot of penetration (30 cm) thus obtaining a systematic indication of the relative density of the materials encountered at depth. This test also helps in determining the depth to a dense soil horizon or bedrock.

Note: The presence of large gravel, cobbles or boulders in the subsoil may distort the results of both the standard penetration test and the dynamic penetration test by giving abnormally high resistance values. When it becomes impossible to drive the cone deeper a refusal ("R") is then recorded.

D- Shear Test

An undrained shear test may be carried out by pushing into the undisturbed soil a vane shear apparatus consisting of a four-bladed vane connected to a rod and by measuring the torque value required to shear the clay. This test may be repeated at regular intervals and the torque values calculated to obtain the undrained shear strength of the clay at each test level. The shear strength profiles permit the calculation of the allowable bearing capacity of the clay. The apparatus used is the "Nilcon" of Scandinavian origin.

E- Permeability Test (Lefranc)

This test consists of determining the coefficient of permeability K of the soil around a permeable lens of known dimensions and which has been formed below the driving shoe. The procedure used is the falling head method. Tests of the Lefranc type are carried out in soils with average granulometry and average permeability.

F- Packer Test

This test is conducted in bedrock by sealing off a section of the borehole with one or two inflatable rubber packers and then pumping water into the isolated section of the hole. The permeability of the rock adjacent to the isolated section of the borehole is measured as a function of the pumping head (pressure) and rate of water loss (absorption) from the sealed-off section over a fixed period of time.

G- Menard Pressuremeter Test

The pressuremeter test developed by Menard (1956) consists of laterally loading the sidewalls of a borehole by dilating a cylindrical probe. The test permits the determination of the modulus $E_M$ and the limit pressure $p_l$, which are a measure of the strength of the soil, and enables the calculation of the bearing capacity and settlements for foundations.
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Appendix A – Photographs
Appendix B – Field Sheets
1.0 INTRODUCTION

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) was retained by Melanie Construction in order to identify the existing fisheries, assess fish and fish habitat sensitivity and provide an impact assessment of the Unnamed Watercourse within the proposed development area. The fisheries inventory and assessment was carried out for the unnamed watercourse within Part of Lots 11 and 12, Concession 2, Russell Township, within the Village of Russell. A drainage channel was also noted entering the Castor River on the subject property. This study has been prepared in support of an application for approval of a proposed subdivision in Russell, Ontario. Recommendations will be provided in order to mitigate impacts on fisheries resources from the proposed subdivision development.

The following report summarizes the fisheries and aquatic ecosystems of the study area, potential impacts that the subdivision may have on these resources and recommends mitigation/protection measures to lessen these impacts. McIntosh Perry carried out a site review on August 11, 2008 and subsequent fisheries inventory and assessment on April 22, 2009. This report summarizes the findings of the summer 2008 and spring 2009 survey.
2.0 STUDY AREA/BACKGROUND

The study area was located on Part of Lots 11 and 12, Concession 2 within the Township of Russell in the Village of Russell. It was also within the jurisdiction of the Ministry of Natural Resources - Kemptville District. The project study area was located immediately north of Church Street and west of Russell Road and included one unnamed watercourse. The unnamed watercourse flowed west to east through the forested portion of the subject property and then north off the property and into the Castor River (Figure 1). The watercourse was located in the northeast corner of the property and conveyed runoff from the surrounding landscape and agricultural fields to the west and into the Castor River.

Melanie Construction is proposing the development of a 300 + single family dwelling subdivision on the existing 27 hectare (68 acre) property. Figure 1 shows the location of the unnamed watercourse and the drainage channel within the subject property.
3.0 METHODOLOGY

A field survey of aquatic habitat and fish communities was carried out on August 11, 2008 and April 22, 2009 by J. King and M. Priddle of McIntosh Perry Consulting Engineers. The survey included, where possible, identification of:

- existing fish communities with the use of a Smith-Root LR- 24 electrofisher;
- watercourse morphology;
- water quality parameters (temperature, conductivity, dissolved oxygen and pH);
- habitat features (e.g. riffles, pools, woody debris, undercut banks, boulder clusters),
- terrestrial groundwater seepage areas, watercourse substrate, bank stability, riparian and aquatic vegetation;
- critical habitat areas (potential spawning, nursery, rearing, migratory and food supply areas);
- physical barriers; and
- potential habitat compensation or enhancement opportunities.

Section 34 of the Fish Act (1985) defines fish habitat as ‘spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes.’ Section 2 of the Act defines fish as ‘parts of fish, shellfish, crustaceans, marine animals and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans and marine animals.’

Under the Department of Fisheries and Ocean’s (DFO) Policy for the Management of Fish Habitat (1986) the DFO’s long-term policy objective is the achievement of an overall net gain of the productive capacity of fish habitat. Areas with the opportunity for net gain were identified during field surveys.

For the purposes of this report a permanent watercourse will be classified as a defined channel which conveys flows more than 8 months out of the year and may only dry up occasionally during the summer. An intermittent watercourse will be considered as a defined channel which conveys flows a minimum of 4 months of the year. An ephemeral stream is a watercourse which may or may not have a defined channel and conveys flows during the spring runoff period and during and after rainfall.
The summer 2008 field survey was carried out by Mr. King and the spring 2009 field survey was conducted with a two-person crew utilizing a backpack electrofisher. All information was recorded on data sheets (Appendix B) as found in the Environmental Guide for Fish and Fish Habitat (MTO, 2006). The survey was carried out for much of the length of unnamed watercourse within the subject property and downstream of the property to the Castor River. Due to low water flows at the time of the survey water quality parameters could not be measured.

Photographs were taken for the watercourse and drainage channel showing typical stream views (Appendix A).
4.0 **EXISTING FISHERIES AND AQUATIC HABITAT**

The following section outlines the existing fisheries and aquatic habitat features of the tributary of the Castor River within Part of Lots 11 and 12, Concession 2, Village of Russell. It should be noted that fish assemblages and aquatic habitat usage represent surveying during August 2008 and April 2009. Table 4-1 summarizes the sensitivity of the watercourse.

No vulnerable, threatened or endangered fish species were identified during the field survey.

4.1 **Unnamed Watercourse**

The unnamed watercourse is considered to be an ephemeral tributary of the Castor River within the property boundaries (Photo 1). This watercourse flowed west to east through the forest in the northeast portion of the property and into the Castor River approximately 150 m downstream of the northeastern property boundary. Downstream of the subject property the watercourse had a moderate gradient and flowed through a channel with moderately eroded slopes. Current land use surrounding the watercourse, on the subject property, consisted primarily of forest (Photo 2) with agricultural fields and residences in close vicinity.

Sand and silt comprised the substrate within the unnamed watercourse. Minimal flow was observed within the watercourse on the subject property during both surveys. Small shallow pools were noted within the channel and were approximately 0.1 m deep and 2.5 m wide. The watercourse had a defined channel with runs observed to be approximately 0.01 m deep and 0.4 m wide during both surveys. Bankfull channel width and depth was approximately 4 m and 0.3 m, respectively. Minimal erosion or areas of high sediment deposition were noted within the subject property boundaries as the terrain was fairly level with slow flows. Downstream of the subject property slopes were less stable and moderately higher flow was observed. A small outlet pipe with flow was observed entering the unnamed watercourse immediately downstream of the subject property (Photo 3) adding to the base flows in this portion of the channel. The channel became undefined within the western portion of the creek, inside the forest boundaries (Photo 4). No defined channel existed outside of the forested area.

Vegetation noted at the time of the surveys included grasses, ostrich fern (*Matteuccia struthiopteris*), sensitive fern (*Onoclea sensibilis*) and jewelweed (*Impatiens capensis*). Woody vegetation observed included maples (*Acer* sp.), poplars (*Populus* sp.) and ash (*Fraxinus* sp.).
Fish habitat noted within the watercourse included woody debris and detritus. Downstream of the property the watercourse flowed into the Castor River (Photo 5). Many species of fish inhabit the Castor River and may spend some of their life cycle in the vicinity of this watercourse outlet.

The length of the watercourse between the subject property and the Castor River was observed in 2008 and 2009. No fish were observed in 2008. Five brook stickleback (Culaea inconstans) were observed during the spring 2009 survey approximately 10 m from the confluence with the Castor River. It is probable that fish will use the lower portions of the watercourse, within 100 m of the Castor River, during the spring freshet and during rain events.

No background data from the Ministry of Natural Resource (MNR), South Nation Conservation (SNC), Canadian Museum of Nature (CMN) or the Royal Ontario Museum (ROM) was available for this watercourse. As noted, this watercourse drained into the Castor River, which is a large tributary of the South Nation River. A number of sport fish and baitfish can be found within the Castor River. The MNR provided data from 1998 and 2005 for the Castor River within the local area around Embrun and Russell. Data indicated that smallmouth bass (*Micropterus dolimeu*), walleye (*Sander vitreus*), pumpkinseed (*Lepomis gibbosus*), rockbass (*Ambloplites rupestris*), white sucker (*Catostomus commersoni*), greater redhorse (*Moxistoma valenciennessi*), silver redhorse (*Moxistoma anisurum*), brown bullhead (*Ameiurus nebulosus*), stonecat (*Noturus flavus*), tadpole madtom (*Noturus gyrinus*), longnose dace (*Rhinichthys cataractae*), fallfish (*Semotilis corporalis*), fathead minnow (*Pimephales promelas*), brook stickleback, log perch (*Percina caprodes*), trout-perch (*Percopsis omiscomaycus*), and Johnny darter (*Etheostoma nigrum*) were present in the vicinity of Russell. Data suggests that the greater redhorse is found in this reach of the Castor River. This species is listed as sensitive on the MNR NHIC website, however it is not listed under SARA or COSEWIC as a species at risk. Greater redhorse are typically found in medium to larger watercourses over sand, gravel or cobble. Their spawning requirements include shallow swift moving waters over a gravel and cobble substrate. The greater redhorse is generally intolerant of highly turbid waters. None of these conditions were present where the unnamed watercourse outlet into the Castor River.

It is highly unlikely that fish migrate upstream onto the subject property during spring flows due to the watercourses ephemeral nature and the fact that no fish were captured within watercourse pools on April 22, 2009. Fish are found in the lower reaches of the watercourse which provides seasonal habitat. During the August 2008 survey, minimal flow was observed in the downstream
portion of the watercourse and a small migration barrier existed at the confluence with the Castor River.

Water flow in the creek comes primarily from runoff from the adjacent agricultural field. No defined channel exists outside of the small forested area on the subject property. Therefore, this watercourse, within the property boundaries, can be considered to provide indirect fish habitat during rain events and spring runoff. It may provide small amounts of nutrients and food to fish located downstream and within the Castor River. It also provides base flow to lower reaches of the watercourse that contain fish for brief periods during the spring.

4.2 Drainage Channel

A drainage channel existed within the property boundaries along the northwest corner of the forested area. This channel outlets directly into the Castor River. As such, this drainage channel is considered to be an ephemeral channel and provide poor quality indirect habitat for fish within the Castor River. A large migration barrier existed adjacent to the Castor River. No flow was observed within this channel during either site visit.
### Table 4-1. Watercourse Sensitivity

<table>
<thead>
<tr>
<th>Waterbody</th>
<th>Flow</th>
<th>Substrate Type</th>
<th>Vegetation</th>
<th>Fish Observed (species)</th>
<th>Directly Supports a Fishery (Y/N)</th>
<th>Type of Fishery Supported</th>
<th>Overall Sensitivity (H, M, L)</th>
<th>Rationale for Sensitivity Ranking/Comments*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Watercourse</td>
<td>Ephemeral</td>
<td>Sand, silt, clay</td>
<td>jewelweed, ferns</td>
<td>None on-site</td>
<td>No</td>
<td>Indirect Fish Habitat</td>
<td>Low</td>
<td>No fish were observed within the property boundaries. Outlets into the Castor River. Fish captured in channel approximately 10 m from confluence with the Castor River. Channel reduced to overland flow where it enters the forest from the agricultural fields.</td>
</tr>
<tr>
<td>Drainage Channel</td>
<td>Ephemeral</td>
<td>cobble, sand</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td>Indirect Fish Habitat</td>
<td>Low</td>
<td>Dry during all surveys. Outlets into the Castor River</td>
</tr>
</tbody>
</table>

*McIntosh Perry Consulting Engineers Ltd.*
5.0 IMPACTS AND ASSESSMENT

No fish were captured or observed within any of the watercourses on the subject property. The unnamed watercourse and drainage channel were noted to be ephemeral. No groundwater upwellings or springs were noted within the subject property. It was determined that the reaches of the unnamed watercourse within the property is an ephemeral system and provides limited indirect fish habitat for downstream sections of the channel and the Castor River. A small number of insect larvae were observed within the standing pools on the subject property.

The developer has proposed to fill in the majority of the channel on the subject property. A ditchline will be excavated at the back of the lots along the east edge of the property to ensure that current flows will be maintained within the watercourse downstream of the subject property. Although this will result in the loss of approximately 275 m of ephemeral indirect fish habitat it is not expected that this will have any significant impact on fish bearing watercourses. Nutrients and food will still be allowed to flow into the Castor River from the development site from the creation of approximately 500 m of channel along the eastern boundary. This watercourse does not have any impact on base flow within the Castor River.

Disturbed sediments resulting from construction activities may be carried downstream to fish bearing areas and as such mitigation measures will be required in order to avoid the downstream effects of sediment on fish. Erosion and sediment control measures (e.g. silt fence, straw bale check dams) should be installed prior to the onset of construction in order to ensure that no sedimentation occurs. These measures should be maintained in good condition for the duration of construction and be removed once the site has stabilized.

Filling in most of the unnamed watercourse on the subject property and the drainage ditch are proposed. Provided proper mitigation measures are maintained around the watercourse no significant negative impacts to fish habitat are expected to occur. It is recommended that vegetation be planted along the channel to be excavated along the properties eastern boundary in order to help mitigate any potential negative impacts.

No lots will be located within 30 m of the high water mark or 15 m from the top of bank of the Castor River, whichever is greater.
The stormwater management plan for the subdivision will ensure conformance to the Environmental Design Criteria laid out in Section 3.3 of the Stormwater Management Planning and Design Manual (MOE 2003). Currently the stormwater pond is proposed to be located in the northwest corner of the property adjacent to the Castor River. It is recommended that the stormwater pond be located a minimum of 30 m from the high water mark or 15 m from the top of bank of the Castor River, whichever is greater.

It is anticipated that no significant negative impacts to the study area watercourse and drainage channel, with respect to their function as indirect fish habitat, will occur from the proposed development. The current agricultural activities that are taking place around the watercourses will be replaced with residential development. With the development of the subdivision a small channel will be provided at the eastern property boundary in order to mitigate the loss of the current channel.

Table 5-1 identifies the scale of negative effects as a result of the proposal and mitigation measures proposed to minimize these effects. Table 5-2 categorizes the project risks on the watercourses.
### Table 5-1. Scale of Negative Effects and Proposed Mitigation

<table>
<thead>
<tr>
<th>Waterbody</th>
<th>Type of Fishery Directly Supported</th>
<th>Type of Work/Undertaking</th>
<th>Potential Impact (stressor from PoE)</th>
<th>Mitigation Measures</th>
<th>Effects</th>
<th>Comments (rationale for scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Watercourse</td>
<td>None</td>
<td>Subdivision development</td>
<td>Sedimentation from runoff, loss of 275 m of ephemeral indirect fish habitat</td>
<td>Standard construction erosion and sediment control measures, creation of channel along eastern property limits</td>
<td>Entire channel will be filled in and replaced with a longer channel along the eastern property boundary. A gain of approximately 225 m of indirect fish habitat which may become d</td>
<td>Low</td>
</tr>
<tr>
<td>Drainage channel</td>
<td>None</td>
<td>Subdivision development</td>
<td>Loss of ephemeral indirect fish habitat. Sedimentation</td>
<td>Standard construction erosion and sediment control measures.</td>
<td>Entire channel will be filled in or utilized for stormwater pond</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Table 5-2. Categorization of Project Risk

<table>
<thead>
<tr>
<th>Waterbody</th>
<th>Sensitivity of Fish &amp; Fish Habitat (L, M, H)</th>
<th>Scale of Negative Effects (L, M, H)</th>
<th>Risk of Project (L, M, H)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Watercourse</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Indirect fish habitat. Will not negatively affect fish habitat with proper mitigation measures installed. Net gain of 225 m of channel</td>
</tr>
<tr>
<td>Drainage channel</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Indirect fish habitat. Loss of ephemeral channel not expected to have a significant effect on Fish Habitat.</td>
</tr>
</tbody>
</table>
6.0 RECOMMENDED MITIGATION AND ENHANCEMENT

In order to minimize or eliminate environmental impacts during any roadway and/or building construction, the following mitigation measures are recommended:

- In order to mitigate the transport of sediment to the watercourse and downstream fish habitat during construction, appropriate erosion and sediment control measures such as silt fence barriers and straw bale flow checks, should be installed prior to the commencement of construction. Sediment control measures should be maintained in good condition for the duration of construction. All measures should be removed from the construction zone once construction is complete and the site has been stabilized.

- Appropriate measures should be taken to eliminate the possibility of sediment from entering the watercourse during channel excavation. Construction should take place ‘in the dry’.

- Native trees and shrubs could be planted in areas adjacent to the proposed channel along the eastern boundary in order to increase bank stability.

- In order to protect downstream fish habitat from unnecessary contamination, it is recommended that all machinery be maintained in good working order and that all machinery be fueled a minimum of 30 m from the watercourse.

- No in water work (including infilling the stream) should occur between March 15 and June 30 to protect breeding fish habitat downstream.

- South Nation Conservation approvals should be sought for all work required within, or adjacent to, the watercourses on site. This would include filling the channel, the removal of riparian vegetation, the installation of a stormwater drainage outlet, and/or regrading.

- It is recommended that any requirement for stormwater design be performed by a qualified engineer. A reduction in suspended sediments will prevent any harmful effects to sensitive fish habitat downstream of the subject property within the Castor River.
7.0 REFERENCES


Environmental Guide for Fish and Fish Habitat, October 2006. Ministry of Transportation of Ontario (MTO 2006)

Fisheries Act (R.S., 1985, c. F-14)

Ministry of Natural Resources. 1998. Data obtained from Anne Bendig, area biologist.

Ministry of Natural Resources. 2005. Data obtained from Anne Bendig, area biologist

Ministry of Natural Resources. 2008. Natural Heritage Information Centre.
8.0 LIMITATIONS

The investigation undertaken by McIntosh Perry with respect to this report and any conclusions or recommendations made in this report reflect McIntosh Perry's judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of the preparation of this report.

This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the site, fisheries investigations at various locations during a specific time interval, as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, or portions of the site which were unavailable for direct investigation.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

If you have any question, comments, or concerns, please do not hesitate to contact the undersigned at McIntosh Perry at 613-836-2184 (x 47).

Sincerely,
Mcintosh Perry Consulting Engineers Ltd.

Jeffrey King, B.Sc., C.Tech., rcji
Fisheries Biologist

H:\01 Project - Proposals\2008 Jobs\CP-08-512 Melanie Const - Patenaude Lands\Fisheries Assessment\Patenaude property fisheries report - final.
Appendix A – Photographs
Photo 1. Unnamed Watercourse upstream of the eastern property boundary, April 22, 2009.

Photo 2. Unnamed Watercourse at the eastern property boundary, August 11, 2008.
Photo 3. Flow entering the watercourse east of the property boundary, August 11, 2008.

Photo 4. Unnamed Watercourse at the western edge of the forest, August 11, 2008.
Photo 5. Castor River at the outlet of the Unnamed Watercourse, August 11, 2008.

Photo 6. Drainage channel at the confluence with the Castor River showing large migration barrier, August 11, 2009.
Appendix B – Field Sheets
**GENERAL INFORMATION**

Project #: CP-08-512  Project Description: Property Development  Day: 02  Month: 04  Year: 2009

Is STREAM REALIGNMENT required for this section:
- Yes  No  Unknown

Collectors: J. Kong  M. Pradelle

Weather Conditions: Sunny with Clouds

Time Started: 10:30  Time Finished: 11:00

**LOCATION**

Name of Waterbody: Tributary of Castor R

Drainage System: Castor River

Crossing #: 1  Station #: __________

Location of Crossing:

UTM Easting & Northing:
- 45,285,372
- 75,368,319

MTO Chainage:

Township:
- Russell

MNR District:
- Kamptville

**LAND USE AND POLLUTION**

Surrounding Land Use:
- Agricultural, Forested

Sources of Pollution:
- Agricultural

**EXISTING STRUCTURE TYPE**

Bridge 0  Box Culvert 0  Open Foot Culvert 0  GSP 0  N/A 0

Other 0

**SECTION TYPE AND MORPHOLOGY**

Section Identifier: ___

Section Location:

Type: Stream  River  Channelized  Permanent  Intermittent

Ephemeral  o

Associated Wetland: None Known

Total Section Length (m): Within property

Current Velocity (m/s):

<table>
<thead>
<tr>
<th>Sub-Section</th>
<th>Run</th>
<th>Pool</th>
<th>riffle</th>
<th>Flats</th>
<th>Inside culvert</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of area</td>
<td>10</td>
<td>85</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean depth wetted (m)</td>
<td>0.03</td>
<td>0.1</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean width wetted (m)</td>
<td>0.35</td>
<td>0.35</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean bankfull width (m)</td>
<td>3.8</td>
<td>4</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean bankfull depth (m)</td>
<td>0.3</td>
<td>0.35</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substrate</td>
<td>Sa Cl</td>
<td>Sa D Si</td>
<td>Sa D Si</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**BANK STABILITY**

<table>
<thead>
<tr>
<th></th>
<th>Stable</th>
<th>Slightly Unstable</th>
<th>Moderately Unstable</th>
<th>Unstable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Upstream Bank</td>
<td>0</td>
<td>0</td>
<td>Ø</td>
<td>0</td>
</tr>
<tr>
<td>Right Upstream Bank</td>
<td>0</td>
<td>0</td>
<td>Ø</td>
<td>0</td>
</tr>
</tbody>
</table>

**HABITAT**

<table>
<thead>
<tr>
<th>IN-STREAM COVER (% surface area):</th>
<th>Undercut banks</th>
<th>Boulders</th>
<th>Cobble</th>
<th>Large Woody Debris</th>
<th>Organic debris</th>
<th>Vascular plants</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instream</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhanging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHORE COVER (% stream shaded):</td>
<td>100 - 90 %</td>
<td>90 - 65%</td>
<td>60 - 30%</td>
<td>30 - 1%</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEGETATION TYPE (%)</td>
<td>Submerged</td>
<td>Floating</td>
<td>Emergent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predominant Species</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MIGRATORY OBSTRUCTIONS:**

- Ephemeral, low
- Seasonal
- Permanent

**POSSIBLE CRITICAL HABITAT LIMITING:**

- Spawning: **NONE**
- Evidence of Groundwater: **NONE**
- Other

**POTENTIAL ENHANCEMENT OPPORTUNITIES:**

- Sedimentation Cleared at Carter R. (Off property)

**COMMENTS:**

Fish captured approximately 10 m W of confluence with Carter R.
Electrofishing survey took place 3 days after rainfall.
Watercourse anticipated to be indirect fish habitat with property boundary and seasonal flood/sediment downstream.
Pools or property were filled with leaf litter and appeared to be stagnant. Almost no flow was noted during survey.

Additional Notes Appended: ❌ No ✔ Yes number of pages
Attention: Mr. Ray Patenaude

Re: Preliminary Stability Assessment
Honey Property Subdivision
Church Street
Russell, Ontario

General

The purpose of this preliminary stability assessment is to establish the ‘Erosion Hazard Limit’ for the portion of the subdivision which will abut the Castor River (refer to Key Plan, Figure 1). This limit constitutes a safe setback for any proposed development along the slope with respect to slope stability. The Erosion Hazard Limit was determined based on the Natural Hazard Policies set forth in Section 3.1 of the Provincial Policy Statements of the Planning Act of Ontario. Current regulations restrict development within the Erosion Hazard Limit.

The slope stability analyses were carried out at Sections ‘A-A’ to ‘G-G’, inclusive, using SLIDE, a state of the art, two dimensional limit equilibrium slope stability program. Sections ‘A-A’ to ‘D-D’ are located within the eastern portion of the site. Sections ‘E-E’ to ‘G-G’ are located within the western portion of the site.

Sections ‘A-A’ to ‘D-D’ were surveyed and provided to us by Annis, O’Sullivan, Vollebekk Ltd. (Ontario Land Surveyors) (refer to Site Plan, Figure 2). The slope profile along Sections ‘E-E’ to ‘G-G’ was inferred from available topographic data.

A site visit was carried out by Houle Chevrier Engineering Ltd. on August 12, 2014. At the time of our site reconnaissance, no signs of deep seated instability, surficial tension cracks or other obvious indications of slope movement were observed at the subject site. Minor erosion was noted along the toe of the slope at the Castor River. The results of the slope stability analyses are provided in Appendix A.
Soil Strength Parameters

The soil conditions used in the stability analyses were based, in part, on the results of borehole 13-101, borehole 13-103, and Seismic Piezocone Test 13-102, which was advanced by Houle Chevrier Engineering in December 2013 as part of a geotechnical investigation for the development of the Honey Property Subdivision. The record of borehole logs and seismic piezocone test results are provided in Attachment B. The slope stability analyses were carried out using silty clay strength parameters based on site specific studies in the Ottawa area. To determine the existing factor of safety against overall rotational failure, the slope stability analyses were carried out using drained soil parameters, which reflect long term conditions. The soil parameters selected are typical values for the Ottawa Valley and are consistent with those values used in published literature.

The following table summarizes the soil parameters used in the analyses:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Estimated Undrained Shear Strength, $C_u$ (kilopascals)</th>
<th>Effective Angle of Internal Friction, $\varphi$ (degrees)</th>
<th>Effective Cohesion, $c'$ (kilopascals)</th>
<th>Unit Weight, $\gamma$ (kN/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown silty sand</td>
<td>-</td>
<td>33</td>
<td>0</td>
<td>18.0</td>
</tr>
<tr>
<td>Weathered silty clay</td>
<td>80</td>
<td>30</td>
<td>10</td>
<td>17.0</td>
</tr>
<tr>
<td>Soft and firm, grey silty clay</td>
<td>20 to 30</td>
<td>30</td>
<td>10</td>
<td>17.0</td>
</tr>
</tbody>
</table>

The results of a stability analysis are highly dependent on the assumed groundwater conditions. No information is available on the long term groundwater levels throughout the year; however, as a conservative approach, we have assumed full hydrostatic saturation with the groundwater level at ground surface and groundwater flow horizontally towards the slope.

Existing Conditions

For the purpose of this slope assessment, only deep seated rotational slope failures are considered for the purpose of establishing safe slope setbacks. In other words, shallow surficial slope failures are not considered. The slope stability analyses were carried out using soil parameters, groundwater conditions and a slope profile that attempt to model the slopes in question but do not exactly represent the actual conditions. For the purposes of this study, a computed factor of safety of less than 1.0 to 1.3 is considered to represent a slope bordering on failure to marginally stable, respectively; a factor of safety of 1.3 to 1.5 is considered to indicate a slope that is less likely to fail in the long term and provides a degree of confidence against failure ranging from marginal (1.3) to adequate (1.4 and greater) should conditions vary from the
assumed conditions. A factor of safety of 1.5, or greater, is considered to indicate adequate long term stability.

Based on the site reconnaissance, the slopes along the Castor River were divided into two areas; Area 1 and Area 2. Area 1 is located within the eastern portion of the subject site and includes Sections ‘A-A’ to ‘D-D’. Area 2 is located within the western portion of the subject site and includes Section ‘E-E’ to ‘G-G’. In general, the slopes within Area 1 (i.e., the eastern portion of the site) are steeper than the slopes within Area 2 (i.e., the western portion of the site). For the purposes of this assessment, the erosion hazard limit (setback) within Area 1 is based on the results of the slope stability analyses carried out for Section ‘C-C’ (the most critical location within Area 1 based on slope geometry). The erosion hazard limit within Area 2 is based on the results of the slope stability analyses carried out for Section ‘G-G’ (the most critical location within Area 2 based on slope geometry).

The slope stability analysis indicates that the existing slope at Section ‘C-C’ (i.e., Area 1), in its current configuration but in a fully saturated condition, has a factor of safety against overall rotational failure of 1.2 for static loading conditions, which is considered marginally stable (refer to Figure A1 in Attachment A).

At Section ‘G-G’ (i.e., Area 2), the slope stability analysis indicates that the existing slope, in its current configuration but in a fully saturated condition, has a factor of safety against overall rotational failure of 1.9 for static loading conditions, which is considered stable under “worst case” conditions (refer to Figure B1 in Attachment B).

**Setback Requirements**

**Area 1**

For unstable slopes, the distance from the unstable slope to the safe setback line is called ‘Erosion Hazard Limit’. In accordance with the Ministry of Natural Resources (MNR) Technical Guide “Understanding Natural Hazards” dated 2001, the Erosion Hazard Limit consists of three components: (1) Stable Slope Allowance, (2) Toe Erosion Allowance, and (3) Erosion Access Allowance.

At Section ‘C-C’, the slope stability analysis indicates the existing slope, in its current configuration in a drained condition is considered marginally stable (refer to Figure A1 in Attachment A). Using the same analysis results, a setback from the crest of the slope which would provide a factor of safety of 1.5 was calculated to be about 7.8 metres.

Therefore, for this preliminary analysis, a minimum setback of 7.8 metres measured perpendicular from the crest of the slope along the Castor River is required.

The watercourse is located at the toe of the slope at this site. In accordance with the MNR documents, we have included a Toe Erosion Allowance of 8 metres to allow for continual
erosion at the toe of the slope. The Toe Erosion Allowance is applied at the crest of the slope (refer to Figure A1 in Attachment A).

The MNR procedures also include the application of a 6 metre wide Erosion Access Allowance beyond the Toe Erosion Allowance to allow for access by equipment to repair a possible failed slope. For the purposes of this preliminary assessment, we have included a 6 metre wide Erosion Access Allowance (refer to Figure A1 in Attachment A). Consideration could be given to constructing a pedestrian/bicycle path within the 6 metre zone defined by the Erosion Access Allowance, provided that heavy and emergency vehicle access is not hindered.

Therefore, the Erosion Hazard Limit for the slopes within Area 1 is located about 21.8 metres from the crest of the existing slopes (refer to Figure 2). We recommend that the top of slope be staked by Houle Chevrier Engineering Ltd. and tied-in by a land surveyor so that the Erosion Hazard Limit can be accurately shown on a plan.

Area 2

At Section ‘G-G’, the slope stability analysis indicates that the existing slope, in its current configurations, has a factor of safety against failure of greater than 1.5 (refer to Figures B1 in Attachment B). Therefore, the Stable Slope Allowance described in the MNR procedures is not required.

As previously indicated, the Castor River is located at the toe of the slopes at this site. In accordance with the MNR documents, we have included a Toe Erosion Allowance of 8 metres to allow for continual erosion at the toe of the slope. The Toe Erosion Allowance is applied at the crest of the slope (refer to Figure B1 in Attachment B).

The MNR procedures also include the application of a 6 metre wide Erosion Access Allowance beyond the Toe Erosion Allowance to allow for access by equipment to repair a possible failed slope. For the purposes of this preliminary assessment, we have included a 6 metre wide Erosion Access Allowance (refer to Figure B1 in Attachment B).

Therefore, the Erosion Hazard Limit for the slopes within Area 2 is located about 14.0 metres from the crest of the existing slopes (refer to Figure 2). We recommend that the top of slope be staked by Houle Chevrier Engineering Ltd. and tied-in by a land surveyor so that the Erosion Hazard Limit can be accurately shown on a plan.

Seismic Slope Stability

Sections ‘C-C’ and ‘G-G’ were also analysed for pseudo-static (seismic) conditions. A seismic coefficient of 0.2 was used in the pseudo-static analysis (i.e., half of the Peak Ground Acceleration for the Ottawa area, based on Seismic Site Class E and the OBC 2012).
For seismic loading conditions, the Erosion Hazard Limit could consist of only the Stable Slope Allowance (i.e., the Toe Erosion Allowance and Erosion Access Allowance are not considered). During a seismic event, the Stable Slope Allowance is the area between the crest of the slope and location where a factor of safety of greater than 1.1 against overall rotational failure is calculated. A Toe Erosion Allowance is not considered since erosion is not the trigger of seismic slope instability. Furthermore, an Erosion Access Allowance is also not considered given that, in general, the philosophy for seismic design corresponds to post-disaster conditions (i.e., to avoid immediate collapse and loss of life).

At Section ‘C-C’, the slope stability analysis indicates that the existing slope, in its current configuration but fully saturated, has a factor of safety against failure of greater than 1.1 for pseudo-static (seismic) conditions at a distance of about 15.0 metres from the crest of the slope (refer to Figure A2 in Attachment A). At Section ‘G-G’, the slope stability analysis indicates that the existing slope has a factor of safety against failure of greater than 1.1 for pseudo-static (seismic) conditions. Therefore, the Erosion Hazard Limit determined for static loading conditions governs for this site.

**ADDITIONAL CONSIDERATIONS**

The existing vegetation and trees along the slope should be maintained, to ensure the stability of the slope is not affected. As part of the overall site grading for any future development, no additional surface water should be directed towards the slope unless adequate erosion control measures are incorporated. This could cause erosion of the slope and could also negatively affect the stability of the slope. Final plans and finished grades for any proposed development adjacent to the slope should be reviewed by a geotechnical engineer to ensure that the guidelines provided on this report have been interpreted as intended.
We trust that this letter is sufficient for your purposes. If you have any questions concerning this information or if we can be of further assistance to you on this project, please call.

Luc Bouchard, P.Eng.

Craig Houle, M.Eng., P.Eng.
Principal
Figure
Project No. 13-538
Scale 1:2500
Revision No. 0

LEGEND
- APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION BY HOULE CHEVRIER ENGINEERING LTD.
- BOREHOLE ELEVATION IN METRES (GEODETIC DATUM)

SCPTu
SEISMIC PIEZOCONE TEST

CROSS SECTION LOCATION IN PLAN

EROSION HAZARD LIMIT (APPROXIMATE)

AREA 1

AREA 2

SLOPE STABILITY ASSESSMENT
HONEY PROPERTY SUBDIVISION
RUSSELL, ONTARIO

Drawing

SITE PLAN

Drawn By D.J.R. Checked By L.B.

Scale 1:2500

Date September 2014

Project No. 13-538 Figure 2

ATTACHMENT A

Slope Stability Analyses
Area 1 - Section ‘C-C’
Figures A1 and A2
Loading Conditions: Static
Groundwater Conditions: Full Hydrostatic Saturation
Soil Properties: Drained
Loading Conditions: Pseudo-Static (0.20)
Groundwater Conditions: Full Hydrostatic Saturation
Soil Properties: Drained
ATTACHMENT B

Slope Stability Analyses
Area 2 - Section ‘G-G’
Figures B1 and B2
Loading Conditions: Static
Groundwater Conditions: Full Hydrostatic Saturation
Soil Properties: Drained
Loading Conditions: Pseudo-Static (0.20)
Soil Properties: Undrained
ATTACHMENT C

Record of Borehole Logs
Seismic Piezocone Test Results
RECORD OF BOREHOLE 13-101

PROJECT: 13-538
LOCATION: See Borehole Location Plan, Figure 2
BORING DATE: December 10, 2013
DATUM: Geodetic
SPT HAMMER: 63.5 kg; drop 0.76 m

SOIL PROFILE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>ELEV (m)</th>
<th>STRATA PLOT</th>
<th>DEPTH (m)</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>BLOWNS/0.3m</th>
<th>SHEAR STRENGTH C_{u} (kPa)</th>
<th>WATER CONTENT, PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Surface</td>
<td>68.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark brown silty sand some organic material (TOPSOIL)</td>
<td>68.23</td>
<td></td>
<td>1</td>
<td>O.O.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very stiff, reddish grey brown SILTY CLAY (WEATHERED CRUST)</td>
<td>66.94</td>
<td></td>
<td>50</td>
<td>O.O.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft to firm, grey SILTY CLAY</td>
<td>65.94</td>
<td>4</td>
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<tr>
<td>End of Borehole</td>
<td>7.01</td>
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</table>

HYDRAULIC CONDUCTIVITY, k, cm/s

| DEPTH SCALE | 1  to  50 |

Dynamic Penetration Resistance, BLOWS/0.3m

Additional Lab. Testing

Piezometer or Standpipe Installation

Bentonite

Filter Sand

51mm diameter, 3.05m long slotted PVC pipe

Groundwater level at 0.85 metres below ground surface (elevation 67.58 metres geodetic datum) on January 10, 2014.
### SOIL PROFILE

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.36</td>
<td>Dark brown silty sand some organic material (TOPSOIL)</td>
</tr>
<tr>
<td>0.91</td>
<td>Loose, brown SILTY SAND, trace clay</td>
</tr>
<tr>
<td>69.00</td>
<td>Wet/saturated</td>
</tr>
<tr>
<td>1.52</td>
<td>Soft, grey SILTY CLAY</td>
</tr>
<tr>
<td>63.81</td>
<td>Firm, grey SILTY CLAY</td>
</tr>
<tr>
<td>7.62</td>
<td>End of Borehole</td>
</tr>
</tbody>
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### HYDRAULIC CONDUCTIVITY, k, cm/s

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>k, cm/s</th>
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</thead>
<tbody>
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<td>80</td>
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<tr>
<td>63.81</td>
<td>60</td>
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<tr>
<td>7.62</td>
<td>60</td>
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### Dynamic Penetration Resistance, BLOWS/0.3m

<table>
<thead>
<tr>
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<th>BLOWS/0.3m</th>
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</thead>
<tbody>
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<td>0</td>
<td>20</td>
</tr>
<tr>
<td>63.81</td>
<td>20</td>
</tr>
<tr>
<td>7.62</td>
<td>20</td>
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### Shear Strength, Cu, kPa

<table>
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<th>Cu, kPa</th>
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<td>0</td>
<td>80</td>
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<tr>
<td>63.81</td>
<td>60</td>
</tr>
<tr>
<td>7.62</td>
<td>60</td>
</tr>
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</table>

### Dynamic Penetration Resistance, BLOWS/0.3m

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>BLOWS/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>63.81</td>
<td>20</td>
</tr>
<tr>
<td>7.62</td>
<td>20</td>
</tr>
</tbody>
</table>

### Water Content, Percent

<table>
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<th>Water Content, Percent</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>63.81</td>
<td>80</td>
</tr>
<tr>
<td>7.62</td>
<td>80</td>
</tr>
</tbody>
</table>

### VALENTINE

- **Date:** December 10, 2013
- **Location:** See Borehole Location Plan, Figure 2

### PROJECT

- **Project:** 13-538
- **Location:** See Borehole Location Plan, Figure 2

### SPT HAMMER

- **Type:** 63.5 kg; drop 0.76 m

### DATUM

- **Geodetic**

---

*Additional Lab Testing*

- **Piezometer or Standpipe Installation:**
  - Native Backfill
  - Bentonite
APPENDIX B
PRE-DEVELOPMENT
AREA PLAN
APPENDIX C
POST-DEVELOPMENT AREA PLAN
APPENDIX D
PRE AND POST-DEVELOPMENT
STORMWATER CALCULATIONS
### AVERAGE PRE-DEVELOPMENT RUNOFF COEFFICIENT CALCULATIONS

<table>
<thead>
<tr>
<th>Area A1</th>
<th>Main Site Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>C (5-yr)</td>
</tr>
<tr>
<td>GRAVEL</td>
<td>0.60</td>
</tr>
<tr>
<td>GRASS</td>
<td>0.20</td>
</tr>
<tr>
<td>BUILDING</td>
<td>0.90</td>
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<tr>
<td>Avg C</td>
<td>0.21</td>
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</tbody>
</table>

### PRE-DEVELOPMENT INTENSITIES

<table>
<thead>
<tr>
<th>Time of conc. (min.)</th>
<th>5-Year (mm/hr)</th>
<th>100-Year (mm/hr)</th>
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<tbody>
<tr>
<td>77.10</td>
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</table>

*Time of concentration calculated using WinTr

### PRE-DEVELOPMENT RUNOFF COEFFICIENT CALCULATIONS

<table>
<thead>
<tr>
<th>Basin</th>
<th>Drainage Area (ha)</th>
<th>Balanced Runoff Coefficient (C) 5-yr</th>
<th>Balanced Runoff Coefficient (C) 100-yr</th>
<th>S-Year Flow Rate (l/s)</th>
<th>100-Year Flow Rate (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1686.8</td>
</tr>
<tr>
<td>Total</td>
<td>50.43</td>
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<td></td>
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<td>1686.8</td>
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</tbody>
</table>

### AVERAGE POST-DEVELOPMENT RUNOFF COEFFICIENT CALCULATIONS

<table>
<thead>
<tr>
<th>Area B1</th>
<th>Main Site Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>C (5-yr)</td>
</tr>
<tr>
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<td>GRASS</td>
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### POST-DEVELOPMENT INTENSITIES

<table>
<thead>
<tr>
<th>Time of conc. (min.)</th>
<th>5-Year (mm/hr)</th>
<th>100-Year (mm/hr)</th>
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<tbody>
<tr>
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<td>178.6</td>
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### POST-DEVELOPMENT RUNOFF COEFFICIENT CALCULATIONS

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<thead>
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<th>Basin</th>
<th>Drainage Area (ha)</th>
<th>Balanced Runoff Coefficient (C) 5-yr</th>
<th>Balanced Runoff Coefficient (C) 100-yr</th>
<th>S-Year Flow Rate (l/s)</th>
<th>100-Year Flow Rate (l/s)</th>
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<td></td>
<td>6573.7</td>
<td>13018.1</td>
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### STORAGE REQUIREMENTS FOR PATENAUBE SOUTHWEST SUBDIVISION

#### 5-YEAR STORM EVENT

<table>
<thead>
<tr>
<th>Tc</th>
<th>I (mm/hr)</th>
<th>Runoff (l/s)</th>
<th>Allowable Outflow (l/s)</th>
<th>Runoff To Be Stored (l/s)</th>
<th>Storage Required (m³)</th>
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</thead>
<tbody>
<tr>
<td>5</td>
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</table>

**Maximum Storage Required (m³) = 4762.7**

#### 100-YEAR STORM EVENT

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<th>I (mm/hr)</th>
<th>Runoff (l/s)</th>
<th>Allowable Outflow (l/s)</th>
<th>Runoff To Be Stored (l/s)</th>
<th>Storage Required (m³)</th>
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</table>

**Maximum Storage Required (m³) = 9104.0**
**Table 0-1**

<table>
<thead>
<tr>
<th>Drainage Area ID</th>
<th>Total Area (m²)</th>
<th>Single Family Unit</th>
<th>Semi-Detached Unit</th>
<th>Townhouse Unit</th>
<th>Roadway and Sidewalk</th>
<th>Condo/Apartment Land Use</th>
<th>Pond Land Use</th>
<th>Composite Curve Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td># of Units Front</td>
<td># of Units Rear</td>
<td># of Driveways</td>
<td># of Units Front</td>
<td># of Units Rear</td>
<td># of Driveways</td>
<td>Sub-Total Impervious Area (m²)</td>
</tr>
<tr>
<td>R1</td>
<td>304333</td>
<td>417</td>
<td>417</td>
<td>417</td>
<td>27812</td>
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<td>417</td>
<td>27812</td>
<td>108</td>
<td>108</td>
<td>108</td>
</tr>
</tbody>
</table>

**Table 3.2 MOE pg 3-10**

- Total Site Area: 50.43 ha
- Total Impervious Area: 17.86 ha
- Composite Curve Number: 82.5

**Note:** Land use area measured in AutoCAD

**Note:** Composite Curve Number calculated by summing the fractions of individual land use areas over the total area (Civil Storm may be slightly different due to rounding of input)

- Extended Detention Storage: 40 m³/ha
- Permanent Pool Storage: 140 m³/ha
- Extended Detention Volume: 50.43 m³
- Permanent Pool Volume: 50.43 m³

**Constants**

- Single Family Unit Front/Rear Area (per Unit) = 75 m²
- Semi-Detached Unit Front/Rear Area (per Unit) = 75 m²
- Townhouse Unit Front/Rear Area (per Unit) = 60 m²
- Single Family Unit Driveway Area (per Unit) = 36.6 m²
- Semi-Detached/Townhouse Unit Driveway Area (per Unit) = 34.8 m²
- Assumed Sidewalk Width (half per road lane) = 0.75 m

**Constants - Curve Numbers**

- Hard Surface - Roofs, Driveways, Paved Road, etc: 98
- Open Space (Good Condition) Grass Cover: 75%
- Woods (Good Condition): 70

**Note:** Composite Curve Number calculated by summing the fractions of individual land use areas over the total area (Civil Storm may be slightly different due to rounding of input).