TECHNICAL MEMORANDUM

DATE November 4, 2013 **PROJECT No.** 12-1127-0062 (8000)

TO Frank Cairo
Richmond Village (South) Limited

CC Mike Green
Mattamy (Jock River) Limited

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BASEMENT DEPTHS, PROPOSED DEVELOPMENT
RICHMOND VILLAGE WESTERN DEVELOPMENT LANDS
OTTAWA, ONTARIO

1.0 INTRODUCTION

This memo provides an assessment regarding proposed basement depths for the Richmond Village (South) and Mattamy (Jock River) developments in the Richmond Village Western Development Lands, in the southwest part of the City of Ottawa.

This issue has been the subject of extensive study and several memos/reports over the past several years. The intent of this current memo is to:

- Compile the applicable information from these previous reports; and,
- Provide a comprehensive recommendation regarding basement depths and, in particular, to document why the proposed founding levels, and the use of sump pumps, are feasible from an engineering/technical perspective.

2.0 BACKGROUND

The proposed development site is approximately 132 hectares (325 acres) in size and is located along the western edge of the Village of Richmond (see Figure 1). The site is legally described as Lot 22, Concessions II, III and IV, Geographic Township of Goulbourn (Village of Richmond). The site boundary is shown on Figure 2.

For the purposes of this memo, and for simplicity of description, the site is described as extending along a north-south axis, with the south limit being adjacent to the Jock River.

The northern part of the site (about two thirds of the area) is actively farmed (corn, wheat and beans) while the southern portion currently consists of fallow fields.

The site is presently zoned for future residential development.

The surrounding lands to the north and west of the site are beyond the Village boundary and are primarily used for agricultural purposes. The lands to the east of the site are within the Village boundary and consist of existing low density residential developments. The Jock River forms the south boundary of the site.

The site is crossed by two existing roadways (Perth Street and Ottawa Street) which approximately divide the site into one-third parcels (north, central, and south).

The ground surface topography across the site is gently sloping, with ground elevations varying from approximately 98 to 94 metres above sea level (masl). The lowest portion of the site is located in the area of Perth Street (between the north and central parcels). To the north of Perth Street, the site is very nearly flat (i.e., just a slight increase in elevation to the north). To the south, the site rises up to Ottawa Street and then to the height-of-land which exists between Ottawa Street and the Jock River.

Berms currently exist along the eastern site boundary, in the vicinity of the Van Gaal Drain, which prevent proper surface water drainage in wet times of the year.

Based on published geological mapping, the subsurface conditions at the site, in a simplified form, can be summarized as follows:

- Overburden soils (see also Figure 3):
  - North half of site (i.e., north parcel and north half of central parcel): marine clay (i.e., Champlain Sea clay);
  - South half of central parcel: fine grained sandy soil (likely existing as a 'cap' over the clay underlying layer); and,
  - South parcel: shallow bedrock.
- Bedrock:
  - Dolomite bedrock of the Oxford Formation; and,
  - Bedrock surface outcropping in the south part of the site, near the Jock River, but sloping down to the north and reaching depths of up to 15 metres beneath the north parcel.

Jacques Whitford Limited conducted a preliminary geotechnical investigation on this site, the results of which were produced in a report dated June 22, 2007. Due to the presence of compressible clay soils beneath portions of the site, the geotechnical report recommended grade raise restrictions which generally vary between 1.0 and 2.0 metres (except for the south part of the site, where clay is absent, and a maximum permissible grade raise of 4.0 metres was specified). For the clay areas, the maximum permissible grade raise relates to the capacity of the clay soil to support the weight of grade raise fill without undergoing significant consolidation/compression, which would lead to the settlement of structures, services, and roadways built on the site.

3.0 PURPOSE OF CURRENT ASSESSMENT

From a site development perspective, it is understood that there are several interrelated and opposing challenges associated with the grading design for this site:

- In accordance with the aforementioned geotechnical report, the site grade raise needs to be limited. This type of geotechnical restriction is a common challenge for site development in the Ottawa area, due to the extensive presence of the sensitive and compressible Champlain Sea clay (i.e., Leda clay) deposit. Where the geotechnical permissible grade raises cannot be accommodated, very costly measures can be required, such as the use of expanded polystyrene (EPS) Geofoam lightweight fill blocks for filling around the houses.
- Conversely, if the grading is kept too low, then the footings would be deeper (for conventional houses with basements), below the groundwater level and on soft wet clay (typically grey in colour), which has very little

capacity to support the footings. House footings are ideally constructed in the shallower clay, which is above the ‘normal’ water level and is therefore generally drier and stiff, since it has been ‘weathered’ by drying and exposure to air, to form a brown ‘crust’ (which is about 2 to 3 metres thick on this site). A minimum level of filling, of generally at least 0.5 to 1.0 metres, is therefore commonly needed if the footings will be constructed in the drier upper portions of the brown clay crust (since a standard-depth basement is about 2.4 metres deep relative to the finished grade around the house).

- From the perspective of the economics of developing the site, it is important to approximately achieve a ‘cut-fill’ balance. That is, the volume of soil excavated to make the excavations down to footing level should ideally equal the soil volume needed on each lot, around the house, to fill to the design finished grade level. If the footing levels are established too shallow, then fill material needs to be imported to the site at significant expense. It is understood that, given the development density, size, and location of this site, any grade raise in excess of 1.3 metres (which corresponds to a footing depth of about 1 metre below existing grade) will result in incremental imported fill costs that can greatly impact the feasibility of the development.

Given the above competing constraints, it is understood that the ‘ideal’ footing depth (i.e., feasible maximum basement depth) for this site is about 1.0 to 1.3 metres below existing grade elevations.

There is, however, an additional challenge related to the site grading, which is the focus of this memo. Because of the stormwater drainage outlet for this site (to the proposed stormwater management ponds which will ultimately discharge to the Jock River via creeks and existing drainage ditches), it is not feasible to construct house basements at 1.0 to 1.3 metres depth and also provide gravity drainage of the foundation drains (i.e., weeping tile) to the storm sewer system during storm events. Due to the elevations of the storm sewer outlets, the storm sewers will need to be installed at a relatively shallow level, with the obverts and hydraulic grade line (HGL) being above the footing level (although the *invert* levels of the storm sewers will still be below the footing levels).

It is therefore proposed to provide these houses with sump pumps. The sump pumps and weeping tile system will collect groundwater inflows during those times of the year when the groundwater level rises above the footing level and will pump to the storm sewer system. A sketch of the proposed arrangement is provided in Appendix A.

This proposed design, with the use of sump pumps, is similar to what is used for rural housing/developments and what is also understood to currently be used by all/most of the existing houses in Richmond Village. In particular, this system is consistent with what is used in the adjacent existing Richmond Oaks development, which directly abuts the east side of the site. It is understood that the use of similar sump pump systems is also common for urban developments in other municipalities of Ontario.

The City of Ottawa does not currently have clear guidelines on the use of sump pumps for *urban* house construction. In the absence of such guidelines, the acceptability of the proposed footing levels has been evaluated based on geotechnical and hydrogeological assessments, as discussed further in following sections of this memo.

It is understood that, for this site, the City of Ottawa is looking for justification to support the desire to establish footing levels at the 1.0 to 1.3 metre depths which have been proposed (and which are needed to make this development feasible). As discussed above, a *shallower* footing arrangement is not feasible for this site due to the geotechnical restrictions on the permissible grade raise and the large cost/quantity of fill material that would need to be imported to the site (since the site would not have a cut-fill ‘balance’). Therefore, it is necessary to document why the proposed founding levels (with the use of sump pumps) are indeed feasible from an engineering/technical perspective.

In the absence of detailed City of Ottawa guidelines, the acceptable founding depths for the use of sump pumps have been evaluated by means of four separate assessments:

1) By the undertaking of technical studies (i.e., groundwater modelling) focused on the expected operating conditions that will apply to the sump pumps;

2) By comparison of the design to the City of Ottawa's practices that are currently applied to individual rural residences, including examination of test pits excavated across the site to directly observe the soil and groundwater conditions;

3) By comparison of the proposed design to other developments with consistent conditions; and,

4) By comparison to the City of Ottawa Sewer Design Guidelines (October 2012).

In the absence of any specified performance objectives by the City of Ottawa, the design team has proposed the following design criteria:

- The footing/basement depths should be selected such that the sump pumps would not operate continuously, but rather, would only need to operate during limited time periods, such as during wet seasons (e.g., spring and fall) or during significant rain events; and,

- When the sump pump is required to operate, the groundwater inflow rate to the foundation drains and the corresponding necessary pumping rate should be well within the capacity of a typical sump pump.

The ultimate objective of these design criteria is to avoid basement flooding, either during power failures or due to overwhelming of the pumping system. It is considered that, provided the above criteria are met, the risk of basement flooding is reasonably small, such as would be accepted by homeowners, insurers, etc., and would be consistent with normal sump pump usage in Ontario.

An added consideration in this assessment is the effect that developing the site will have on the long-term groundwater levels. Much of eastern Ontario is underlain by Champlain Sea clay, which is a soil with a low hydraulic conductivity. As a result, and due to the relatively flat topography prevalent in the area, the natural groundwater levels in Eastern Ontario tend to be relatively shallow. This is also the case for this site, where the shallow groundwater levels reflect the current agricultural land uses and poorly drained conditions which have been created (due to the aforementioned berms which currently prevent the free-drainage of surface water).

However, urban and suburban development is well known to create conditions which lead to long term groundwater level *lowering*. The installation of sewer pipes within a 'surround' of granular material (as needed to support and install the pipes) creates an inherent subsurface drainage system. In addition, natural infiltration is reduced by development, since much of the post-development surface area is relatively impermeable (e.g., roofs, asphalt roadways, etc.) and rainwater is conveyed rapidly to the storm sewer system. This resulting combined effect of subsurface drainage and reduced infiltration causing groundwater level lowering is well known to local geotechnical engineers and, in fact, measures are sometimes implemented to prevent the groundwater level lowering from being excessive (because, in some cases, the lowering can lead to ground settlement). In the case of this site, the use of a sump pump drainage system is made even more feasible when viewed in the context that the post-development groundwater levels will end up lower than the pre-development levels. Considering the rather shallow footing levels that are proposed (at only about 1.0 to 1.3 metres depth), there is little likelihood of groundwater levels persisting above that level after full build-out of the development.

The following sections provide further detail on each of the four assessments, as described above, of the conditions on this site, in terms of using sump pumps.

It should be noted that the assessments discussed in this memo are focused on the north and central portions of the site, which are those parts underlain by clay and the surficial sandy deposit. For the south portion of the site, which is adjacent to the Jock River and where bedrock is near surface, it is proposed to set the footing levels such that the footings and foundation drains should not be below the 100-year flood level in the Jock River.

4.0 TECHNICAL STUDY

Golder Associates Ltd. (Golder Associates) has undertaken a multi-staged numerical modelling program to simulate the hydrogeologic conditions at this site, with the objective of quantitatively evaluating the future groundwater levels and potential inflows to a sump pump system, based on the proposed conceptual design.

4.1 Hydrogeologic Subsurface Investigation

For this assessment to be meaningful, it was necessary to first carry out a supplementary subsurface investigation and monitoring plan to:

- Better evaluate the subsurface stratigraphy on the site;
- Evaluate the hydraulic conductivity of the various strata (e.g., of the clay, sand, and bedrock); and,
- Evaluate the groundwater levels and, if possible, the range of groundwater level variations.

The subsurface investigation was carried out by Golder Associates in April 2010 and included the drilling of eight boreholes across the site, as shown on Figure 3. The boreholes were advanced to depths varying from about 4 to 6 metres below present ground surface. Some of the boreholes were also advanced/cored into the shallower bedrock that exists on the south part of the site. Monitoring wells were installed in the boreholes, including wells at multiple depths in some of the boreholes.

‘Rising head’ testing was carried out in the monitoring wells to evaluate the hydraulic conductivity of the soil and bedrock strata. This testing involved rapidly pumping down the water level in the well (or conversely *raising* the water level in the well) and then monitoring the rate at which the water level recovered.

The investigation program also included monitoring the groundwater levels in the monitoring wells over a 13 month time period, between April 2010 and April 2011, plus two follow-up monitoring sessions in May 2012 and July 2013 (see Table 1).

In summary, the results of the subsurface investigation, hydrogeologic testing, and groundwater level monitoring indicated/confirmed the following:

- The hydraulic conductivities of the key strata are as follows:
  - Surficial weathered brown silty clay crust: $4x10^{-6}$ to $1x10^{-5}$ m/s;
  - Underlying unweathered grey silty clay: $5x10^{-6}$ m/s;
  - Surficial sand and silt (central portion of site): $1x10^{-6}$ to $7x10^{-6}$ m/s;
  - Glacial till: $5x10^{-6}$ m/s; and,
  - Dolomite bedrock: $5x10^{-6}$ to $1x10^{-4}$ m/s.

- The groundwater levels varied as follows:
  - From near ground surface to 1.3 metres below ground surface in the spring and fall (average 0.5 metres below ground surface); and,
  - From 0.3 to 1.8 metres below ground surface in the summer and winter (average 0.9 metres below ground surface).

4.2 Numerical Model Construction

Two separate numerical groundwater flow models were developed (using the MODFLOW commercial software). The two models were as follows:

- The first model is referred to as the "Long Term Drainage Model". It was made to be representative of a large portion of the proposed development area and was used to predict the long term (i.e., steady state) groundwater levels that will ultimately be created at the site, for the post-development condition; and,
- The second model is referred to as the "100-year Storm Event Model". It was made to be representative of a single lot and was used to evaluate the short-term sump pump response to the 100-year storm and the spring freshet (i.e., during periods of high rain water infiltration and groundwater levels).

The details and findings of these two models are discussed separately below.

4.3 Long Term Drainage Model

The details regarding the construction of the Long Term Drainage Model are summarized as follows:

- This model was used to predict the long term groundwater levels that that will exist over a representative large section of the proposed development, for the post-development condition, and the model therefore covers an area of approximately 700 by 900 metres in size.
- The model topography and size was selected to be representative of the conditions within the central portion of the proposed development, and to represent the conditions for the construction of the first houses (approximately 150 houses in total).
- The hydraulic conductivity values (for horizontal flow) were selected based on the aforementioned testing results, as follows:
  - Overburden: 5 x10^{-6} m/s (for all soil types);
  - Upper weathered bedrock (2 metre thick layer): 5x10^{-5} m/s; and,
  - Deeper bedrock: 5x10^{-7} m/s.

These values are representative of the average measured values from the subsurface investigation.

- The natural (pre-development) groundwater flow was modelled to be to the north-east, towards an existing drainage ditch (un-named tributary).
- The model boundary conditions and parameters were calibrated such that the initial groundwater levels corresponded to the highest recorded groundwater levels from the aforementioned monitoring (which were the water levels recorded in the spring of 2011).

- The effects of developing the site were simulated as follows:
  - The model simulated the installation of higher hydraulic conductivity (i.e., 'free draining') granular material as the granular 'surround' of the storm sewers, based on the alignments and invert depths of the storm sewer system as designed by DSEL, which range from about 2.0 to 2.5 metres below the future roadway surface. [*Note: It is understood that the extent of any higher conductivity pipe surround material would be subject to City approval.*]
  - The proposed 'Pond 1' storm water management pond (SWMP) was included in the model, since it will form a groundwater discharge point. The pond water level in the model was set to the 'normal operating level' of the pond (92.35 masl).
  - Infiltration to the water table from surface (recharge) was set to be consistent with current conditions (i.e., with the existing soil and vegetation cover). This represents a 'conservative' condition, since, as discussed previously, infiltration will actually be reduced due to the impermeable surfaces present in the developed condition (e.g., roofs, pavement, etc.).

The results of the modelling are summarized as follows:

- The long term (i.e., steady-state) water table within the proposed development would be at greater than approximately 1.9 metres depth (relative to the roadway level), which is below the proposed footing and foundation drain level.
- These conditions would be achieved after complete build-out of the storm sewer network. However, the effect of dewatering during construction (i.e., pumping from the trenches while the sewers are installed) and the reduced infiltration that will exist after development would decrease the time required to achieve steady-state conditions.

These results are considered to be applicable to all those portions of the site underlain by silt and clay, which includes essentially the north half of the site.

4.4 100-Year Storm Event Model

The details regarding the construction of the 100-year Storm Event Model are summarized as follows:

- This model focused on making a prediction of the sump pump response of a single house to transient/high groundwater levels, such as would occur during the 100-year storm and during the spring freshet (i.e., thaw). The model was therefore constructed to focus on 'smaller scale' conditions analogous to the development of a single lot/house, and covers an area measuring 10 metres by 14 metres (which allowed more detailed refinement of the model structure around the foundation drains).
- The model ground level and boundaries were selected to correspond to an area that is close to, and therefore hydraulically connected to, the Pond 1 SWMP, such that the groundwater levels could be evaluated during filling of the pond up to the 100-year storm event level.
- The hydraulic conductivities of the strata were consistent with the Long Term Drainage Model, as discussed previously.
- The foundation drain elevation was set at 2.4 metres depth below the finished grade around the house (which is about 2.1 metres below the roadway surface), consistent with conventional basement construction and slightly deeper than currently proposed.

- The conditions during a 100-year storm event were simulated by raising the groundwater level in the storm sewer trench backfill, up to the design storm level in the pond. To further simulate the additional impact of the 100-year storm occurring concurrently with the spring freshet, the recharge was set at 2000 millimetres per year during the same 24 hour period. Two additional simulations were completed in which the recharge was increased to 4000 millimetres per year and 8000 millimetres per year to further evaluate the sensitivity of the model to this parameter. The latter two values are well in excess of the possible actual level of infiltration, even during the spring thaw.

The results of the modelling are summarized as follows:

- The calculated groundwater inflow to the foundation drain is shown on Figure 4.
- The peak anticipated inflow to the foundation drain during the 100-year storm event ranged from 1.4 to 2.0 m^3/day for the range of recharge values simulated (2000 to 8000 millimetres per year). These flows represent the maximum expected sump pump pumping rate due to groundwater inflow.
- Following the storm event, flow to the foundation drains ended within 12 hours (as also shown on Figure 4).

Included in Appendix B is a data sheet for a typical sump pump, such as would be installed in these houses. The capacity of the sump pump, as noted in the Performance Data plot on the second sheet in the attachment, is about 100 Litres per minute for the total 'head' that this pump will need to overcome. This pumping rate is equivalent to more than 140 m^3/day, and therefore is well above the anticipated maximum required pumping rate determined from the modelling.

In the event of power outages, the proposed back-up power for the sump pump configuration will provide an additional level of protection. An assessment of the back-up pump endurance is provided in the DSEL memo provided in Appendix C.

4.5 Modelling Conclusions

The results of this modelling exercise, even if considered to provide a conceptual/qualitative rather than precise quantitative findings, provide the following three key conclusions:

- Consistent with local experience and common knowledge of geotechnical engineers and hydrogeologists, developing this site with an urban residential subdivision will result in a lowering of the groundwater level, and the resulting water table will be below the planned depth of the footings and foundation drains. As a result, sump pumps for this development would not be expected to operate continuously.
- The time required for the groundwater levels to be lowered will not be long, on the order of one year after build-out of the storm sewer network. The time would in fact likely be less, since the modelling did not consider the dewatering that would be carried out during installation of the sewer systems (i.e., the pumping from the trenches during installation of the site services).
- Even during periods of high infiltration, high groundwater levels, and high water levels in the on-site SWMPs, the rate of inflow to the foundation drains would be modest and well below the pumping capacity of a normal sump pump.

5.0 COMPARISON TO CURRENT CITY RURAL PRACTICE USING TEST PIT OBSERVATIONS

Although the City of Ottawa does not have detailed guidelines regarding the use of sump pumps for urban developments (and the corresponding founding levels and site grading design), there is understood to be an 'unwritten' protocol for establishing the suitable grading for individual rural houses. It is our understanding that the protocol for rural houses is as follows:

- The homeowner's septic system contractor has a test pit excavated at the site.
- A representative of the Ottawa Septic Office (which is managed by the local Conservation Authority) inspects the test pit and establishes where the groundwater level is located. This level is established either by observed seepage or by the colour change in the soil, with the soil being browner above the water table and greyer below. The absorption trenches of the septic system then need to be constructed 0.9 metres above that level.
- The City of Ottawa's building inspector uses that groundwater level to set the deepest allowable footing level for the house.

This protocol appears to operate from the practical perspective that the basement should be located above the groundwater level that is established based on observations made in an actual excavation at the site just prior to issuance of the building permit.

A series of test pits was thus excavated across this site in late July 2013 under observation by Golder Associates. In total, 19 test pits were excavated across the site, and were extended to depths ranging from 1.4 to 2.2 metres. City of Ottawa staff were present for excavation of several of the test pits.

The test pits were spread across the site, including the clay (north), sandy (south-central), and shallow bedrock (south) parts of the site.

The conditions observed in the test pits are summarized as follows:

- In general, groundwater seepage was observed to be at about 1.0 to 1.3 metres depth.
- A locally deeper groundwater level was observed in one test pit excavated in the sandy portion of the site, at 1.8 metres depth.
- In both the clay and sandy portions of the site, the rate of groundwater inflow to the test pits was similar and very modest. From a practical perspective, there was no noticeable difference in the rate of inflow between the clay and the sand. The sandy deposit was observed to be very fine grained (i.e., to be very 'silty') while the clay has very fine fissures. The result is that the conditions in the two deposits are similar (similar hydraulic conductivity), resulting in minor groundwater inflow.
- From a geotechnical/constructability perspective, it was also observed that the clay deposit at 1 metre depth was sufficiently dry and stiff to form a suitable subgrade for footing construction; i.e., the clay soil at this depth was dry to touch (did not wet the hand) and dry enough to stand on without the clay being slippery.

Based on these conditions, it is considered that a founding level at about 1 metre depth would be entirely acceptable from both a geotechnical and hydrogeological perspective. It would not be expected that, with basements constructed to this depth, the sump pumps would be required to operate other than during the spring/fall or during rain events. In addition to providing a very direct and practical assessment of the appropriate founding depth (i.e., for which sump pumps would have to work only intermittently), this exercise also emulated what is understood to be the City of Ottawa's practice for establishing the lowest founding depth for rural houses.

In regards to this assessment, the following two additional points should be noted:

- These test pits were excavated during a period of raining weather; and,
- The surface water drainage on the lower-lying portions of the site, near Perth Street, has been intentionally blocked by the construction of berms. That condition, which impedes the free runoff of rainwater to the ditches and adjacent municipal drains, has likely created a condition of increased recharge and of groundwater levels that are elevated and unrepresentative of the levels that would otherwise exist.

Figures 5a through 5g present plots of groundwater elevations at the monitoring wells, the proposed USF and storm sewer invert elevations in the vicinity of the monitoring wells, and schematics showing a foundation wall and footing drain. Only at MW10-4 and MW10-7 are the groundwater levels consistently above the proposed USF elevations. However, at these locations the storm sewer invert will be below the proposed USF elevations (as shown on Figures 5a through 5g). Therefore, because the granular material surrounding the storm sewers will control the groundwater levels (i.e. will lower the water table), the normal water table elevation will be below the USFs and will rise above the USFs only during spring/fall and rain events. [*Note: it is our understanding that groundwater level monitoring will be undertaken during site development, to monitor the effects of site grading and the installation of sewer infrastructure. DSEL will review and possibly increase USF elevations in the vicinity of MW10-4 and MW10-7 at the detailed grading design stage, based on the groundwater level monitoring results.*]

In summary, it is concluded that, based on the conditions directly observed in actual test pits at the site, a founding depth of up to 1 metre is entirely feasible and appropriate from the perspective of the operation of sump pumps (i.e., having only intermittent/seasonal flow that is well within the pump's capacity). This assessment is based on:

- The depths at which water seepage was observed in the test pits, which was at or below that level;
- The observed modest rates of groundwater inflow, even for the test pits excavated in the sandy soil; and,
- What the acceptable founding levels would be if this work had been carried out for setting the founding level of a rural house, based on our understanding of the City of Ottawa's current protocol.

6.0 COMPARISON TO OTHER DEVELOPMENTS

The proposed founding depth of 1 metre is very common and consistent with other developments in the Ottawa area, both for those equipped with sump pumps as well as those with gravity controlled foundation drainage systems. In fact, for the latter case, houses are frequently founded at greater depth in the clay, because a deeper founding level is required when the permissible grade raise is low, as established by the geotechnical conditions (i.e., based on the capacity of the clay to support the weight of the grading fill). To our knowledge, we are unaware of any difficulties in the City of Ottawa with basements that are installed to their full 2.4 metre depth in these clay deposits, even when located below the groundwater level. Although drainage systems may initially convey a continuous flow of groundwater, the flow is not sustained because the groundwater level is ultimately lowered to at/below footing level, such that the foundation drains only operate during wet seasons. These conditions are considered representative of the performance expected at this site. That is, there should be little to no actual day-to-day sustained flow into the foundation drains. The sump pumps will only be required to operate intermittently, during storms and wet seasons.

There is an existing development which is located immediately adjacent to the east side of this site which is useful for comparison purposes. The following details are understood about that development, which is known as Richmond Oaks:

- The ground conditions are understood to be similar (largely consisting of clay and a shallow water table);
- Based upon plans available, the founding depths of the houses appear to range from 0.8 to 1.1 metres below original ground surface, and the site grade raise is approximately 1.2 metres, which is consistent with what is proposed for this site. The houses are serviced with sump pumps which discharge to storm sewers; and,
- The footing level is below the storm sewer HGL.

We are not aware of any issues regarding basement flooding or the performance of the foundation drainage system and sump pumps in this development. Considering the similarity between the two developments, it would not be unreasonable to permit the use of sump pumps on the currently proposed site.

More generally, it is understood that essentially all of the houses in the entire Village of Richmond use foundation drainage systems with sump pumps. It is understood that DSEL contacted the insurance industry to obtain data on the history of claims related to basement flooding and that inquiry revealed no history of such claims. By extension, there would therefore appear to be no technical reason, from a hydrogeologic perspective, to not similarly permit the use of sump pumps for this site.

Thus, there appears to be no history of basement flooding problems in Richmond that would indicate issues with sump pump operations.

7.0 CITY OF OTTAWA SEWER DESIGN GUIDELINES

The October 2012 City of Ottawa Sewer Design Guidelines make reference to sump pumps in Section 5.7.1 (Connections General), which states, “Three types of systems are available…(2) Sump pit and pump discharging to a ditch.” Although the proposal is to discharge to a storm sewer, as the development will not be serviced with ditches, the guideline allows for the use of sump pumps. Section 6.4.3 (Water Table Considerations) states, “All development shall ensure that each foundation footing is above the average water table elevation.” As discussed in Sections 4.0, 5.0 and 6.0 of this memorandum, developing this site with an urban residential subdivision will result in a lowering of the groundwater level, as is common for developments on clay in the City of Ottawa, such that foundation footings will be above the average water table elevation.

8.0 SUMMARY AND CONCLUSIONS

This memo has summarized the results of four separate assessments regarding the basement/founding levels and the use of sump pumps in this development. It is our opinion, based on these three assessments, that the conditions on this site are suitable to have the footings and foundation drains constructed at up to 1 metre depth. More specifically, it has been shown that the following design/performance criteria would be met:

- The sump pumps would not operate continuously; and,
- When required to operate, the pumping rate would be well within the capacity of the pumps.

These conclusions have been based upon the following:

- Hydrogeologic analyses have shown that, within about a year of the site being developed (and probably sooner), the steady-state groundwater level would be lowered to below the footing level;

- Hydrogeologic analyses have also shown that, during periods of high precipitation/infiltration, when groundwater levels and surface water levels would be high (such that the sump pumps would be required to operate), the rates of inflow to the foundation drains would be well below the capacity of a normal sump pump;
- Test pits excavated across the site have shown that groundwater inflow was only observed below about 1.0 to 1.3 metres depth, the clay above that level is rather dry, and the actual rates of groundwater inflow to the test pits were modest. Furthermore, this assessment methodology was consistent with the practice which has been successfully used for setting the basement levels of individual rural houses;
- The adjacent development has similarly been constructed with sump pumps, with the basements at similar depths, and there are no known troubles or history of basement flooding;
- The entire Village of Richmond is understood to be serviced with sump pumps, and insurance records show no history of basement flooding; and,
- The proposed use of sump pits and pumps is consistent with the current City of Ottawa Sewer Use Guidelines.

At a very simple and conceptual level, it must be recognized that the proposed 1 metre founding depth is very shallow. It is also well known to local geotechnical engineers and hydrogeologists that development of sites with clay or low permeability soils results in groundwater level lowering in the long term. Therefore, given the low hydraulic conductivity of the soils and the shallow founding depths proposed on this site, there is no reason to believe that basement flooding due to groundwater inflow should be of concern.

9.0 CLOSURE

We trust that this memo is adequate for your current needs. Please contact the undersigned if you have any questions.

Yours truly,

GOLDER ASSOCIATES LTD.

for Mike Cunningham, P.Eng.
Associate, Geotechnical Engineer

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Nov 4/13
PROVINCE OF ONTARIO

MIC/BTB/sg
n:\active\2012\1127 - geosciences\12-1127-0062 richmond village drainage and sump design\reporting\phase 8000\12-1127-0062 tech memo on basement depths 4nov2013.docx

Attachments:

Important Information and Limitations of this Memorandum
Table 1 – Groundwater Monitoring Data
Figure 1 – Key Plan
Figure 2 – Site Plan
Figure 3 – Surficial Geology
Figure 4 – Simulated Flows to Foundation Drain (100-Year Storm Model)
Figures 5a through 5g – Groundwater vs Proposed USF
Appendix A – Sump Pump Detail
Appendix B – Sump Pump Data Sheet
Appendix C – DSEL memorandum dated October 30, 2013

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, Richmond Village (South) Limited and Mattamy (Jock River) Limited. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

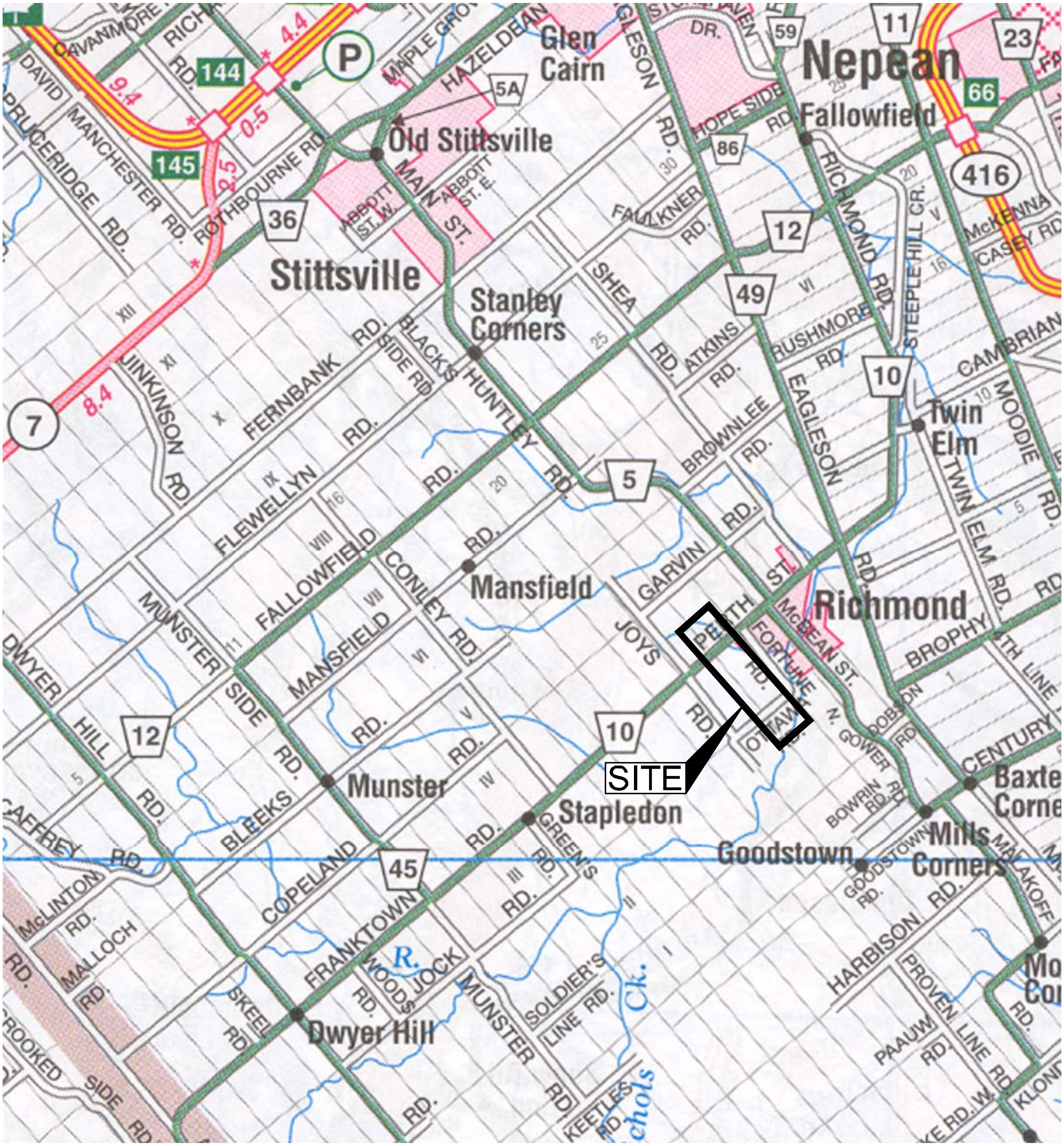
Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

Table 1: Groundwater Monitoring Data

Well ID	Ground Surface Elevation (geodetic)[1]	Screen depth (middle of screen) (mbgs)	Soil/rock at depth of well screen	Groundwater Depths (mbgs)															
				Apr.29 & 30, 2010	May 14, 2010	Jun.16, 2010	Jul. 15, 2010	Aug. 20, 2010	Sept. 16, 2010	Oct. 1, 2010	Oct 18, 2010	Nov. 19, 2010	Dec. 15, 2010	Jan. 18, 2011	Feb. 14, 2011	Mar. 15, 2011	Apr. 21, 2011	May 1, 2012	July 31, 2013
MW10-1A	94.55	3.15	Grey silty Clay	0.67	0.72	0.74	0.75	0.72	0.75	0.55	0.71	0.66	0.73	0.94	1.15	0.83	0.58	0.77	0.92
MW10-1B	94.55	1.21	Grey brown silty Clay (weathered crust)	0.66	0.69	0.72	0.72	0.71	0.73	0.55	0.67	0.65	0.70	0.89	1.09	0.83	0.58	0.75	1.23
MW10-2	94.90	2.12	Grey brown silty fine Sand	0.70	0.64	0.83	0.63	0.93	0.91	0.14	0.56	0.31	0.53	0.75	0.86	0.53	0.10	--[5]	0.82
MW10-3A	93.99	4.55	Fresh grey Dolomite	0.18	0.22	0.54	0.24	0.19	0.21	-0.13[2]	0.04	-0.09[2]	--[4]	--[4]	--[4]	--[4]	-0.25[2]	-0.09	0.08
MW10-3B	93.99	2.12	Grey brown silty Clay (weathered crust) / grey brown fine sandy Silt	0.81	0.80	0.86	0.78	0.86	0.84	0.42	0.71	0.55	0.72	0.89	0.75	0.67	0.27	0.61	0.68
MW10-4A	94.34	3.03	Grey brown fine sandy Silt	0.41	0.40	0.49	0.42	0.57	0.55	0.04	0.40	0.19	0.37	0.46	0.56	0.34	0.14	--[5]	0.46
MW10-4B	94.34	1.21	Grey brown silty Clay (weathered crust)	0.40	0.42	0.49	0.42	0.57	0.55	0.01	0.39	0.18	0.37	0.48	0.58	--[4]	0.18	0.46	0.61
MW10-5A	94.82	3.03	Glacial Till	0.81	0.78	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]
MW10-5B	94.82	1.21	Grey brown silty fine Sand	0.85	0.84	1.29	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]
MW10-6A	95.67	4.24	Fresh grey Dolomite	1.36	1.36	1.96	1.32	1.29	1.50	0.64	0.82	0.65	0.66	1.20	1.42	0.53	0.43	0.94	1.16
MW10-6B	95.67	1.52	Grey brown silty Sand trace Clay	1.27	1.26	1.82	1.57	1.10	1.53	0.29	0.60	0.23	0.47	1.14	1.40	--[4]	0.03	0.85	1.15
MW10-7	95.36	2.42	Grey brown silty fine Sand	0.46	0.44	1.04	0.93	0.33	0.42	-0.02[2]	0.01	-0.01[2]	-0.02[2]	--[4]	--[4]	--[4]	-0.03[2]	--[5]	0.44
MW10-8	96.32	2.42	Weathered to fresh grey Dolomite	0.98	1.11	1.48	1.35	1.20	1.25	0.19	0.27	0.22	0.23	0.76	0.77	--[4]	0.15	0.40	0.77

Notes:

Groundwater depth measurements revised in September 2013 to reflect surveyed top of casing and ground surface elevations (From May 14, 2010). Previously presented data reflected manually measured height of casing at time of well construction.
Ground surface elevations at MW10-8 and MW10-5 revised in September 2013 as per surveyed elevations
1: Survey completed on May 14, 2010 by J.D. Barnes Limited (Ottawa).
2: Artesian conditions exist. Groundwater level above ground surface.
3: Monitoring well MW 10-5 A and B vandalized and groundwater levels not available.
4: Groundwater in monitoring well frozen. Depth to groundwater level could not be measured.
5: Only select wells were monitored in May 2012 as a component of a hydraulic response testing program.



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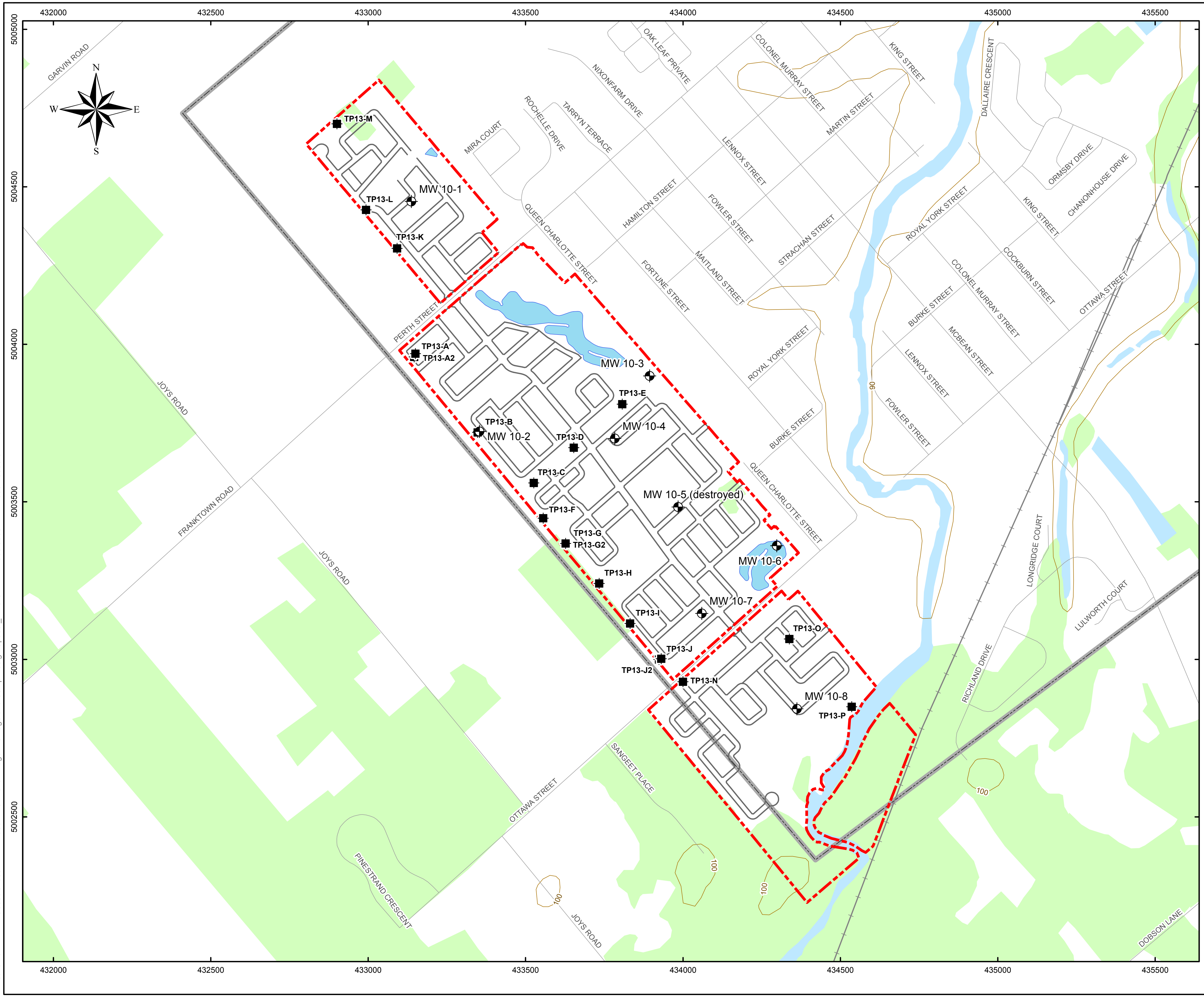
NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. TECHNICAL MEMORANDUM No. 12-1127-0062-8000

Golder Associates Ottawa, Ontario, Canada	SCALE 1:100,000 DATE 2013-10-16 DESIGN CAD JM	TITLE	KEY PLAN
FILE No. 1211270062-8000-01.dwg	CHECK MIC	RICHMOND VILLAGE ASSESSMENT OF SUBSURFACE DRAINAGE	FIGURE 1
PROJECT No. 12-1127-0062 REV.	REVIEW BTB		

PLOT DATE: October 16, 2013
FILENAME: N:\Active\2012\1127 - Geosciences\12-1127-0062 Richmond Village Drainage and Sump Design\Spatial_IM\CAD\Phase 8000\1211270062-8000-01.dwg



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LEGEND

- MONITORING WELL LOCATION
- TEST PIT LOCATION (JULY 2013)
- RAILWAY
- PROPOSED ROADS
- ROAD
- TOPOGRAPHIC CONTOUR (m)
- PROPOSED STORMWATER MANAGEMENT POND
- RICHMOND VILLAGE BOUNDARY
- WATERBODY
- VEGETATION
- SITE BOUNDARY

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES TECHNICAL MEMORANDUM No. 12-1127-0062-8000

REFERENCE

BASE DATA - CANVEC PROVIDED BY HER MAJESTY THE QUEEN IN RIGHT OF CANADA, DEPARTMENT OF NATURAL RESOURCES
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

350 175 0 350 Meters

1:12,000

PROJECT

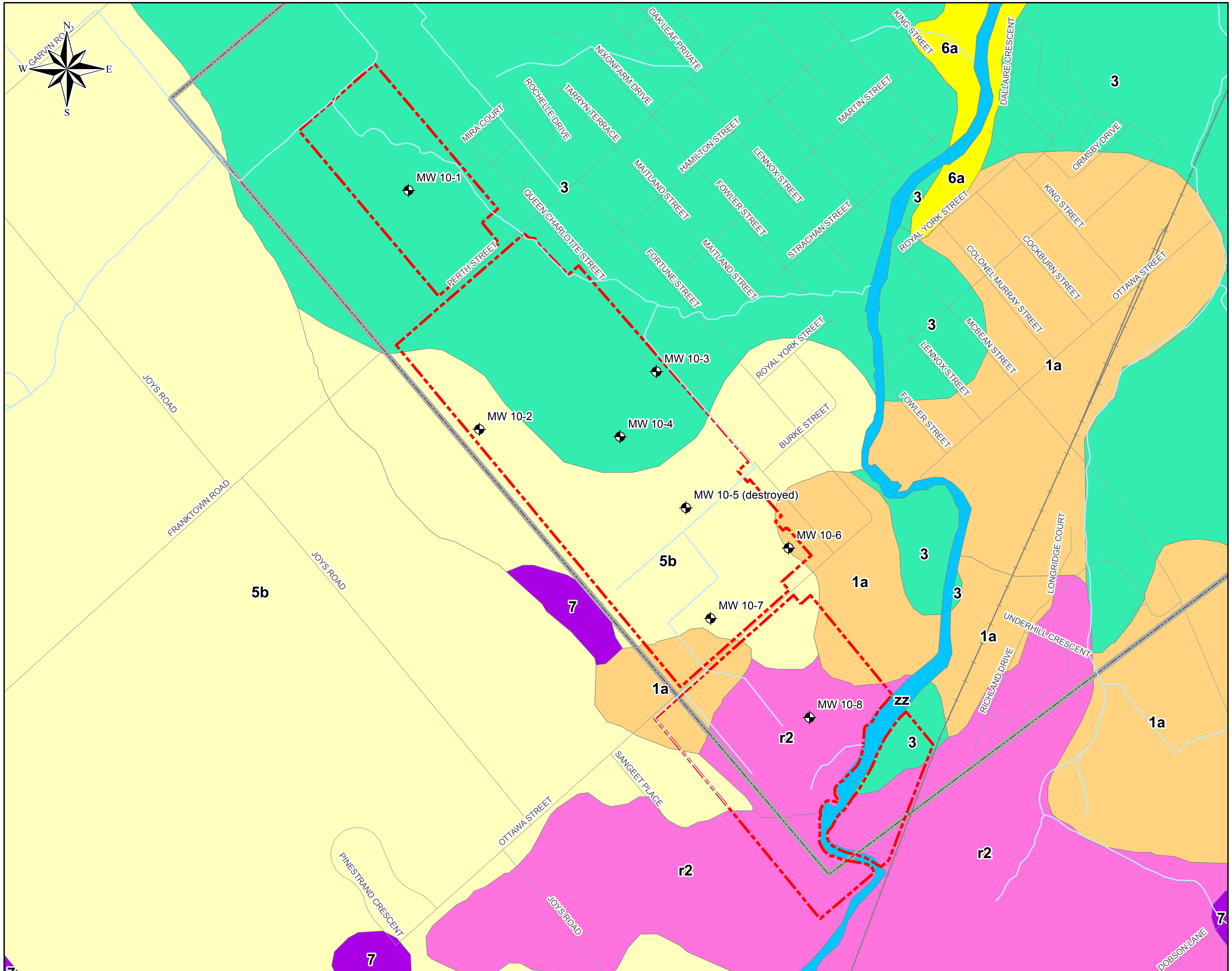
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

TITLE

SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1127-0062			SCALE AS SHOWN	REV. 0.0
DESIGN	NB	2012-05	FIGURE 2	
GIS	JEM/BR	2013-09		
CHECK	MIC	2013-10-16		
REVIEW	BTB	2013-10-16		



LEGEND

- MONITORING WELL LOCATION
- WATERCOURSE
- RAILWAY
- ROADWAY
- PROPOSED DEVELOPMENT LANDS
- RICHMOND VILLAGE BOUNDARY

SURFICIAL GEOLOGY

- 7 Organic Deposits: Muck & Peat
- 6a Alluvial Deposits: Silty Sand, Silt, Sand & Clay
- 5a Nearshore Sediments: Gravel, Sand & Boulders
- 5b Nearshore Sediments: Fine To Medium Grained Sand
- 3 Offshore Marine Deposits: Clay, Silty Clay & Silt
- 1a Till, Plain With Local Relief <5m
- 3a Offshore Marine Deposits: Clay, Silt Underlying Erosional Terraces
- 1c Till, Hummocky To Rolling With Local Relief 5 To 10m
- r2 Bedrock: Limestone, Dolomite, Sandstone & Local Shale
- zz Water

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES TECHNICAL MEMORANDUM. 12-1127-0062-8000

REFERENCE

BASE DATA - CANVEC PROVIDED BY HER MAJESTY THE QUEEN IN RIGHT OF CANADA, DEPARTMENT OF NATURAL RESOURCES
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

475 237.5 0 475
Meters
1:12,000

PROJECT

RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

TITLE

SURFICIAL GEOLOGY

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1127-0062			SCALE AS SHOWN	REV. 0.0
DESIGN	NB	2012-05	FIGURE 3	
GIS	ABD	2012-07		
CHECK	MIC	2013-10-16		
REVIEW	BTB	2013-10-16		

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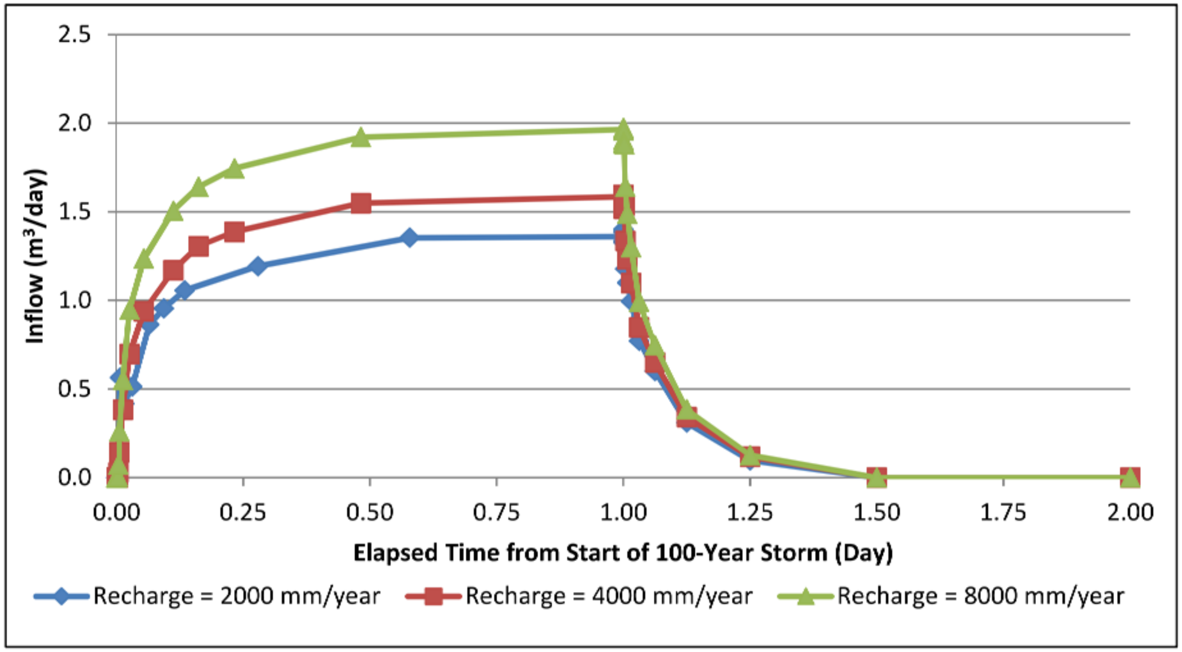

NOTE

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Ottawa, Ontario, Canada

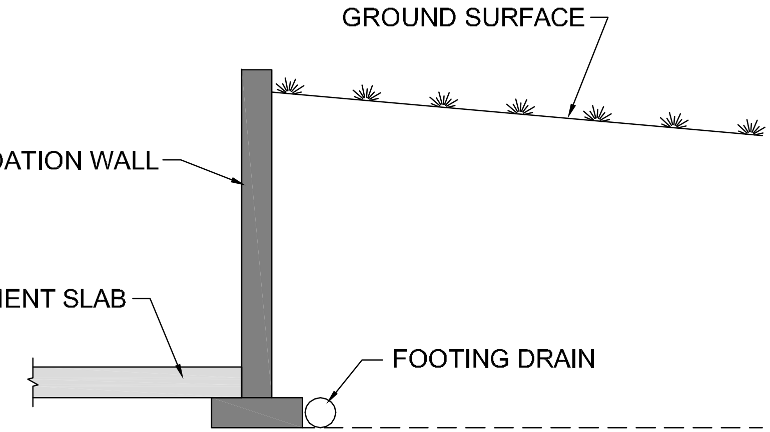
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

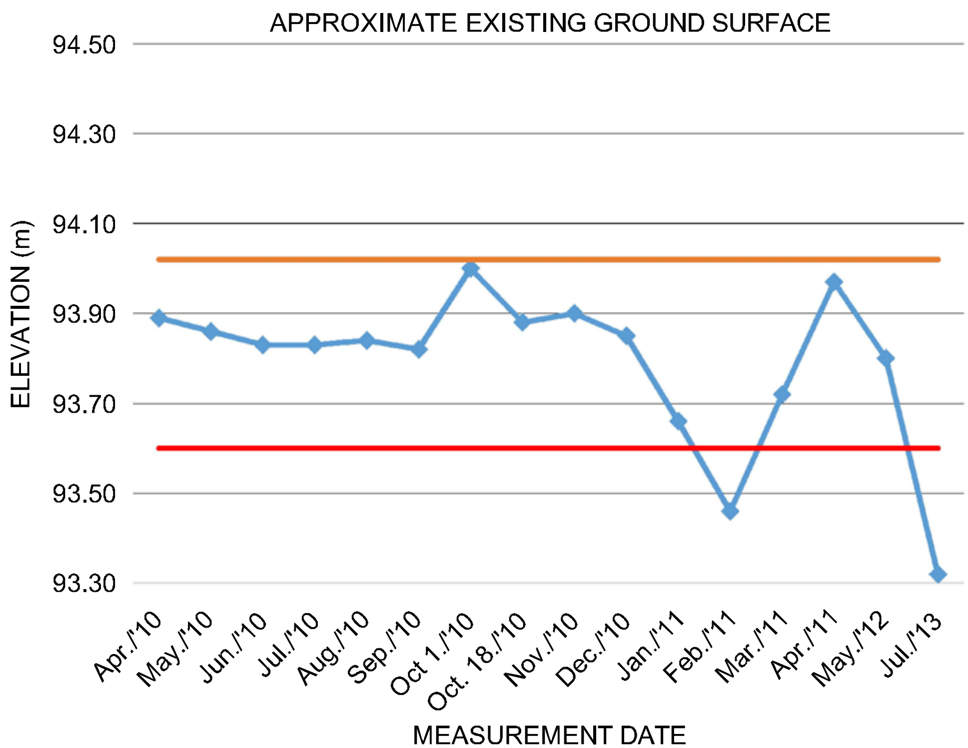
SIMULATED FLOWS TO FOUNDATION DRAIN (100-YEAR STORM MODEL)

FIGURE 4

PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

PLOT DATE: November 1, 2013
FILENAME: N:\Active\2012\1127 – Geosciences\12-1127-0062 Richmond Village Drainage and Sump Design\Spatial_IM\CAD\Phase 8000\1211270062-8000-05.dwg





LEGEND

- MW10-1
- ESTIMATED USF @ MW10-1
- STORM SEWER INVERT

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL
2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

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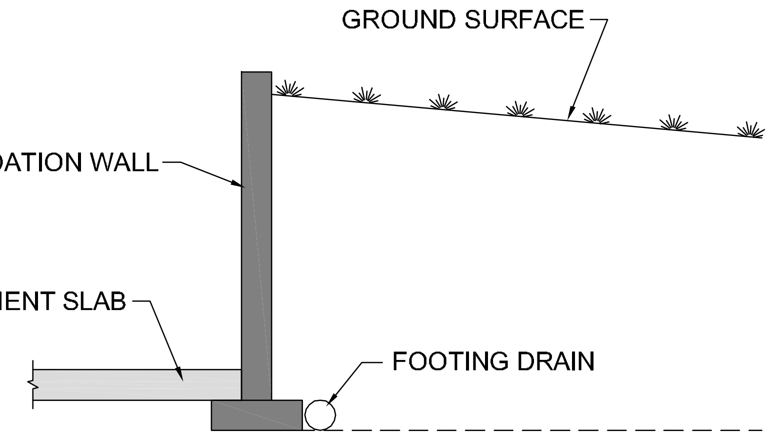
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

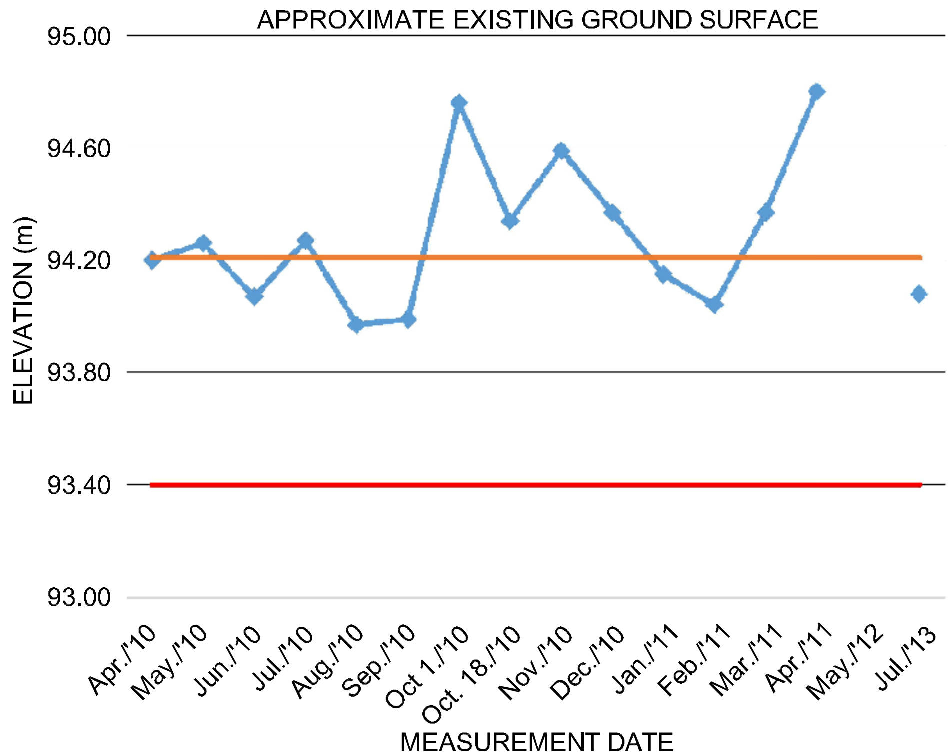
GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-1

FIGURE 5A

PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

PLOT DATE: November 1, 2013
FILENAME: N:\Active\2012\1127 – Geosciences\12-1127-0062 Richmond Village Drainage and Sump Design\Spatial_IM\CAD\Phase 8000\1211270062-8000-05.dwg





LEGEND

- MW10-2
- ESTIMATED USF @ MW10-2
- STORM SEWER INVERT

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL
2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

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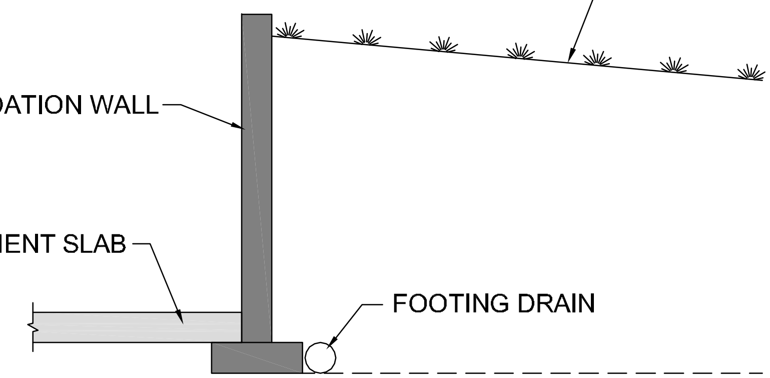
PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

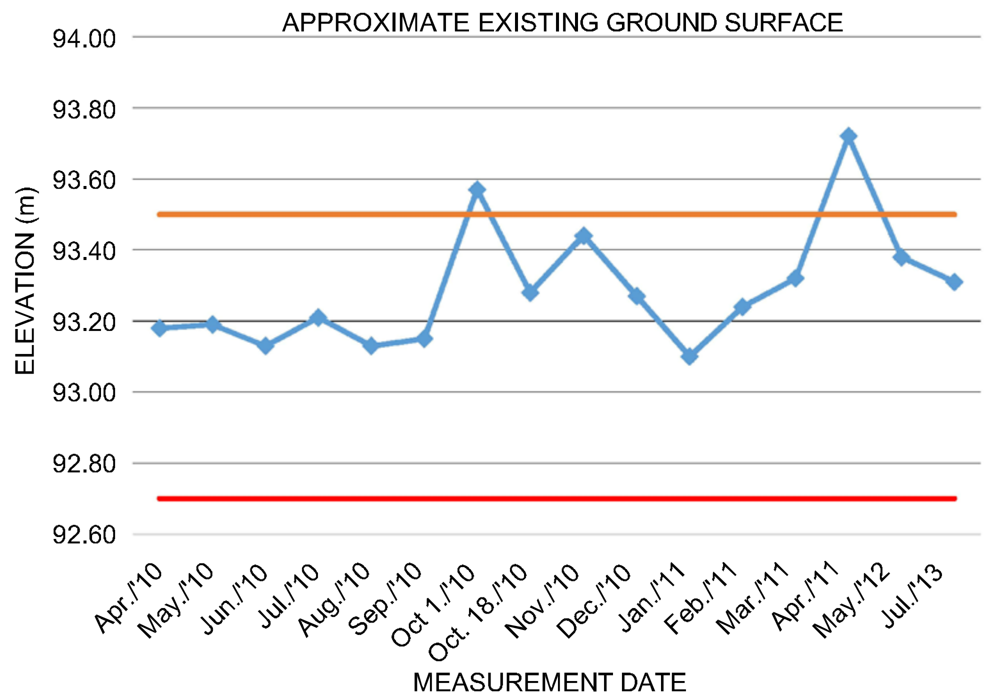
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-2

FIGURE 5B

PLOT DATE: November 1, 2013
FILENAME: N:\Active\2012\1127 – Geosciences\12-1127-0062 Richmond Village Drainage and Sump Design\Spatial_IM\CAD\Phase 8000\1211270062-8000-05.dwg





LEGEND

- MW10-3
- ESTIMATED USF @ MW10-3
- STORM SEWER INVERT

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL
2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-3

FIGURE 5C

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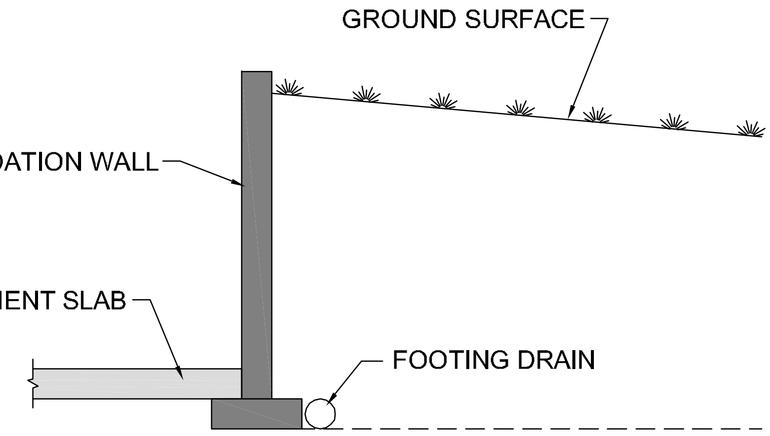
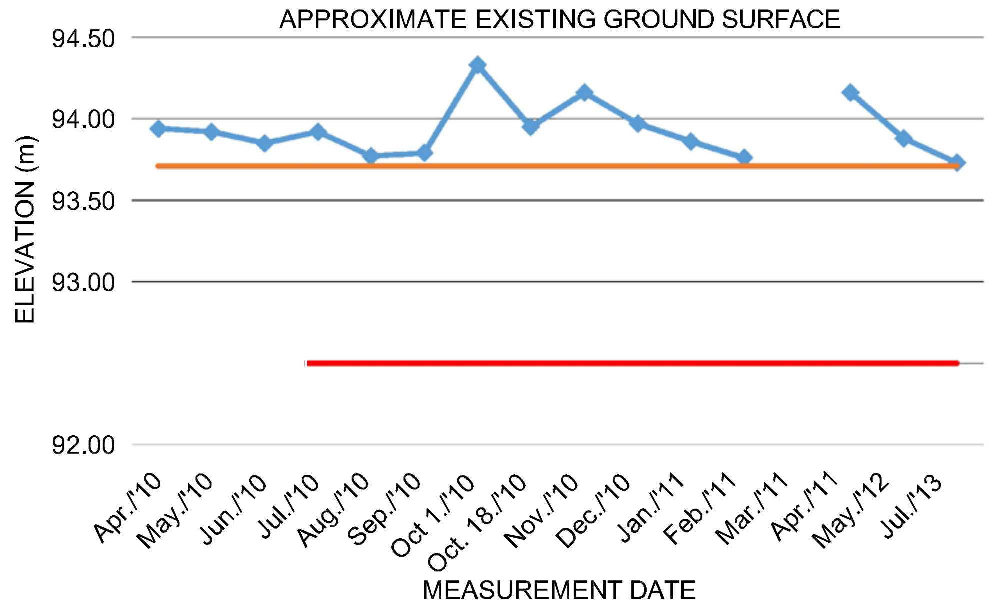
PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

PLOT DATE: November 1, 2013
FILENAME: N:\Active\2012\1127 - Geosciences\12-1127-0062 Richmond Village Drainage and Sump Design\Spatial_IM\CAD\Phase 8000\1211270062-8000-05.dwg





LEGEND

MW10-4

ESTIMATED USF @ MW10-4

STORM SEWER INVERT

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL

2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

3. IT IS RECOMMENDED THAT AREA SPECIFIC USF RAISES IN EXCESS OF THE GENERIC USF ELEVATION SHOWN BE REVIEWED AT THE DETAILED DESIGN STAGE TO BRING USF ELEVATIONS IN LINE WITH ANY FUTURE MONITORED GROUNDWATER ELEVATIONS.

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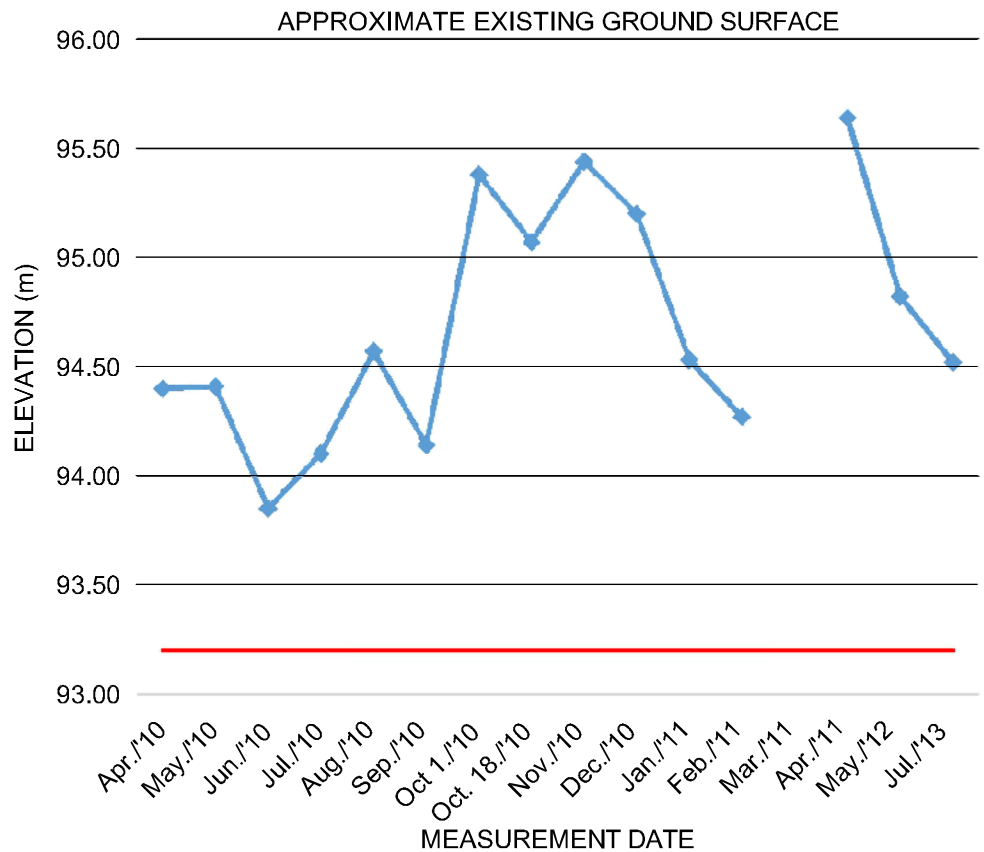
Ottawa, Ontario, Canada

RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-4

FIGURE 5D

PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM



LEGEND

MW10-6

POND 2 PERMANENT POOL

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL

2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

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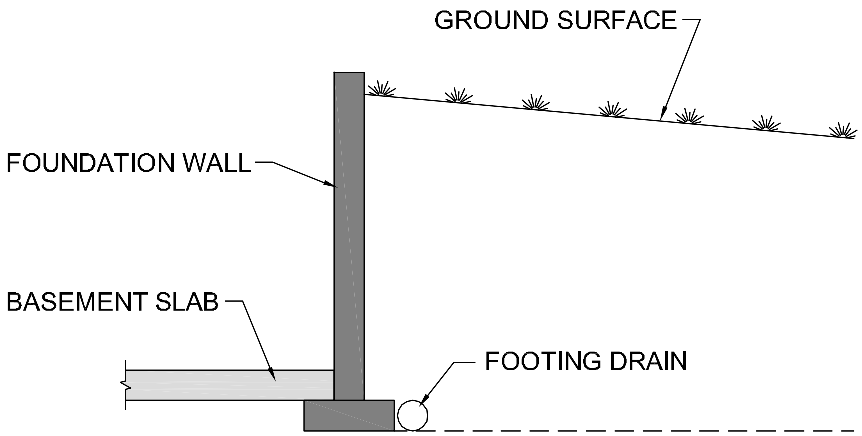
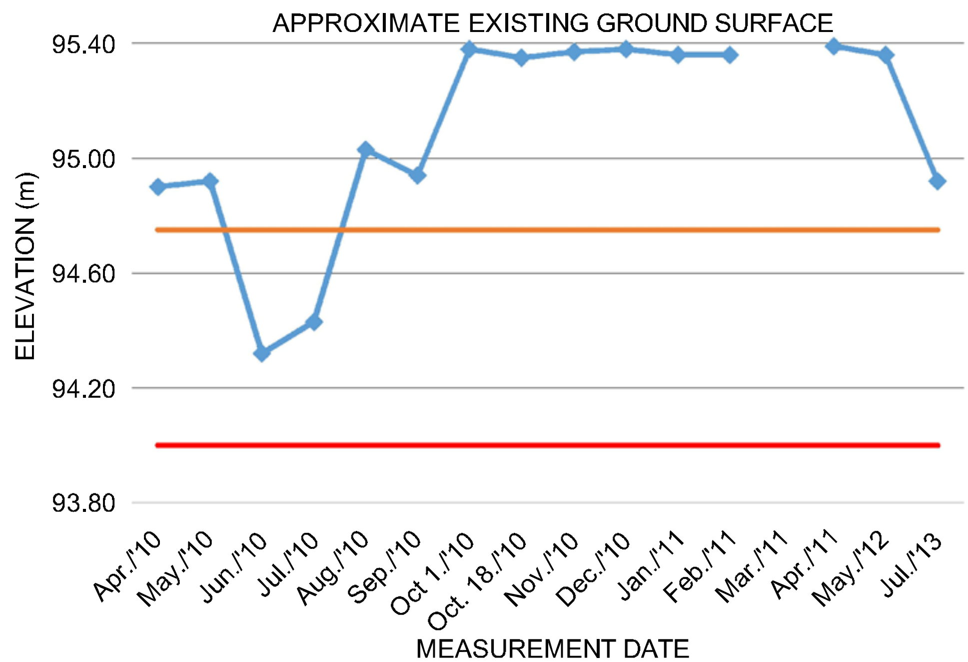
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-6

FIGURE 5E

PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM





LEGEND

- MW10-7
- ESTIMATED USF @ MW10-7
- STORM SEWER INVERT

NOTE

1. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL
2. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000
3. IT IS RECOMMENDED THAT AREA SPECIFIC USF RAISES IN EXCESS OF THE GENERIC USF ELEVATION SHOWN BE REVIEWED AT THE DETAILED DESIGN STAGE TO BRING USF ELEVATIONS IN LINE WITH ANY FUTURE MONITORED GROUNDWATER ELEVATIONS.

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RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-7

FIGURE 5F

PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

PLOT DATE: November 1, 2013
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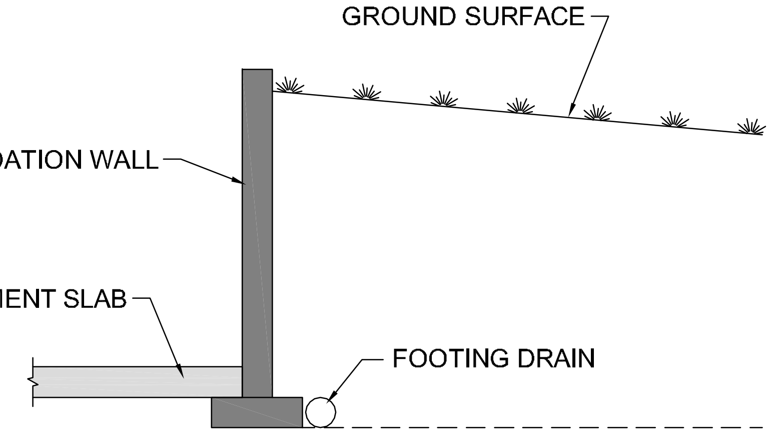
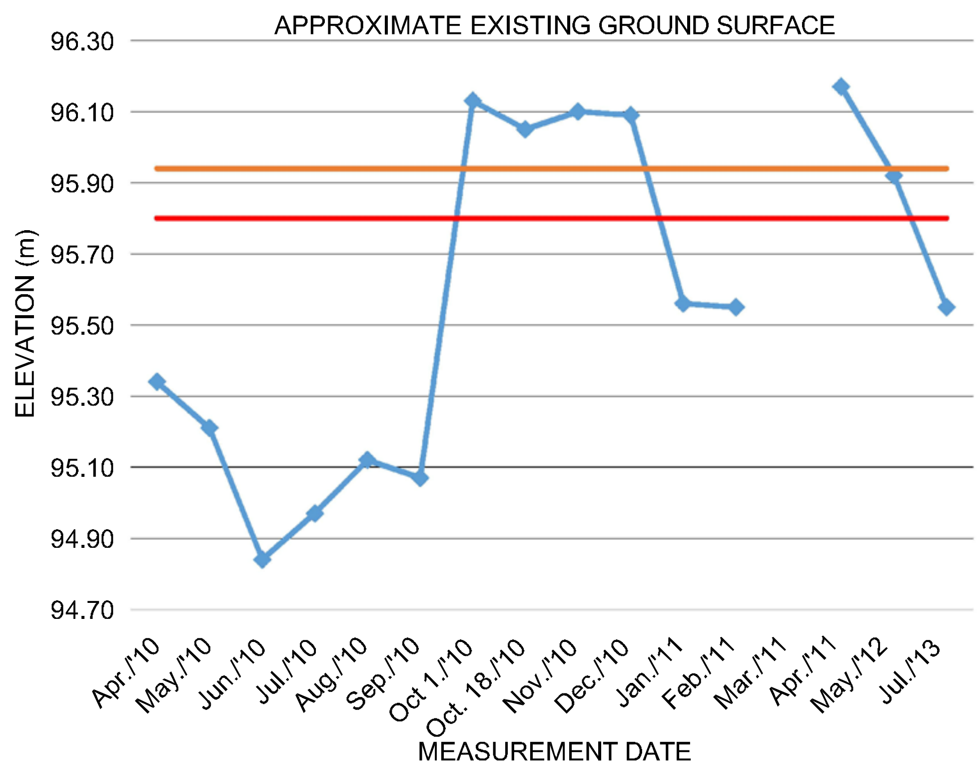




LEGEND

- MW10-8
- ESTIMATED USF @ MW10-8
- STORM SEWER INVERT

NOTE

1. THESE GROUNDWATER LEVELS ARE IN BEDROCK
2. NO OVERBURDEN GROUNDWATER LEVELS WERE MEASURED
3. CONCEPTUAL USF ELEVATIONS PROVIDED BY DSEL
4. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 12-1127-0062-8000

RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

GROUNDWATER VS. PROPOSED USF IN THE VICINITY OF MONITROING WELL MW10-8

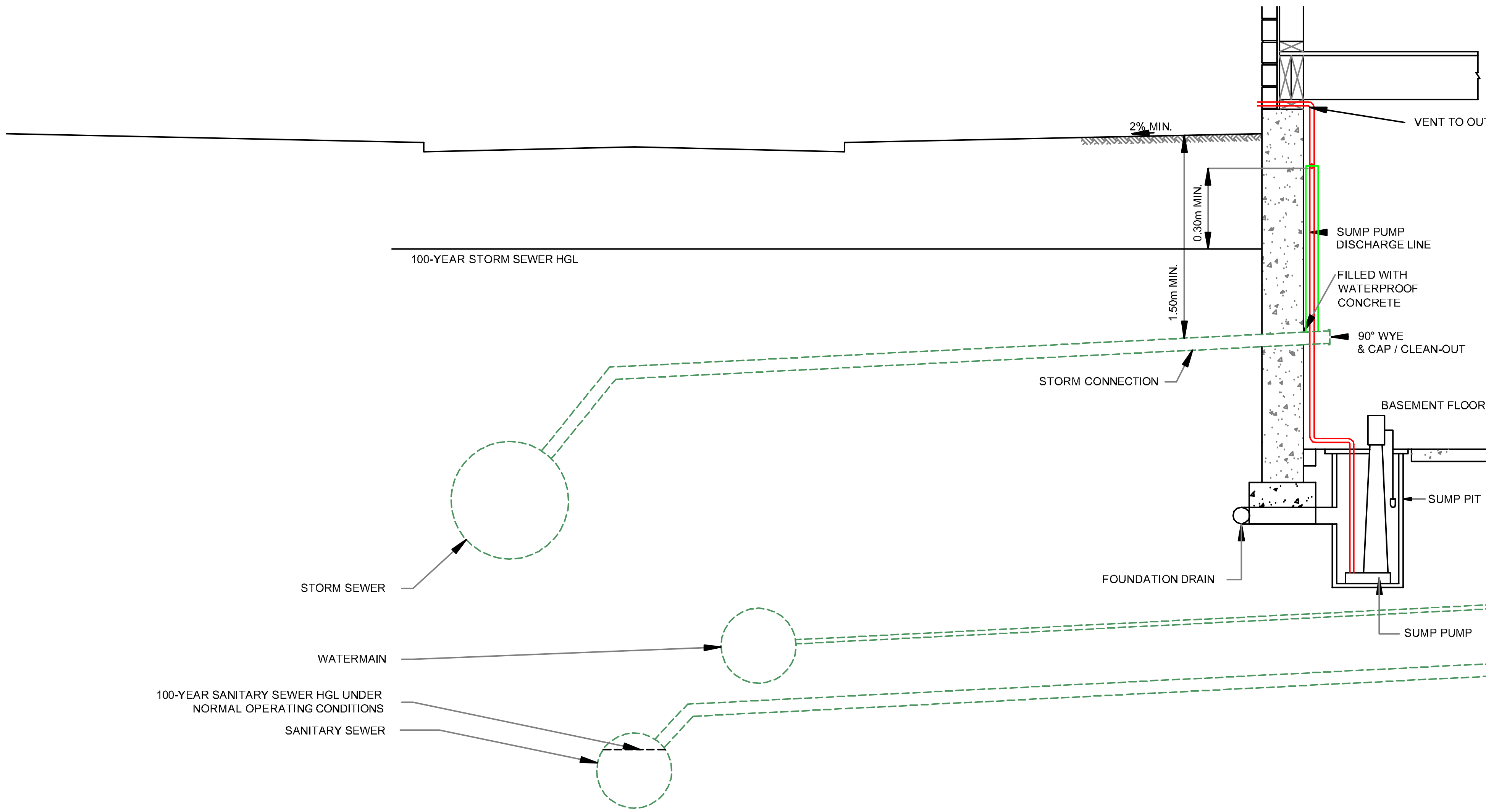
FIGURE 5G

Golder Associates
Ottawa, Ontario, Canada

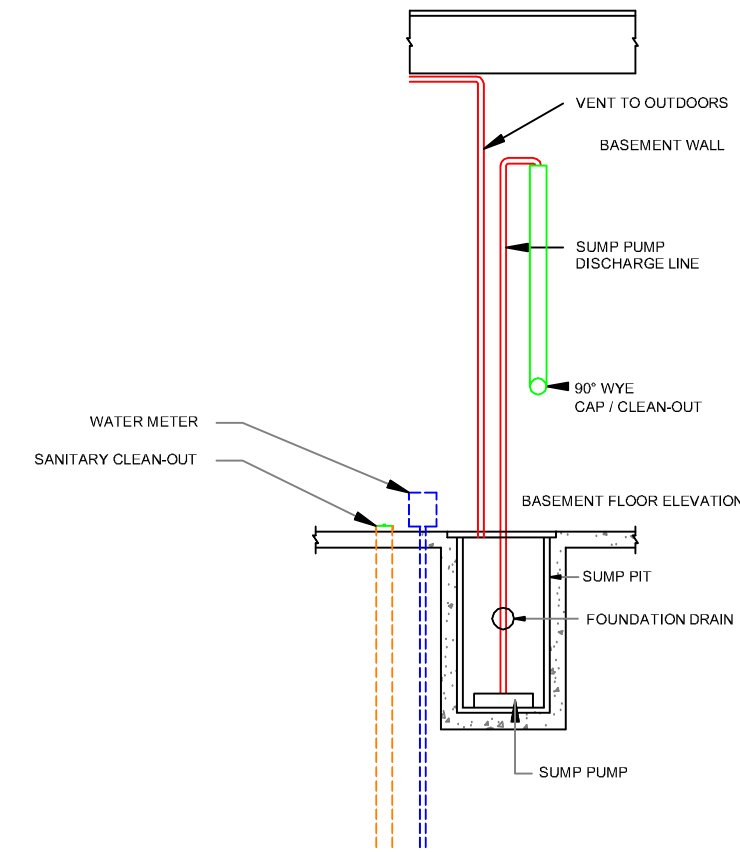
PROJECT No. 12-1127-0062 DATE 2013-10-16 CAD JM

APPENDIX A

Sump Pump Detail



SECTION VIEW



FRONT VIEW

david schaeffer engineering ltd

120 Iber Road, Unit 203
Stittsville, Ontario, K2S 1E9
Tel. (613) 836-0856
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www.DSEL.ca

MATTAMY - VILLAGE OF RICHMOND
WESTERN DEVELOPMENT LANDS

SUMP PUMP DETAIL

CITY OF OTTAWA

PROJECT No.: 13-654
DATE: MARCH 2013
DRAWN BY: KM / ADF
SCALE: N.T.S.
FIGURE: 6

APPENDIX B

Sump Pump Data Sheet

HYDROMATIC®

FG-100A BATTERY BACK-UP SUMP PUMP

Protects Home
If AC-powered pump fails

Backs Up Residential Sump Pump
Automatically during power outage or pump failure (primary pump and piping not included)

Reliable Operation
Self-Charging System
Continuous

Solid-State Controller
Monitors battery charge and pump operation

Audible Alarm
Sounds when standby pump activates

Controller
Includes connectors for pump, charger, float switch and battery*

Area Light
Illuminates dark, powerless work area

Works with Flooded and Sealed AGM Deep Cycle Lead-Acid Battery
Can use two batteries for extended protection

Resettable Circuit Breaker
Eliminates the need for a fuse

2A 5-Stage Charger
Maintains 90% charge

* Deep cycle marine-type battery (Group 24) recommended – not included with FG-100 system

Catalog Number	Volts	Hz	Cord Length	Aprox. Wt. Lbs.
FG-100A	12	60	8'	14.75

System includes: *Pump, dual check valves, 1-1/4 x 1-1/2 inch adapter tee, battery box and control panel (battery not included).*

Pentair Water™

HYDROMATIC SUPPORTS THE PROFESSIONAL

FG-100A BATTERY BACK-UP SUMP PUMP

Features

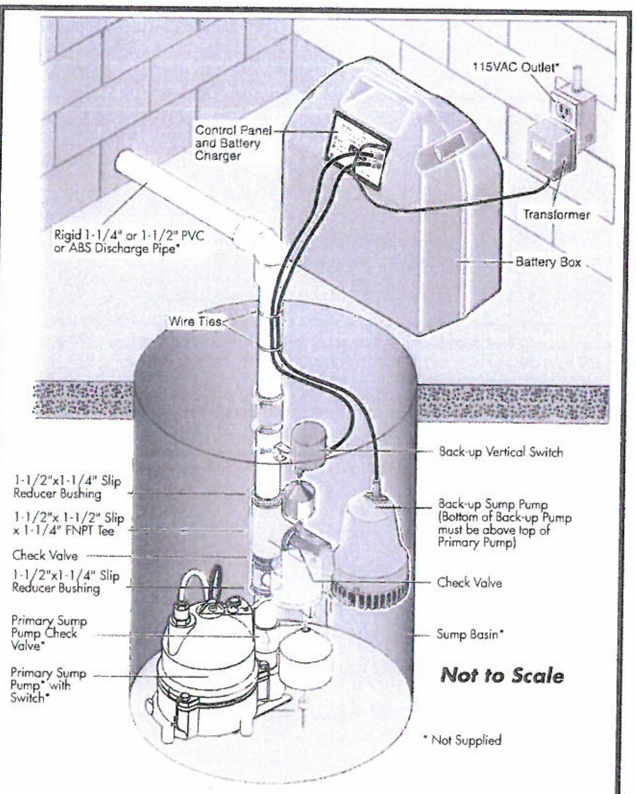
The Hydromatic® FG-100A battery operated back-up sump pump is designed to back up primary residential sump pumps in case of pump or power failure. A must for those installations where an inoperative sump pump cannot be tolerated. Separate float switch and built-in alarm automatically start back-up system and activates warning buzzer to protect against high water damage and warn of primary pump failure.

Details

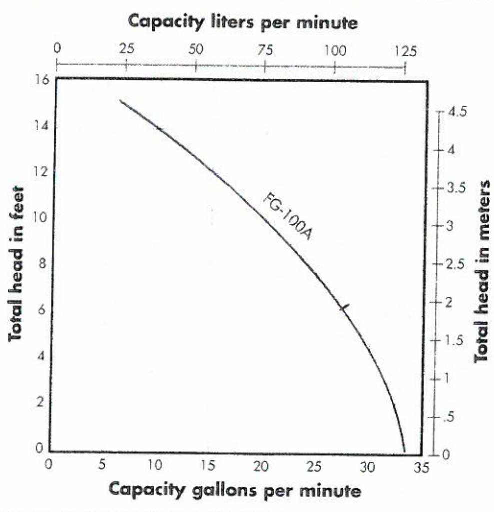
Specifications

- Housing – Thermoplastic
- Intermittent Liquid Temperature – Up to 77°F (25°C)
- Pump Down Range – Variable with float setting
- Pump Discharge – 1.25" NPT (31.75 mm)
- Motor – 12V, DC, 9A at 10 ft. (3M) lift
- Impeller – Thermoplastic
- Power Cord – 8 ft. SJT, 16/2 GA
- Capacities – Up to 30 GPM (114 LPM)
- Heads – To 16 ft. (4.88 m)
- Battery Charger – Input 120V, 60 Hz; Output 12V, 2A; Plug-in type wall-mounted transformer
- Check Valve – Dual check valves
- Battery Requirement* – 12V, deep cycle, marine type (Group 24), minimum 75–120 AH

Typical Installation



Performance Data



* Deep cycle marine-type battery (Group 24) recommended – not included with FG-100 system

HYDROMATIC®
Pentair Water

– Your Authorized Local Distributor –

USA
740 East 9th Street, Ashland, Ohio 44805
Tel: 1-888-957-8677 Fax: 419-281-4087

www.hydromatic.com

CANADA
269 Trillium Drive, Kitchener, Ontario, Canada N2G 4W5
Tel: 519-896-2163 Fax: 519-896-6337

Item #: W-02-7740 7/08

APPENDIX C

DSEL Memorandum Dated October 30, 2013

DSEL
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SMART SUBDIVISIONS™

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October 30, 2013
DSEL File: 10-468

Attention: **Note to File**

Re: Richmond Village – Western Development Lands – Sump Pump Back-Up Evaluation

Through review of development options in the Western Development Lands, in the Village of Richmond, it has been concluded that the provision of sump pumps will be required. The sump pumps and weeping tile system will collect groundwater inflows during those times of the year when the groundwater level rises above the footing level and pump to the storm sewer system. Additional rationale is provided in Golder Associates' ***Technical Memorandum 12-1127-0062(8000).*** The proposed use of sump pumps is similar to the majority of the existing homes in Richmond.

In addition to the typical sump pump configuration, a back-up sump pump option (with standby power) is also proposed. In the event of power outages, the back-up configuration will provide an additional level of protection. After review of various guidelines it is appears that this is not a mandatory requirement of the City of Ottawa.

With the chosen back-up pump model (Hydromatic FG-100A or equivalent), the manufacturer recommends a marine-type battery with a minimum of 75 "amp-hours (AH)" of service. The AH rating is based upon testing over a standard 20 hour period to establish how long it takes the battery to drain. A 75AH battery indicates that a 3.75A load was applied over 20 hours to drain the battery (i.e. 3.75A x 20hr = 75AH). Note: Higher amp loading than the 3.75A tested will equate to less amperage hours available[1]. Assumed to be 10% efficiency loss in this case (i.e. lowers to 90% of original rating).

For a battery with 75AH of service, the pump (9 amp for this model) would have the ability to provide pumping for 7.5 hours (75AH/9A x 0.90 = 7.5 hours). At the pump rating of 100 L/min this would be equivalent to 100 L/min x 7.5hr x 60min = 45,000 L (45 m^3) of outflow. If predicted inflows to the weeping tile system (per the Golder technical memo) are in the order of 2.0m^3/day this equates to approximately 22 days of backup pumping. The back-up power would provide sufficient pumping even in extended periods of power outages.

David Schaeffer Engineering Ltd.

Per: Kevin L. Murphy, P.Eng.

[1] Peukert's law expresses the **capacity** of a **lead–acid battery** in terms of the rate at which it is discharged. As the rate increases, the battery's available capacity decreases.