STORMWATER MANAGEMENT REPORT

FOR

RICHMOND VILLAGE (SOUTH) LIMITED

CITY OF OTTAWA

PROJECT NO.: 11-468

APRIL 2012 – REV 1

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APRIL 2012 – REV 1

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1.0 INTRODUCTION

Richmond Village (South) Limited has retained David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management Report in support of their application for draft plan of subdivision.

This study constitutes a resubmission of previously submitted work and addresses the City of Ottawa comments on the Stormwater Management Report submitted by DSEL for Mattamy Richmond Lands in March 2010. The City and Agency comments received to date are summarized in ***Appendix A***.

The March 2010 stormwater management report presented facility treatment types, locations, and provided a recommended stormwater facility solution for the subject lands. This study expands upon the previously recommended solution. Furthermore, this report outlines various storm conveyance alternatives and presents a detailed review of the recommended conveyance solution.

The objective of this report is to provide sufficient detail with respect to the stormwater management system including minor and major system conveyance and stormwater facilities to support the Richmond Village (South) Limited's draft plan of subdivision application. Furthermore, this study provides a stormwater solution for the adjacent development lands.

1.1 Site Context

The Village of Richmond is located within the City of Ottawa planning boundary and is approximately 10km south of Stittsville and 12km west of Manotick, as illustrated on ***Figure 1***.

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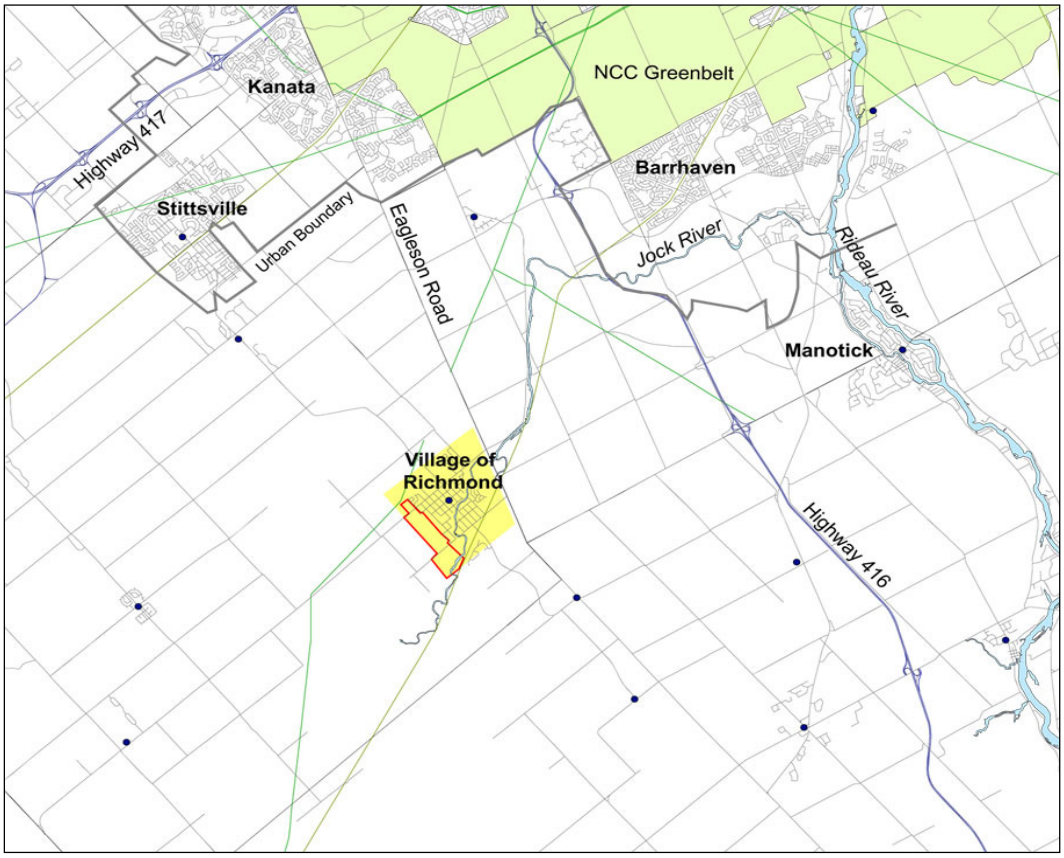

Figure 1: Location of the Village of Richmond

The subject lands lie along the western perimeter of Village of Richmond planning boundary. The subject land extends north of Perth Street and south of Perth Street to the Jock River, as illustrated on ***Figure 2***. The existing property is currently being farmed and is relatively flat with slopes ranging from 0.1% to 0.5%.

The majority of the subject lands are within the Van Gaal sub-watershed which is a tributary to the Jock River. The sub-watershed area is approximately 1,115 ha and is mostly undeveloped, consisting of wooded, wetlands, and agricultural lands fallow, and row crop areas.

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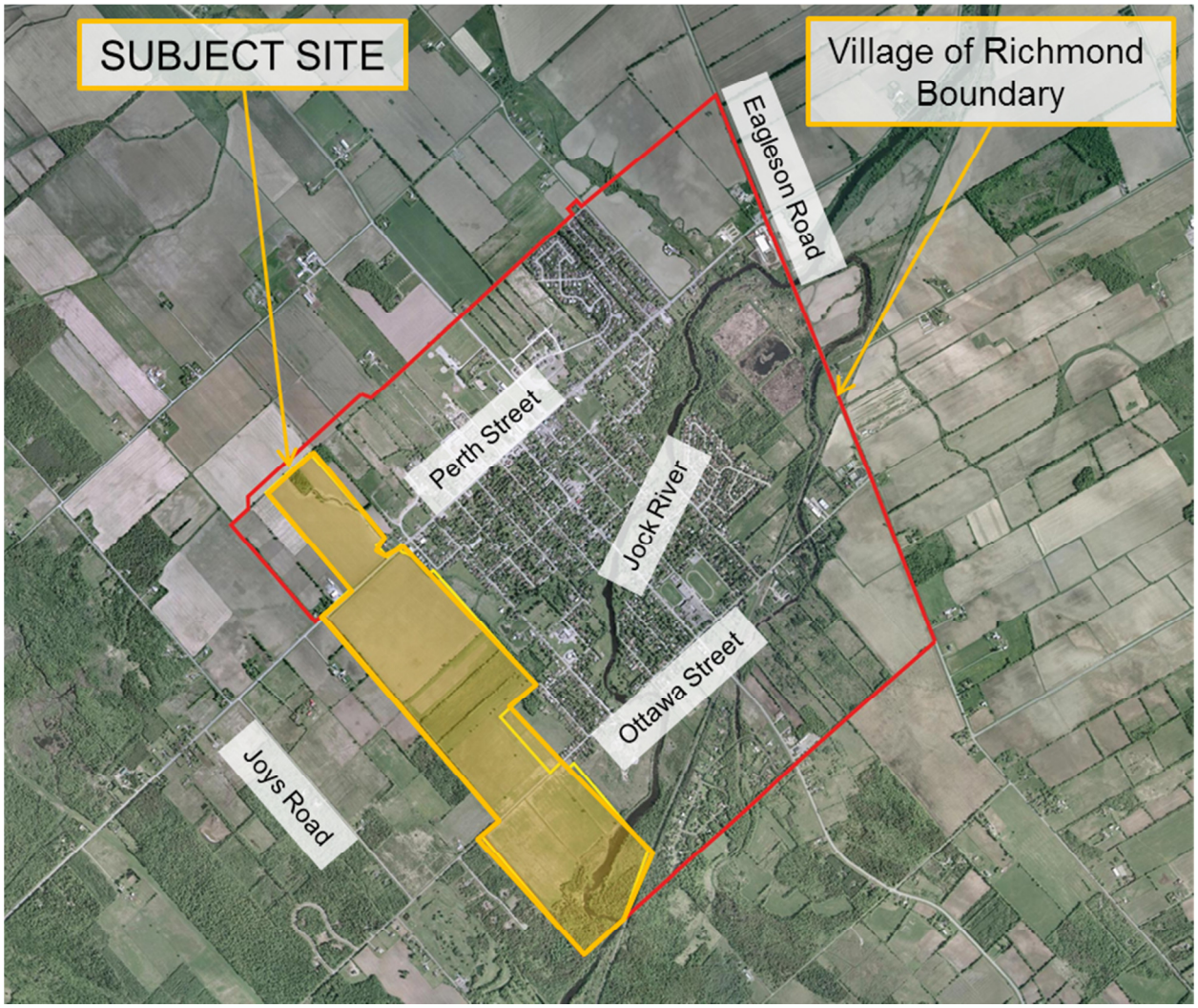

Figure 2: Site Context

1.2 Required Permits / Approvals

Richmond Village (South) Limited is subject to the following permits and approvals:

1.2.1 City of Ottawa

The City of Ottawa is required to approve the engineering design drawings and reports for the Richmond Village (South) Limited Subdivision. The City of Ottawa must review and sign off on the design and forward to the Ministry of the Environment (MOE) for their transfer of review program.

1.2.2 Ministry of the Environment

The MOE is required to review the engineering design and issue Environmental Compliance Approvals (ECA) for Sanitary and Storm Sewers and Stormwater

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Management. The ECA is a new instrument of Environmental Approval which replaces the Certificate of Approval (CofA).

Richmond Village (South) Limited subdivision will not require an Environmental Compliance Approval (ECA) for watermains. The City will review the watermains on behalf of the MOE.

The MOE will also be required to issue an approval for any proposed temporary sedimentation systems such as on-site ditches and / or temporary sediment ponds. To allow dewatering of the subject site, a Permit to take Water (PTTW) is required.

1.2.3 Rideau Valley Conservation Authority (RVCA)

Concurrent with the City and MOE approvals, approvals are required from the Rideau Valley Conservation Authority as it relates to Ontario Regulation 174/06 "The Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" for the ditch creation(s), alteration(s) and / or enclosure(s).

There are two floodplain amendments being proposed to support the proposed development area. Additional information regarding the proposed amendments is discussed under ***Section 3.2***.

1.2.4 Department of Fisheries and Oceans (DFO)

Approval will be required from the RVCA, acting as an agent for the DFO, regarding the infilling and re-alignment of the Van Gaal Drain north of Perth Street and the closure of the existing ditch(s) located between Perth Street and Ottawa Street.

1.3 Public and Agency Consultation

Numerous public and agency consultations took place between April 2008 and present. The Stormwater Management Report submitted by DSEL for Mattamy Richmond Lands in March 2010 summarizes the meeting results and times under sub-section 1.3.

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2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report.

- **Ottawa Sewer Design Guidelines,**
  City of Ottawa, November 2004.
  (City Standards)

  - **Technical Bulletin ISD-2012-1**
    City of Ottawa, January 31, 2012.
    (*ISD-2012-1*)

- **Stormwater Planning and Design Manual,**
  Ministry of the Environment, March 2003.
  (SWMP Design Manual)

- **Ontario Building Code Compendium**
  Ministry of Municipal Affairs and Housing Building Development Branch, January 1, 2010 Update
  (OBC)

- **Hydrology Report – Jock River Flood Risk Mapping**
  Rideau Valley Conservation Authority, July 2004.

- **Hydraulics Report – Jock River Flood Risk Mapping**
  Rideau Valley Conservation Authority, November 2004.

- **Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond**
  Rideau Valley Conservation Authority, November 2009.

- **Stormwater Management and Drainage Plan for the Mattamy Richmond Lands**
  DSEL, JFSA, AECOM, and Kilgour & Associates Ltd., March 2010.
  (March 2010 SWM Report)

- **Village of Richmond Community Design Plan**
  City of Ottawa, July 2010.
  (CDP)

- **Preliminary Geotechnical Investigation Report**
  Jacques Whitford, June 22, 2007.
  (Geotechnical Study)

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3.0 EXISTING CONDITIONS

3.1 Geotechnical

Jacques Whitford carried out a Geotechnical Investigation of the subject property in June 2007, included in ***Appendix B***. The following summarizes the results of their investigation.

North of Perth Street, the soils consist of a thick deposit of clay overlying a till deposit overlying inferred bedrock. Bedrock is anticipated at depths in excess of 6 m below ground surface to the north of Perth Street and becoming shallower to the south of Perth Street.

Between Perth and Ottawa Street the soils consist of a thin deposit of clay overlying a sandy silt deposit over a till deposit over inferred bedrock. Bedrock is anticipated at depths between 3 m to 4 m below ground surface.

South of Ottawa Street the soils consist of a deposit sandy silt over a till deposit over inferred bedrock. Bedrock is anticipated at depths ranging from greater than 4 m to less than 1 m below ground surface.

A compressible deposit of clay was encountered within the northern section of the site. Due to the compressible nature of the clay, grade raises over sections of the site should be restricted to minimize total settlements. The ***Table 1*** summarizes the preliminary grade raise restrictions for the site. ***Drawing 1 – Constraints Plan*** depicts the grade raise constraint areas.

Table 1
Summary of Maximum Grade Raise Constraints

Site Area	Maximum Grade Raise above Existing Site Grades
PIN 0062, 0061; North of Perth Street	1.0m
PIN 0285, 0286; Parcel to the south of Perth Street	1.5m
PIN 0287; Parcel north of Ottawa Street	2.0m
PIN 0714, 0746, 0047, 0075; Parcels north and south of Ottawa Street	4.0m

3.2 Regulatory Floodplain

The Jock River and Van Gaal Drain are adjacent to the subject lands and have established regulatory floodplains that are subject to modifications approved through the CDP process. The following sections describe the regulatory floodplain limits and the amendment process.

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3.2.1 Jock River

The Rideau Valley Conservation Authority completed floodplain mapping for the Jock River in November 2004.

Figure 3 was extracted from the Jock River Flood Risk Map and illustrates a significant portion of the subject lands south of Ottawa Street within the Regulatory Flood Limit.

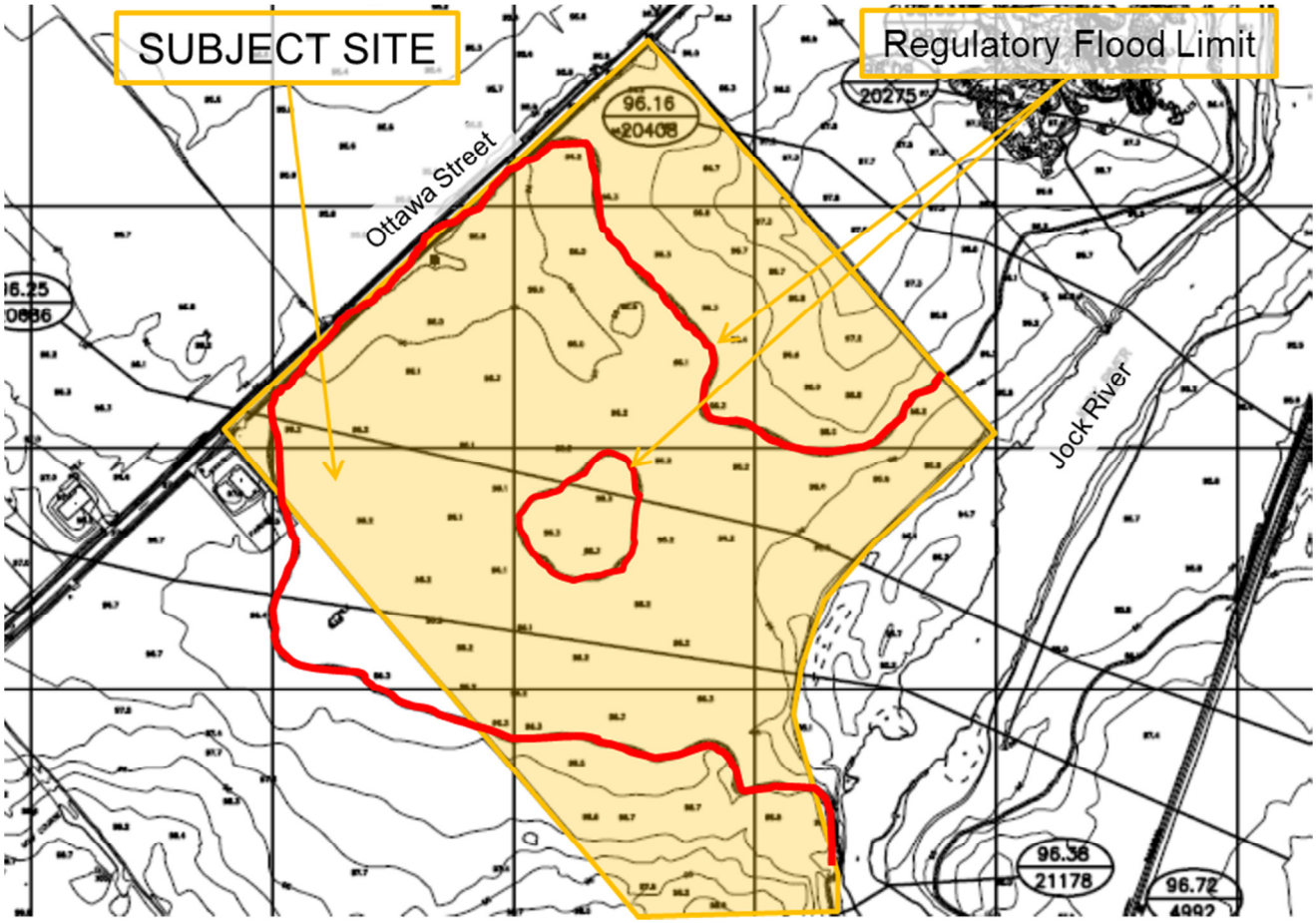

Figure 3: Regulatory Floodplain Mapping – Jock River

In December 2005, a letter of permission was issued by the RVCA to the original landowner for the construction of a berm to maintain flood risk mapping land levels as per (the 1980 Acres Floodplain) Mapping Study (96.0m) south of Ottawa Street. On March 3, 2009, the RVCA issued a letter of permission, included in ***Appendix B***, authorizing works to be conducted based on past approvals granted on the property. The authorized works involve removal of the existing berm and relocation to the approved 2005 location. The existing flap gate and culvert from the drainage easement are to be removed. The berm will also extend parallel along both sides of the drainage easement north up to Ottawa Street. The permission letter also includes the placement of fill between the new berm and Ottawa Street to a maximum level of 96.5**.**

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3.2.2 Van Gaal Drain

The Rideau Valley Conservation Authority completed floodplain mapping for the Van Gaal Drain in November 2009.

Figure 4 was extracted from the Van Gaal and Arbuckle Drain Floodplain Mapping and illustrates a significant portion of the subject lands north of Perth Street within the Regulatory Flood Limit.

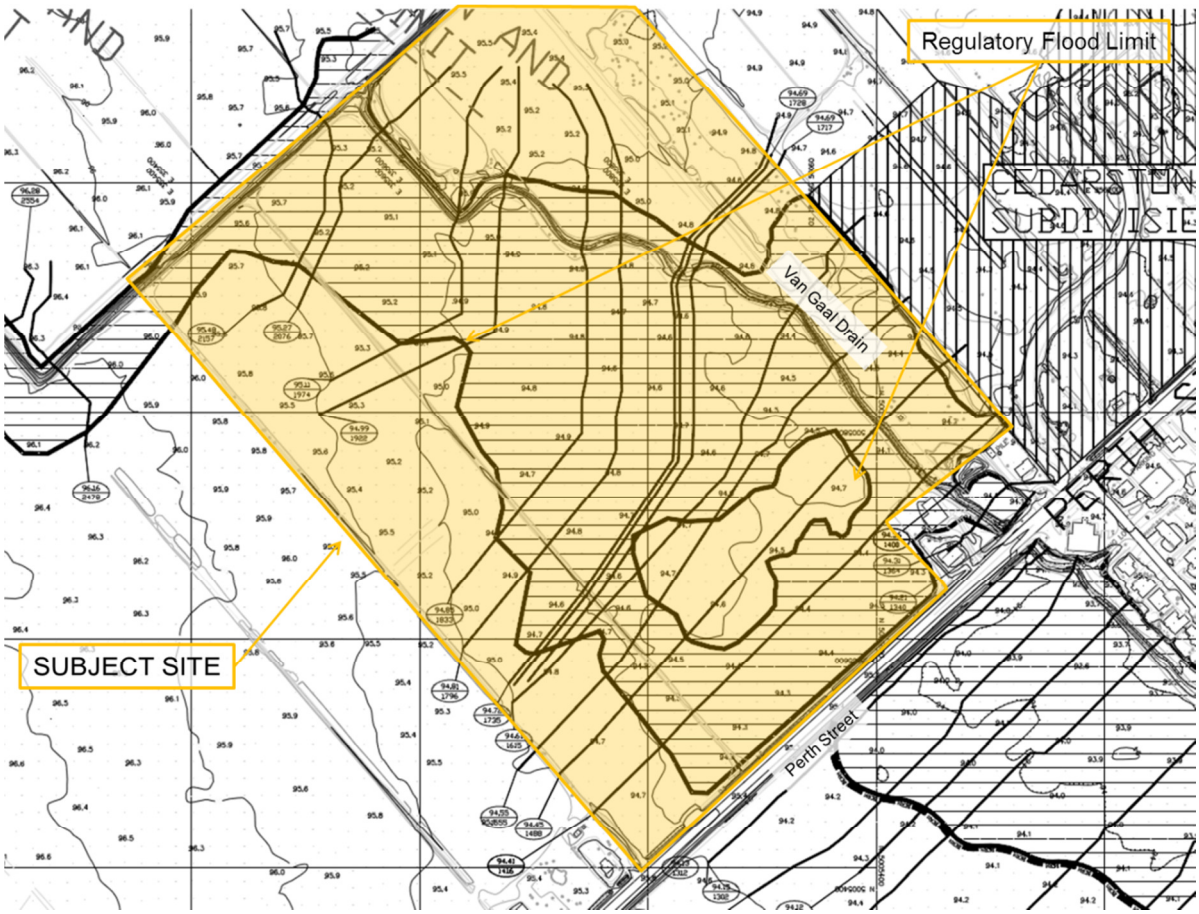

Figure 4: Regulatory Floodplain Mapping – Van Gaal Drain

The "*Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drain in the Village of Richmond (November 2009)"* was supported by RVCA staff and was brought forward for approval to the January 28, 2010 RVCA Executive Board Meeting. At this meeting, the Board approved the report and mapping as the regulatory floodplain mapping. The Board also approved the RVCA staff recommendation to allow for channel modifications to be undertaken north of Perth Street that would allow for an amendment to the regulatory floodplain limit. The approach and process are documented in the January 14, 2010 minutes of meeting which are contained in

Appendix C. In summary, additional channel modifications will be completed north of Perth Street to increase the channel's conveyance capacity that meet the 1:100 year water surface profile in J.F. Sabourin & Associates Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains Report (November 2009). On approval and completion of the channel modifications, RVCA will amend its flood hazard and regulation limits mapping based on the completed works.

DSEL prepared a preliminary design for the proposed Van Gaal Drain modifications based on comments received during a pre-consultation meeting that took place on May 19, 2011. The submission package is included in ***Appendix C***. RVCA reviewed the preliminary proposal and issued comments via email on August 8, 2011, included in ***Appendix C***. The RVCA comments will be addressed once a development wide servicing scheme is revised, as the proposed major / minor system is anticipated to have an impact on the flow directed to the re-aligned channel.

3.3 Geomorphology

Richmond Village (South) Limited have retained JTB Environmental Systems to review and confirm the previously submitted the erosion threshold analysis. At the time of publication JTB Environmental systems had conducted field observations and sampling.

3.4 Existing Drainage Conditions

JFSA was retained to develop hydrologic and hydraulic models of the existing areas to assess the impact of the proposed urban development. The calculated flows included in ***Appendices E and I*** were prepared based upon the same methodology used for the 2009 Richmond Floodplain Mapping study, taking into consideration the timing of peak flows of the Van Gaal drain and Jock River. The calculated WSELs were determined using the 2009 Richmond Floodplain HEC-RAS spring and summer models, which do not include features including the berm that has been constructed upstream of Perth Street or any modification to Fortune Street culvert.

Table 2
Summary of Peak Flows to be conveyed through Subdivision

Tributary Area	100-year, 3-hour Chicago Storm	100-year, 12-hour SCS Type II Storm	100-year 10 Day Spring Snowmelt and Rainfall Event
	(m^3/s)	(m^3/s)	(m^3/s)
VG-2 & VG-5	3.26	4.03	2.18
VG-6	1.42	1.90	1.63
VG-7 & JR-1	1.60	2.01	1.30

Please refer to JFSA memorandum in Appendix I and ***Drawing 1***, for locations of external areas to be conveyed through the proposed development.

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3.5 Hydrogeology

Richmond Village (South) Limited have retained Golder and Associates to evaluate the proposed drainage plan with respect to the hydrogeological conditions encountered at the site. At the time of publication Golder Associates had conducted and complied field observations and sampling. ***Appendix F*** contains a technical memorandum of their one year review of groundwater monitoring.

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4.0 EVALUATION STORM CONVEYANCE SYSTEMS

Modern storm conveyance systems were considered in light of ***City Standards,*** the Technical Memorandum Technical Bulletin ISD-2012-1, as well as the proposed subdivision plan and streetscaping plan presented in the ***CDP***.

The City of Ottawa provided feedback on the evaluation matrix utilized to assess the preferred stormwater management scheme presented in the ***March 2010 SWM Report***. ***Table 3*** summarizes the evaluation criterion employed to select the preferred conveyance and servicing system.

Table 3
Summary of Decision Matrix Categories

Parameter	Indicators	Weighting
Caring and Healthy Communities		**30%**
C3 Impact on level of service	Maintains or improves level of service to the existing and future village residents.	15%
C9 Consistency with infrastructure planning policies	Compatibility with infrastructure servicing corridors and flexibility for enhancements to land use.	15%
Constructability and Functionality		**30%**
CO2 Schedule / Staging Opportunities	Ability to phase infrastructure to facilitate development phasing	6%
CO3 Construction Risk	Conforms to geotechnical, geomorphology, hydrological, etc.	9%
CO5 Disruption during construction	Location of new infrastructure in built up areas and nuisance effects	6%
CO6 Operation and maintenance	Proven track record, ease of operating and maintenance	9%
Cost		**40%**
E9 Annual Cost	Estimated annual maintenance cost	15%
E11 Total Capital Cost	Estimated capital costs.	25%

Each alternative is ranked based on the criteria presented in ***Table 4***. Under this ranking system, each individual criterion was ranked relatively for each alternative. For example, the 1 to 5 ranking for an individual alternative is determined based on the relative impact compared to all the other alternatives being evaluated. In regards to cost, the least costly will be automatically assigned a 5, while the most will be 1, with the remaining option prorated between 1 and 5 according to their estimated costs.

Capital cost for each scenario considered cut / fill requirements, trunk routing, and local storm services. While life cycle cost were considered to be the anticipated maintenance and operation of the sewer collection system, excluding the stormwater management facilities. The estimated costs are based on past data and are presented for comparison of alternatives only and are not for budgetary purposes.

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Table 4
Decision Matrix Categories Ranking System

Ranking	Description
5 - Positive or No Impact	The alternative meets all applicable requirements, provides tangible benefits
4 – Minor Impact	The alternative has some minor negative impacts or dis-benefits that may easily be mitigated or compensated for
3- Moderate Impact	The alternative has noticeable negative impacts, however, the severity of the impacts may be reduced or compensated for
2 – Noticeable Negative Impact	The alternative has significant negative impacts which may be mitigated, although these may be costly, time consuming or result in other negative impacts
1 - Negative or Significant Impact	The alternative does not meet applicable requirements, results in significant dis-benefits and/or negative impacts cannot be mitigated

4.1 Summary of Alternatives Assessed

The conveyance systems reviewed contain minor and major conveyance components. Minor components were those with a 5-year carrying capacity, while the major system designed to convey runoff in excess of the minor capacity. The following summarizes the conveyance systems and storm service arrangements evaluated for use in the subject area.

- Foundation service to street storm sewer – Gravity connection
- Foundation service to dedicated foundation collector – Gravity connection
- No Foundation Service – Slab on grade units
- Foundation service to street storm sewer – Sump pump

4.2 Description of Alternatives

4.2.1 Foundation service to street storm sewer

A foundation service that outlets to a street storm sewer with a gravity connection is typically applied throughout the City of Ottawa in greenfield developments. In this servicing arrangement homes are established with underside of footings set 0.30m above the modeled 100-year hydraulic grade line in the sewer. ***Figure 5*** illustrates the servicing arrangement. ***Figure 5*** illustrates the estimated sewer size and associated HGL determined for the recommended solution at MH ID 402.

The majority of the existing Village of Richmond is reliant on sump pumps for foundation drainage. A gravity serviced home in the Village of Richmond would raise the level of service in the area as the home owner would not be reliant on maintenance of privately owned sump pumps.

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Construction phasing and staging is contingent upon the completion of the receiving stormwater management facility.

As illustrated this servicing arrangement results in an approximate grade raise of 1.6m above existing ground, and therefore will result in areas exceeding grade raise restriction. In order to mitigate the settlement, surcharging is commonly employed. Any surcharging requirements necessary to construct homes would have potential negative impact on construction phasing. Most notably the time spent on waiting for settlement objectives to be reached as well as the transportation of surcharge material.

It was estimated that the site required a total net fill of ***1,302,158m^3***. See ***Figure 6*** for an overview of estimated cut / fill.

The estimated capital cost for the construction of storm sewers and earthworks was ***$38,736,000***, while the 25 year life cycle costs were estimated to be ***$97,000***. See ***Appendix G*** for detailed cost breakdown.

4.2.2 Foundation service to dedicated foundation collector

Foundation services connected to a dedicated foundation collector sewer are not typically employed in Greenfield subdivision developments in the City of Ottawa. However, these systems are used in site plan developments where the parking lot drainage is separated from foundation drainage. The advantage being that the foundation drainage is hydraulically separated the system collecting street and parking lot drainage. ***Figure 7*** illustrates the estimated sewer size and associated HGL determined for the recommended solution at MH ID 402.

Several foundation drain routing options were investigated. Due to the topography of the area, a gravity outlet is not available to the site that would be cost effective from either a fill or sewer routing perspective. Therefore, it was conceived that this servicing arrangement would utilize a lift station to convey foundation drainage collected into the Van Gaal Drain. This would enable the site grading to take place at a much lower elevation. As depicted in ***Figure 7***, the site would be approximately ***1.1m*** lower than ***Option 4.2.1***.

As described in ***Section 4.2.1***, the majority of the Village of Richmond is reliant on sump pumps for foundation drainage. This alternative would increase the level of service to the home owner as the home owner would not be reliant on maintenance of privately owned sump pumps. In this scenario, the liability would be on the municipality to ensure continuous operation of the pump station during periods where foundation drainage was collected.

Construction phasing and staging is contingent upon the completion of the receiving stormwater management facility and foundation drainage lift station.

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This servicing arrangement respects the grade raise restriction throughout the development area. It was estimated that the site required a total net fill of ***351,953m^3***. See ***Figure 8*** for an overview of estimated cut / fill.

The estimated capital cost for the construction of storm sewers and earthworks was ***$32,113,000***, while the 25 year life cycle costs were estimated to be ***$286,000***. See ***Appendix G*** for detailed cost breakdown.

4.2.3 No Foundation Service – Slab on grade units

Slab on grade units, ie no basements or limited crawl spaces only, do not require foundation drainage. Foundation walls have equal amount of hydrostatic pressure on both sides and there would be no living space in the subsurface that would require a storm service. Slab on grade units have never been constructed for an entire community within the City of Ottawa.

As depicted in ***Figure 9***, the street storm sewer would be placed a minimum elevation below the finished grade.

This servicing arrangement respects the grade raise restriction throughout the development area.

It was estimated that the site required a total net fill of ***592,580m^3***. See ***Figure 10*** for an overview of estimated cut / fill.

The estimated capital cost for the construction of storm sewers and earthworks was ***$26,030,000***, while the 25 year life cycle costs were estimated to be ***$97,000***. See ***Appendix G*** for detailed cost breakdown.

4.2.4 Foundation service to street storm sewer – Sump pump

Foundations equipped with sump pumps that outlet to storm sewers are not typically employed in Greenfield subdivision developments in the City of Ottawa. In this servicing arrangement homes are situated with underside of footings 0.15m above the invert of the receiving sewer. The sump pump will be equipped with a swan neck that is 0.30m above the modeled 100-year hydraulic grade line. ***Figures 11 and 12***, included in ***Figures*** illustrate the servicing arrangement. ***Figure 11*** illustrates the estimated sewer size and associated HGL determined for the recommended solution at MH ID 402

As described in ***Section 4.2.1***, the majority of the Village of Richmond is reliant on sump pumps for foundation drainage. This alternative remains consistent with the existing level of service within the Village of Richmond.

Construction phasing and staging is contingent upon the completion of the receiving stormwater management facility.

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As depicted in ***Figure 11***, the street storm sewer would be placed a minimum elevation below the finished grade. This servicing arrangement respects the grade raise restriction throughout the development area.

It was estimated that the site required a total net fill of ***395,941m^3***. See ***Figure 13*** for an overview of estimated cut / fill.

The estimated capital cost for the construction of storm sewers and earthworks was ***$22,541,000*** while the 25 year life cycle costs were estimated to be ***$97,000***. See ***Appendix G*** for detailed cost breakdown.

4.3 Comparison of Alternatives

Table 5
Comparison of Alternatives

Parameter	Option 4.2.1. Gravity System	Option 4.2.2. Foundation Collector	Option 4.2.3. Slab on Grade Units	Option 4.2.4 Sump Pumps
Caring and Healthy Communities				
C3 Impact on level of service	Improves level of service when compared to Village of Richmond at large	Improved level of service to individual home owner	Reduced level of service. No basements provided.	Consistent with Village of Richmond level of service.
C9 Consistency with infrastructure planning policies	Consistent with City of Ottawa Greenfield development. Potential negative impact on land use due to fill requirements.	A departure from typical greenfield development.	Limits land uses by not providing foundation drainage services.	A departure from typical greenfield development outside of the Village of Richmond. However, common with Village limits.
Constructability and Functionality				
CO2 Schedule / Staging Opportunities	Phasing potentially inhibited by fill requirements, obtaining fill and potential surcharging requirements in areas exceed grade raise parameters.	Increased capital cost on the outset of the project for lift station. Third pipe will increase construction time.	No impact to construction phasing.	No impact to construction phasing.
CO3 Construction Risk	Exceed geotechnical parameters.	Meets geotechnical parameters.	Meets geotechnical parameters.	Meets geotechnical parameters.
CO5 Disruption during construction	Significantly more imported material to site for filling. Increased construction traffic	Increased construction duration for third pipe and lift station construction.	No additional construction disturbance expected.	No additional construction disturbance expected.

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CO6 Operation and maintenance	Sewer arrangement a proven track record, with normal operating and maintenance expected. Anticipate increased road work maintain for potential settlement issues.	Increased operation and maintenance for additional pipe and lift station. A lift station failure would impact entire development.	Sewer arrangement a proven track record, with normal operating and maintenance expected.	Sewer arrangement would require normal operating and maintenance. Sump pump maintenance would be required by home owner.
Cost				
E9 Est. Maintenance cost	$97,000	$286,000	$97,000	$97,000
E11 Est. Capital Cost	$38,736,000	$32,113,000	$26,030,000	$22,541,000

4.4 Ranking of Alternatives

Table 6
Ranking of Alternatives

Parameter	Weighting	Option 4.2.1		Option 4.2.2		Option 4.2.3		Option 4.2.4	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
Caring and Healthy Communities									
C3 Impact on level of service	15%	5	0.75	4	0.60	1	0.15	2	0.30
C9 Consistency with infrastructure planning policies	15%	5	0.75	3	0.45	2	0.30	3	0.45
Constructability and Functionality									
CO2 Schedule / Staging Opportunities	6%	1	0.06	2	0.12	5	0.30	5	0.30
CO3 Construction Risk	9%	1	0.09	5	0.45	5	0.45	5	0.45
CO5 Disruption during construction	6%	1	0.06	2	0.12	5	0.30	5	0.30
CO6 Operation and maintenance	9%	4	0.36	1	0.09	5	0.45	2	0.18
Cost									
E9 Est. Maintenance cost	15%	5	0.75	1	0.15	5	0.75	5	0.75
E11 Est. Capital Cost	25%	1	0.25	2.0	0.51	3.9	0.98	5	1.25
Total	**100%**		**3.07**		**2.49**		**3.68**		**3.98**

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4.5 Conveyance System Conclusion

Each alternative was described in detail under ***Section 4.2.*** and was compared side by side in tabular format in ***Section 4.3***. ***Section 4.4*** presented the weighting and ranking that was applied to each based on the discussion presented in the previous subsections. Option 4.2.4 emerged with the highest ranking.

Option 4.2.2, was ranked lowest. It scored poorly in sections C06, E9 and E11. Operating and maintaining a third pipe as well as a lift station set this alternative back.

Option 4.2.1, was most consist with typical subdivision designs, but due to exceeding grade raise recommendations, the significant amount of fill required and associated concerns, this option was not selected.

Option 4.2.3, scored strongly in construction and functionality as well as capital cost. However, it scored slight lower in the C3 and C9 categories than the preferred solution.

Sections ***5.0 - Stormwater Conveyance*** and ***6.0 - Stormwater Management Facilities***, provide master servicing level detailed information designed on the basis of Option 4.2.4. – Foundation Service to street storm sewer with homes equipped with sump pumps.

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5.0 STORMWATER CONVEYANCE

As presented in Section 4.0, the recommended stormwater servicing solution consist of a major system, a minor system, and homes with basements will be equipped with sump pump to provide foundation drainage. ***Figures 11 and 12***, included in ***Figures*** illustrate the servicing arrangement.

The following sub-sections provide additional analysis of the recommended stormwater servicing solution.

5.1 Grade Control Plan - Major System

The proposed master grading plan is depicted on ***Drawing 2***. ***Drawing 2*** illustrates centerline of road grades, which were established on three criteria:

- Minimum depth to pipe invert = 2.1m
- Minimum depth to pipe obvert = 1.5m
- Minimum slope of saw tooth road pattern = 0.15% from high point to high point.

Where major system flow is shown to cross Perth Street and Ottawa street, the minor system was designed to covey flow under these streets. Additional information regarding conveyance through the minor system is contained in ***Section 5.2***.

5.2 Minor System

Drawing 3 illustrates the proposed minor system. ***Table 4*** summarizes the minimum parameters utilized to size the stormwater conveyance system.

Table 7
Storm Sewer Design Criteria

Design Parameter	Value
Intensity Duration Frequency Curve (IDF) 5-year storm event. A = 998.071 B = 6.053 C = 0.814	$i = \frac{A}{(t_c + B)^C}$
Minimum Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	250mm diameter
Minimum Manning's 'n'	0.013
Service Lateral Size	100mm dia PVC SDR 28 with a minimum slope of 1.0%. Homes to be equipped with sump pump flow.
Minimum Depth of Cover	2.0m from crown of sewer to grade

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Minimum Full Flowing Velocity	0.8m/s
Maximum Full Flowing Velocity	3.0m/s
Additional Considerations	Storm sewer maintenance holes serving sewers 900mm diameter and less shall be constructed with 300mm deep sumps. Maintenance holes for storm sewers greater than 900mm must be benched.
Extracted from Sections 5 and 6 of the City of Ottawa Sewer Design Guidelines, November 2004.	

A Rational Method design sheet is contained with ***Appendix H***. The pipe sizes were confirmed through hydraulic modeling as described in ***Section 5.3***.

The subject lands slope generally from west to east. As described in ***Section 3.4***, there are significant areas west of the subject land that currently drains through the development property. As illustrated on ***Drawing 3*** the external areas are summarized below:

- 63.1ha Perth Street road side ditch north;
- 34.4ha Perth Street road side ditch south;
- 94.2ha approximately midpoint between Perth and Ottawa Streets;
- 39.2ha Ottawa Street road side ditch north and;
- 34.5ha Ottawa Street road side ditch south.

Due to anticipated urbanization of Perth Street and Ottawa Street as well as the site at large, these external areas will be collected and conveyed within storm sewers. These areas will be directed through the stormwater management facilities.

5.3 Sump Pump Service

In traditional City servicing arrangements the underside of footings are typically 0.30m above the sewer obvert, the proposed configuration is a minor modification to the configuration where footings are 0.15m above the storm invert. Situating the underside of footings above the sewer invert will promote the accumulation of groundwater to drain away from the house footings toward the sewer system.

The sump pump will be equipped with a swan neck that is 0.30m above the modeled 100-year hydraulic grade line. The elevation of the swan neck provides protection to the homes during significant storm events. ***Figures 11 and 12*** illustrate the servicing arrangement.

5.4 Hydraulic Grade Line

JFSA was retained to prepare hydrological and hydraulic models to assess the performance of the sewer system. Results of their analysis is included in ***Appendix I***. Their analysis concluded that the proposed drainage systems safely capture and

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convey the all storms up to and including the 100-year event in accordance with City of Ottawa modeling practices.

The hydraulic analysis assumed that the external areas would be captured in the minor system. Furthermore, sump pump contribution during the simulated 100-year events assumed that 50% of the sump pumps would be on at any given time and that each lot would contribute 0.23L/s.

Profiles of the proposed Trunk sewers are illustrated on ***Drawings 4, 5, and 6***. The profiles illustrate the existing ground, minimum depth of cover to finished grade, and hydraulic grade line elevations.

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6.0 STORMWATER MANAGEMENT FACILITIES

JFSA was retained to prepare hydrological and hydraulic models to assess the performance of the proposed stormwater management facilities. Their analysis is included as ***Appendix I***.

The following summarizes each stormwater management facility as well as the operational parameters of each.

6.1 Stormwater Management Facility #1

Pond 1 is located south of Perth Street and is situated between the regulatory flood limit (94.11m) and the maximum water level estimated on the Van Gaal drain (between 93.72m and 94.04m). The regulatory flood limit was established by way of a backwater effect on the Jock River during a 100-year 10-day snowmelt plus rainfall event that was based on AES Ottawa CDA snowmelt plus rainfall IDF curves. The maximum water level established on the Van Gaal Drain was established based on the same event with some improvements to the Fortune Street culvert. It is proposed to increase the size of the existing 4.2m wide culvert at Fortune Street with a 6.3m span.

The Van Gaal Drain peaks at 113.3 hour into the 10-day event, while the Jock River elevation peaks at 122.0 hour at the Van Gaal Drain. At the 122 hour mark flow contributions from the Van Gaal catchment are significantly lower. JFSA have accounted for the interactions between flow from the development and water levels on the Van Gaal drain. Additional modeling details are provided in ***Appendix I***.

Pond 1 is proposed as a wet pond with an erosion, quality, and quantity release components. Pond 1 outlets to the existing Van Gaal drain. Low flows are directed to a storm sewer and outlet approximately 40m downstream of the Fortune Street culvert. ***Figure 14*** illustrates the proposed pond layout and cross-section. The sewer profile of the outlet is depicted on ***Drawing 6.*** Runoff generated during events in excess of a 25-year storm would be released to the Van Gaal drain through the overflow weir in addition to the low flow outlet. The outlet structure will consist of two orifices to attenuate flow to the Quality and Erosion control targets. ***Table 8*** summarizes the outlet control design parameters.

Table 8
Summary of SWMP 1 Outlet Structure Design

Quality Control	Erosion Control	Quantity Control
Vertical Orifice	Vertical Orifice	Rectangular Weir
300mm dia	220mm dia	45m Wide
INV = 92.35	INV = 92.45	INV = 93.68

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Table 9 summarizes the pond's operational characteristics.

Table 9
Summary of SWMP 1 Storage Characteristics

Pond Component	Pre-development Outflow (m^3/s)	Pond Level (m)	Pond Outflow(2) (m^3/s)	Volume Used(2) (m^3)
Permanent Pool	N/A	92.35	N/A	42,008
Quality Control	N/A	92.45	0.025	3,043
2yr/24hr SCS	3.518	93.66	0.319	48,640
5yr/24hr SCS	5.458	93.75	1.720	52,121
10yr/24hr SCS	6.806	93.78	2.792	53,460
25hr/24hr SCS	8.524	93.81	4.019	54,805
50yr/24hr SCS	9.872	93.83	4.903	55,711
100yr/24hr SCS	11.337	93.85	5.805	56,576

6.2 Stormwater Management Facility #2

Pond 2 is located north of Ottawa Street and is a wet pond with quality and quantity release components. Pond 2 outlets to the Jock River via a 1200mm diameter sewer. In the event of a blockage the emergency overflow is directed to the north toward the Van Gaal Drain. ***Figure 15*** illustrates the proposed pond layout and cross-section. The sewer profile of the outlet is depicted on ***Drawing 6.***

The outlet structure will consist of a vertical orifice and rectangular weir to attenuate flow to the quality and quantity control targets. ***Table 10*** summarizes the outlet control design parameters.

Table 10
Summary of SWMP 2 Outlet Structure Design

Quality Control	Quantity Control
Vertical Orifice	Rectangular Weir
350mm dia	1.15m Wide
INV = 93.20	INV = 93.35

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Table 11 summarizes the pond's operational characteristics.

Table 11
Summary of SWMP 2 Storage Characteristics

Pond Component	Pre-development Outflow (m^3/s)	Pond Level (m)	Pond Outflow(2) (m^3/s)	Volume Used(2) (m^3)
Permanent Pool	N/A	93.20	N/A	17,136
Quality Control	N/A	93.35	0.047	1,983
2yr/24hr SCS	0.646	93.82	0.784	9,606
5yr/24hr SCS	1.007	93.99	1.143	12,606
10yr/24hr SCS	1.257	94.10	1.386	14,582
25hr/24hr SCS	1.576	94.23	1.696	17,106
50yr/24hr SCS	1.826	94.34	1.939	19,089
100yr/24hr SCS	2.096	94.45	2.204	21,253

6.3 Stormwater Management Facility #3

Pond 3 is a dry pond with an oil / grit separator as an inlet structure. Pond 3 outlets to the Van Gaal Drain upstream of Perth Street. ***Figure 16*** illustrates the proposed pond layout and cross-section. Low flows will pass through the oil / grit separator, while higher flows will be attenuated in the dry pond.

The outlet structure will consist of a vertical orifice and rectangular weir to attenuate flow to the quality and quantity control targets. ***Table 12*** summarizes the outlet control design parameters.

Table 12
Summary of SWMP 2 Outlet Structure Design

Quality Control	Quantity Control
Vertical Orifice	Rectangular Weir
400mm dia	0.50m Wide
INV = 94.10	INV = 94.81

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Table 13 summarizes the pond's operational characteristics.

Table 13
Summary of SWMP 3 Storage Characteristics

Pond Component	Pre-development Outflow (m^3/s)	Pond Level (m)	Pond Outflow(2) (m^3/s)	Volume Used(2) (m^3)
2yr/24hr SCS	0.161	94.47	0.142	323
5yr/24hr SCS	0.244	94.62	0.196	483
10yr/24hr SCS	0.300	94.72	0.223	593
25hr/24hr SCS	0.370	94.83	0.256	733
50yr/24hr SCS	0.425	94.91	0.298	833
100yr/24hr SCS	0.483	94.99	0.348	937

6.4 Stormwater Management Conclusions

JFSA reviewed the impact of the proposed subdivision, the associated storm sewer collection system, and stormwater management facility designs in accordance with standard City of Ottawa modeling techniques.

Peak flow to the Van Gaal Drain generally decreases between the existing and proposed conditions. The volume attenuated in stormwater management facility 1 is primarily responsible for the decrease in flow.

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7.0 WATER BUDGET

To investigate the effect of proposed developments on existing infiltration rates the pre and post development hydrologic models prepared for this study were converted to continuous simulations. This included the conversion of CALIB NASHYD and CALIB STANDHYD commands to CONTINUOUS NASHYD and CONTINUOUS STANDHYD. The output files are included in ***Appendix J.*** These new hydrograph commands add time dependent parameters used in updating various hydrologic data during continuous simulations including initial abstraction recovery time, interval event time, etc. These new hydrographs commands are used with a COMPUTE API (Antecedent Precipitation Index) command which also updates various hydrological parameters during continuous simulations. Simulations were completed using AES (Atmospheric Environment Services Canada) rain gauge data from 1967 through to 2000.

To determine the infiltration under existing conditions, we look at the relationship that the infiltration is the difference between the total rainfall and the runoff and initial abstraction. A hypothetical CONTINUOUS STANDHYD command was used to determine the initial abstraction. By setting the ratio of total impervious area and directly connected impervious area to a very high value, we can calculate the runoff with no infiltration in which the difference between the total rainfall and runoff volume from this hypothetical impervious area gives us the initial abstraction. The output from the CONTINUOUS NASHYD commands provides us with the actual runoff volume, used to determine the infiltration value.

The water budget exercise concentrated on three areas having slightly different percent impervious values under proposed conditions. The approach taken to calculate the infiltration under proposed conditions is similar to that used for existing. By using a hypothetical CONTINUOUS STANDHYD with Horton's infiltration equation set to very low values (essentially eliminating losses due to infiltration), we can determine the initial abstraction. The output from the actual CONTINUOUS STANDHYD command provides us with the actual runoff volume, used to determine the infiltration rate.

For the proposed model, a variation of total impervious area and directly connected impervious area was completed to view the range over which infiltration rates may vary. The three scenarios are:

1. XIMP=TIMP: Means all impervious areas are directly connected to the storm sewer. This scenario would represent roof leaders directed to impervious areas.

2. XIMP=TIMP-0.15: Means 15% of the total impervious area is disconnected from the storm sewer (for example majority of roof leaders directed to grassed rear yards)

3. XIMP=TIMP-0.20: Means 20% of the total impervious area is disconnected from the storm sewer (for example all roof leaders directed to grassed rear yards)

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Table 14 summarizes the estimated average annual infiltration volume for the proposed development under existing conditions and post-development conditions. The complete results of the Continuous simulation from 1967 to 2000 is located in ***Appendix J. Table 15*** summarizes the average percent decrease in infiltration as a result of development. As demonstrated, directing roof leaders to grassed areas improves post-development infiltration substantially.

Table 14
Pre-development Infiltration

Subcatchment ID	Location	Average Infiltration Rate Existing Conditions (mm/yr)	Estimated Annual Infiltrated Volume (m^3/yr)		
			XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
VG-3	North of Perth Street	178.60	111.56	158.44	174.01
VG-8	Between Perth Street and Ottawa Street	175.99	107.56	159.36	176.69
JR-2	South of Ottawa Street North of Jock River	178.60	102.39	154.20	171.52

As demonstrated in ***Table 15***, maximizing opportunity for directing roof leaders to grassed areas significantly improves post-development annual infiltration volume.

Table 15
Post-development Infiltration

Subcatchment ID	Location	Average % Decrease in Infiltration		
		XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
VG-3	North of Perth Street	37.54	11.29	2.57
VG-8	Between Perth Street and Ottawa Street	39.77	10.77	1.07
JR-2	South of Ottawa Street North of Jock River	42.67	13.66	3.96

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8.0 CONCLUSION AND RECOMMENDATIONS

Richmond Village (South) Limited has retained David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management Report in support of their application for draft plan of subdivision.

This report provides sufficient detail with respect to the stormwater management system including minor and major system conveyance and stormwater facilities to support the Richmond Village (South) Limited's draft plan of subdivision application. Furthermore, this study provides a stormwater solution for the adjacent development lands.

DSEL recommends the following:

- Works required to amend floodplain limits will need to be implemented prior to the development proceeding;
- A storm sewer system consisting of a minor and major systems with homes serviced through sump pump is recommended;
- Three stormwater management facilities will service the development lands;
- A site grading scheme was developed to ensure major system conveyance and respect the grade raise restrictions, exceed was limited to small areas north of Perth Street;
- The stormwater management system result in slightly lower water levels on the Van Gaal Drain;
- The proposed stormwater management system meets the design objectives.

Prepared by,
David Schaeffer Engineering Ltd.

Reviewed by,
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Per: Adam D. Fobert, P.Eng

Per: Stephen J. Pichette, P.Eng

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APPENDIX A

City of Ottawa and Agency Comments

Our File: 468B

VILLAGE OF RICHMOND - STORMWATER MANAGEMENT
CITY OF OTTAWA
PLANNING AND GROWTH MANAGEMENT
File

RESPONSE LETTER

	COMMENT	Comment Type	Response Provided by	Response
	Comments from City of Ottawa - Memo dated April 20, 2010 from Darlene Conway			
	A. Use of Sump Pumps			
1	The groundwater modeling assessment (Golder, March 17, 2010), appears to presume a lowering of the water table with the SWM ponds in place. (i.e., increased time to flood indicated for this scenario). There has, however, been no discussion of the potential impacts of such a lowering of the water table. Confirmation should be provided that base flows to the adjacent watercourses will not be reduced; existing (shallow) wells will not be affected; existing/future foundations will not be impacted, etc.	Water Table	Golder	Golder are in the process of preparating a technical memo to address.
2	Note that the final permanent pond levels used in the groundwater modeling should be consistent with the permanent water levels in the ponds (at or above 2 year spring flood levels).	Pond	DSEL	MOE recommends that the NWL be at or above the 2-year water level in the receiving water course. Hyraulic modeling contained in Appendix I demonstrate that the proposed ponds function correctly.
3	There appears to have been no consideration of the impact during the regulatory flood event. In this case, the flood level will rise to 94.11m on the Van Gaal Drain and much higher (96.25m, 96.38m) further upstream on the Jock, adjacent the development below Ottawa St. - below which many, if not all, foundations will be set, according to the currently proposed grading. This is also a spring event on the Jock - so the hydrograph will peak and recede relatively slowly, i.e., what will the impact of this slowly rising and receding flood level be on the water table and hence the amount and duration of the pumping required? (information re: the Jock River hydrograph in this location should be reviewed by the proponent and should be available from RVCA). Given that the level of service is protection from flooding during a 100-year event, this condition must be assessed.	Water Table	Golder	Golder are in the process of preparating a technical memo to address.
4	Further, given the 100-year hydraulic gradelines documented in Appendix I of the SWM/drainage report - there are locations noted where the HGL is less than 0.50m below centerline of road - will there be sufficient head available between the level of the gooseneck and the HGL for the pumped flows to be discharged?	Sump Pump	DSEL	DSEL have revised the HGL, road grade, and underside of footing elevation. The HGL is in response to all contributions including sump pumps.
5	p. 71 - Backwater valves are proposed for the storm connections; however, there has been no discussion regarding the risk and potential frequency of backwater valves being closed during high water levels from the Jock while at the same time pumping is required, which would be expected to occur particularly in the spring.	Sump Pump	DSEL	Backwater valves are no longer proposed. Note that the HGL reported includes contributions from Sump pumps.
6	Should the sump pumps fail during a significant event and unequal hydrostatic pressures develop (inside and outside the basement walls), is there any concern regarding lifting/cracking of the basement slab?	Sump Pump	Golder	No. If the pump failed and the water level rose above the basement elevation, water would enter the basement via the sump. This is what happens in any home that relies on a sump pump.
	B. Storm Sewers (standing water):			
7	It is estimated that for Option C (recommended solution), in the order of 3km of storm sewer will be subject to permanent standing water, ranging from fully submerged at the pond inlets to about 0.3m of standing water. There appears to have been no consideration given to the increased operation and maintenance burden this represents in terms of assessing alternative grading strategies. Further, on p. 72, it is indicated that the storm sewer system will be designed in accordance with City standards including a minimum (full flow) velocity of 0.8m/s. This criterion has not be demonstrated for the minor system design events (5 and 10 year) and, given the amount of submergence currently proposed, will likely not be achieved. Accordingly, additional alternative options need to be considered that will significantly reduce or eliminate the extent of standing water.	Pipes	DSEL	Revised sewer layout eliminates standing water in proposed storm sewer system.

8	In this regard, it is also noted from Drawing 12 that the proposed preliminary cut-fill for option 3C results in an excess cut of almost 240,000 cubic metres (is this correct?) although this differs from the value of excess cut (81,500 cubic meters) noted in Table 14. A cursory review of the maximum fill depths throughout the site also appears to indicate that these depths are generally well below the preliminary maximum fill depths recommended in the Jacques Whitford report, except for lands north of Perth St., where there are exceedances of up to 0.5m above the recommended maximum fill depth. That being said, alternative options should look at intermediate fill depths that would reduce or eliminate standing water in the sewers and assess other required measures should it be necessary to exceed the maximum recommended fill depths.	Pipes	DSEL	DSEL have revised the servicing solution to eliminate standing water in the pipes. The resulting cut and fill volumes have been revised accordingly.
9	While the preservation of existing hedgerows is a laudable objective, the costs associated with maintenance of sewer with excessive depths of standing water is a significant concern. In terms of balancing various objectives, perhaps consideration could be given to extra depth lots adjacent to the hedgerows to transition increased fill depths.	Pipes	DSEL	Dulely noted. Balancing site keeps grades near existing and reduces cost to home owners.
10	Some 600 metres of large, low gradient box culvert is proposed, much of which is subject to significant or complete submergence. Notwithstanding the comments regarding the need to significantly reduce or eliminate the extent of submergence, the use of box culverts in these conditions (permanent standing water) is generally not acceptable.	Pipes	DSEL	No standing water. Require box pipes to reduce fill requirements.
	C. Major System Capacity and External Drainage: ***Note:** these comments are to be addressed incorporating latest findings of stormwater subcommittee - Technical Bulletin ISDTB-2012-1			
11	p.73 Conveyance of Major System Flows: As previously requested, regardless of how foundations are drained, a major system analysis must be undertaken to confirm there is sufficient capacity within the rights-of-way to safely convey major system flows to outlet(s) and/or identify additional major system storage requirements. Again, it is also not acceptable to suggest that if the major system flow exceeds the conveyance capacity of the right-of-way then the storm sewers will be upsized. This type of analysis is required for all major development application and master planning exercises, and in this case is of particular importance given the flatness of the site and the relatively flat road grades proposed throughout the development (0.2%). Such an analysis is required to confirm whether additional dry storage facilities may be required to ensure major system flows are contained within the limits of the right-of-way and do not result in surface flooding of private property or public property beyond the right-of-way.	Grading Major System	DSEL	Updated analysis demonstrates the conveyance of external drainage areas through the development.
12	Further description of the modeling approach used to calculate the 100 year HGL is required in the main report (output in the Appendix appears to indicate that an analysis was completed with SWMHYMO). A description of the modeling approach and assumptions used should be provided with a general description of the results. Further, can this analysis be used to assess the proposed major system? Does it adequately reflect the minor system capture during a 100 year event, can it assess flooding depths on the roads, etc.?	Pipes	JFSA	JFSA have prepared a technical memorandum that outlines modeling assumptions and approach.
13	p.73 – External Drainage: MAT-A and MAT-B: The recommendations for these areas differ on p.60 and p.73 – please adjust accordingly. Given that Perth St. is to be urbanized it is presumed that the p.60 description correct, i.e., these areas will be picked up by storm sewer and directed to Pond 1. Please confirm.	Grading Major System	DSEL	Revised to indicate that MAT-A and MAT-B will be coveyed through Pond 1.
14	How are flows north of Perth St. to be conveyed across Perth St. to Pond 1?	Grading Major System	JFSA	Flow north of Perth Street will be conveyed via storm sewers to the pond.
15	MAT-E: Is there sufficient capacity along the existing Ottawa St. right-of-way to convey all major system flows directed there (external and uncontrolled developed)? What is intended by the "100 YEAR CAPTURE" notes shown south of Ottawa St. on Dwg. No.1?	Grading Major System	DSEL	Sewers along Ottawa Street have been designed to convey external areas.

16	p.60 – It is noted that the Jock River Estates drainage (MAT-E) is proposed to be conveyed north of Ottawa Street through a new culvert to the redesigned Moore Tributary channel and then to the Van Gaal/Arbuckle drain. It is not clear how this is to be achieved with a culvert. Please clarify. It is also important that no additional drainage be directed to the Van Gaal/Arbuckle Drain that was not accounted for in the recent floodplain mapping exercise. It is recognized that some drainage will be directed to the Jock in future (Pond 2 catchment) that may offset this, however, the overall drainage areas should be closely balanced given the considerable sensitivity regarding flood levels in the drain. As requested elsewhere in these comments, a drawing indicating post-development drainage boundaries and where each catchment (internal and external) will drain in future should be provided.	Grading Major System	DSEL	JFSA have prepared a post-development model of the impact on the Van Gaal drain. The model has shown lower peak water levels on the drain.
17	It must be demonstrated how uncontrolled major system flows south of the east-west portion of the Moore Drain are to be conveyed across the Moore Drain to Pond 1, i.e., confirm the capacity of the road crossings and other (pedestrian?) crossing to convey the total uncontrolled flows directed to those locations – otherwise, uncontrolled flows will bypass Pond 1.	Grading Major System	DSEL	Revised storm service layout and draft plan. Moore Drian is proposed to be closed.
	D. Geotechnical / Hydrogeological			
18	As currently proposed, the bottom of Pond 2 is some 3 to 4 metres below existing grade and into bedrock. The bottom of Pond 1, some 3 metres below existing grade as currently proposed, may be at or marginally below bedrock. Some of the sewers (storm and sanitary) may also intercept the bedrock, in particular below Ottawa St. There has been no discussion provided as to the potential impacts on adjacent shallow wells and / or potential impacts on pond operation. Some discussion should be provided regarding these potential concerns and recommendations to mitigate any potential impacts should be provided as required.	Water Table	Golder	Golder will review and provide comment on the impact to surrounding areas.
19	p. 11 of the geotechnical report (Jacques Whitford, 2007) indicates that settlement estimates have been based on no grade changes but notes that these estimate are highly dependent on grade changes and that the geotechnical resistance values will need to be reviewed in conjunction with the proposed grading plan. Has this been done taking into account the proposed grade changes?	Grading Major System	Golder	Golder will review proposed site grading plan and provide feedback.
20	As noted in the sump pump strategy comments above, the permanent water levels in the SWM ponds would appear to presume a considerable lowering of the water table. Also, could the use of potentially some 2000 sump pumps result in an eventual permanent water table lowering throughout the site? There has been no discussion of potential impacts if this occurs. Confirmation should be provided that base flows to the adjacent watercourses will not be reduced; existing (shallow) wells will not be affected; existing/future foundations will not be impacted, potential settlement will not impact linear infrastructure.	Sump Pump	Golder	Golder will review and provide comment.
	E. Proposed Pond in Floodplain			
21	The technical feasibility of this proposal has not yet been demonstrated. As per the MOE SWM Planning and Design Manual (p. 4-5), locating a pond in a floodplain is an exception subject to a number of criteria, including: -The cumulative effects resulting from changes in floodplain storage and balancing cut and fill do not adversely impact existing or future development. - The outlet invert elevation of the SWMP should be higher than the 2 year floodline and the overflow elevation must be above the 25 year floodline. Specifically,	Pond	DSEL	Modeling has been prepared to support the proposed pond in the floodplain.

22	p. 83 - The justification for locating the pond in the floodplain is based upon locating it above the summer event given that the higher regulatory flood level results from a backwater effect from the Jock River. However, the 100-year spring event on the drain (93.83m at 910), though lower than the backwater condition from the Jock, is still higher than the summer event (93.60 at 910), Fortune St. culvert upgraded). While the timing of peak flows may apply to the much larger Jock River and the spring even backwater condition, it is not apparent that this is an appropriate assumption when comparing spring and summer events on the much smaller drain. Further, the rationale of locating the pond only above the summer condition floodplain could set a precedent such that ponds are proposed in future within the regulatory (spring) floodplain where there is no comparable backwater effect. From a technical perspective, if a pond is to be considered to be located in the floodplain, it should be located above the 100-year spring event on the drain (i.e.: described as Scenario 2).	Pond	DSEL	Pond will be situated between the event creating the peak water level on the Van Gaal Drain and the 100-year spring event resulting from the backwater on the Jock River. The stormwater management modeling exercise demonstrates the pond's functions.
23	The pond design, as currently proposed, requires filling in areas of the floodplain below the 100-year regulatory elevation in order to achieve a minimum top of pond of 93.90. There should be no filling to achieve the required pond storage.	Pond	DSEL	It is the intention that no filling or berming will take place. Additional topographical information has been gathered to ensure that this is the case.
24	The overflow spillway is set at elevation 93.30, which is less than the required 25 year level (spring condition) of 93.68m (section 910) documented in the JFSA levels for frequent events provided in an e-mail dated March 26, 2010, entitled P709(02) Richmond 2, 5, 10, 25 Year WSEL Results (it is not known what the resultant spring 25 year level would be with the Fortune St culvert upgraded).	Pond	DSEL	Pre and Post modeling has been completed to evaulate water levels on the Van Gaal drain with the pond present.
25	The permanent water level / pond outlet is set at elevation 92.65m which is below the 2 year water level (spring condition) of 94.14m (section 705) documented in the JFSA levels for frequent events (March 26, 2010).	Pond	DSEL	Duley noted.
26	Further, the proposed pond block has apparently not accounted for a required sediment drying / storage area (this must be located outside the regulatory floodplain, hence non-floodplain area requirements to serve this purpose should be identified now).	Pond	DSEL	Sediment drying areas have been included in the proposed pond layout.
27	As per the MOE manual, given that the location of the SWM pond in the floodplain is already an exception, the above requirements regarding the design and operation of the pond must be demonstrated before further consideration can be given to this option.	Pond	DSEL	Pre and Post modeling has been completed to evaulate water levels on the Van Gaal drain with the pond present.
28	p. 88 - Other Examples in the Province of Ontario: The examples given re: other Conservation Authorities permitting ponds within the floodplain are not consistent with current guidelines available from those CAs and should be confirmed and/or corrected. Specifically:	Pond	DSEL	Noted. This section has been removed from this study. The justification for this pond location is purely based on technical feasibilty for this case only.
29	i) CVC will only allow ponds outside the 100 year (but within Regional/Hazel) and subject to a number of other concerns.	Pond	DSEL	As above
30	ii) CLOCA will only allow ponds within the 100 year floodplain if they are for water quality only; quantity control ponds must be outside the 100-year floodplain.	Pond	DSEL	As above
31	Regarding the proposal to increase the Fortune St. culvert capacity - an assessment of both potential fisheries and maintenance impacts should be provided, i.e., will fish passage be reduced given reduction in low flow depth? will increased capacity lead to increased sedimentation of culvert?, etc.	Fish	Kilgour and Associates	Kilgour and Associates will review detailed culvert upgrades.

	F. Stormwater Management Criteria and HGL:			
32	p. 75 - The reference to p. 3-15 of the MOE SWMP manual regarding the 2-year event being frequently adopted as the design event to set storage volumes to mitigate erosion impacts is taken out of context. By itself, this does not represent an acceptable design criteria as further explained in the MOE manual. Rather, as generally accepted and as previously requested, a continuous analysis is required to assess the impact of increased runoff volumes and flow duration in the post-development condition. (The response to previously comments indicates this has been provided in section 9.5.5 of the revised report but there is no documentation of this and nothing further in Appendix I) Further, the erosion analysis should be integrated with the proposed measures to meet water balance targets (i.e. reducing runoff volumes from frequent events should assist in meeting erosion targets). As previously requested, this proposed approach to mitigate erosion impacts should be confirmed with City staff prior to proceeding with the analysis.	Erosion	JTBES	JTBES has been retained to provide comment on Erosion Control release rates from each stormwater pond.
33	Geomorphology: It appears that an assessment, RSAT, erosion threshold, etc, of VG-R1 (the reach immediately downstream of the development) has not been provided? The erosion criteria cannot be confirmed without this information - for example, it must be confirmed whether this reach is more sensitive than the reach immediately upstream and whether it will govern the release rates and storage required.	Geomorpholgy	JTBES	JTBES has been retained to provide comment on Erosion Control release rates from each stormwater pond. Their study is currently on going.
34	p. 49 - The water budget results seem ambitious. i.e., indicating that all roof leaders (rear and front) directed to grass will almost equal or even slightly exceed existing infiltration rates. Some further discussion re: assumptions and justification of these values should be provided. Further, it is understood that eavestroughing is not a requirement of the Building Code so how is implementation to be achieved (i.e., will this be provided by the developer / builder?). Also, what are the implications of the development with respect to maintaining existing recharge amounts to the Moore and Arbuckle Drains?	Water Budget	JFSA	JFSA are reviewing water balance approach with consideration for proposed rooftop drainage.
35	What is the (dry) storage volume required for Pond 3? Can the hydrodynamic separator proposed for quality control operate under submerged/partially submerged conditions?	Pond	DSEL	Pond 3 will contain a hydrodynamic separator to address quality, while the dry pond will address quantity.
36	Development is shown north of the village boundary. Is this correct? If not, please remove from drawings.	Grading Major System	DSEL	DSEL have revised plans accordingly.
37	p. 85 - Given that the low flow outlet indicated on Dwg No. 6 crosses under (not into) the Moore Drain to connect to the Van Gaal, it is not apparent how cool "baseflow" can continue to be directed to the top of section 2 of the Moore. Further, it is not apparent the water from a SWM facility can be considered cool, or at least as cool, as groundwater. Should the Arbuckle Drain petition proceed, is a lowering of the Moore Drain proposed? (this could preclude location of the outlet beneath the Moore Drain for which there is only some 0.2m of cover for now)?	Pond	Kilgour and Associates	Dulely noted.
38	Please provide a summary table that compares pre- and post-development peak flows/water levels/runoff volumes for the various events at cross-sections throughout the development area and downstream i.e., at more locations than the three locations provided in Table 19). Also, clearly document the conditions assumed, i.e., Table 19 assumes the Fortune St culvert has been upgraded? Table 19 indicates future peak flows are decreasing somewhat - is this a result of Pond 1 overcontrolling? timing? etc. Please provide discussion.	Pipes	JFSA	Complete pre and post water elevation tables have been included with resubmission.
39	It appears that no post-development hydrology files (for the OPA lands) have been provided. (digital and sample hard copy print-outs). If they have been provided (hard copy example) in the Appendices, then clearly indicate where. Also, a text file listing of the various scenarios should be provided for ease of review.	Pipes	JFSA	Digital copies provided in re-submission.

40	p. 71 - Reference is made to the sanitary sewer HGL being completed by Stantec. The results of this analysis should be plotted on the preliminary plan/profiles to confirm the adequacy of the proposed grading.	Sanitary	JFSA	Stantec completed a sanitary analysis on 2010-08-07 that considered pumping station failure.
41	p. 72 - It is indicated that storm sewer calculation sheets have been provided in Appendix I but only 100 year HGL calculations are provided - 5 year capacity sheets should be provided as well.	Pipes	DSEL	Design sheets provided.
42	p. 72 - The report indicates that the governing 100 year HGL has been plotted on the plan/profiles but it has not been. Further, please provide a better description and justification of what is intended by the free outfall and "restrictive downstream conditions" i.e., would not the 100 year water level in the ponds govern? Please clarify the outlet condition assumptions.	Pipes	JFSA	JFSA have provided additional modeling descriptions.
	G. Grading:			
43	Given the removal of the spill area below Ottawa St, there may be the creation of a low area (i.e., the existing Legion property and a portion of Jock River Estates) that will no longer be able to drain which will have to be accounted for, i.e. picked up by catchbasin. That external drainage area should be flagged on the plans and others have been.	Grading Major System	DSEL	All external areas have been accounted for in re-design.
44	Assuming the grades on Perth St are proposed, there is considerable amount of fill that may impact the existing lot at the east limit of Perth St within the development. How is this to be mitigated for the affected property owner?	Grading Major System	DSEL	Existing grades at existing landowner areas are maintained.
	H. Drawings:			
45	Drawing 1: For ease of reference, include drainage areas (ha) on drawing for each (major) catchment.	Pond	DSEL	Revised drawings provided.
46	An overall post-development drainage plan should be provided (i.e., similar to Existing Conditions provided in Drawing 1) that clearly shows where both internal and external drainage is to be directed.	Pond	DSEL	Revised drawings provided.
47	Please ensure that all (preferred approach) drawings generally provide consistent information re: permanent water levels, outlet channel configurations, major system drainage approach, etc. There are a number of inconsistencies on the preliminary drawings that require correction to ensure clarity and avoid confusion in future.	Pond	DSEL	Revised drawings provided.
	RVCA Comments - Memo dated May 11, 2010			
	Design Objectives:			
48	The water quality objective is the enhanced level of treatment for all discharges into Van Gaal Drain and the Jock River. This is acceptable.	Pond	DSEL	Noted.
49	The water quantity control objective is the control of peak flows at the pre-development level for Pond 3. Please confirm whether it is also the design objective for Pond 1.	Pond	DSEL	Release rate requirements for each pond have been added to report.
50	We suggest that the design objectives for each pond be listed clearly.	Pond	DSEL	As above.
51	The uncontrolled discharge from Pond 3 to the Jock River, limited only by the pipe capacity, is not acceptable (for reasons of unacceptable cumulative impact on flood risk ~ to be discussed later on).	Pond	JFSA	JFSA to provide additional information on impact to Jock River.
52	A table showing all pre~ and post development flows from all ponds for all storm events with return periods from 2 to 100 years should be provided.	Pond	JFSA	Table provided in JFSA analysis.
	Cumulative Impacts:			
53	RVCA requested an analysis to demonstrate that there will be no adverse cumulative impact on the flood risk from the lands earmarked for development. A memo by AECOM in Appendix G was submitted to address this issue.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.

54	This cumulative impact assessment only addressed the summer condition, but not the spring condition (which was also requested by RVCA). We need the professional opinion of the consultant, supported by appropriate technical rationale, that the proposed project will not increase the spring flood risk. (Intuitively, one would expect spring impacts to be lesser than the summer impacts; RVCA is prepared to accept this rationale if that is the conclusion the consultants have drawn from their analysis.)	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
55	The submitted calculations indicate that upstream development will have no impact on the Jock River flow up to Richmond, but will slightly increase the summer flood further downstream from Eagleson Road to the Rideau River.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
56	We need to know, upstream of Eagleson Road, exactly where the impact becomes detectable. In particular, if any location within the Village will experience increased flood risk.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
57	In view of the increased summer flood flow spread over a considerable length of the Jock River from Eagleson Road to the Rideau River, we like to point out that a number of downstream stormwater facilities have been designed based on the current flood propagation characteristics of the river and can potentially be adversely impacted by any increase in flood level and flood duration.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
58	So far the consultants have limited their analysis to the projected increase in flood flow, without discussing how it will translate into flood level and the extent of inundation. Any affected lands need to be identified and impact assessed.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
59	Based on the above, we are not convinced that there will not be any adverse impact on the flood risk along the Jock River. Therefore, we shall not support any stormwater facility which allows increased flow to the Jock River.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
60	It is prudent to provide information on any increased flood risk, however small, to the affected land owners and other stakeholders ~ so that they understand the issue and can provide feedback.	Offsite	JFSA	JFSA to provide additional information on impact to Jock River.
	Modified Summer Flood Lines			
61	The summer flood lines shown in the constraints plan (Drawing 2), is based on the assumption of wider culvert at Fortune Street and is therefore different from the summer lines one could plot based on the existing conditions as depicted in the recent flood mapping report. Adequate and clear topographic information and drawings are needed for us to verify the accuracy of the proposed summer flood lines.	Pond	DSEL	Received additional topographical survey to this effect flood limit has been revised accordingly.
62	We note that any change in the culvert geometry is likely to change the spring flood lines too, specially the event dominated by the 100 year flow along the Van Gaal Drain (as opposed to the backwater condition from Jock River). This should be checked and documented.	Pond	JFSA	Post-development flood lines reviewed and revised accordingly.
63	Any change in flood lines needs detailed review and permit approval by RVCA. If that is the intention, appropriate report, model and maps should be submitted to RVCA.	Pond	JFSA	Noted.
	Locating Pond in the Flood Plain:			
64	Pond 1 has been placed within the regulatory floodplain, but outside the (modified) summer floodplain. No technical justification has been provided on why a pond is justified within the summer floodplain. There is no reference to summer floodplains in any guidelines.	Pond	DSEL	Pond will be situated between the event creating the peak water level on the Van Gaal Drain and the 100-year spring event resulting from the backwater on the Jock River. The stormwater management modeling exercise demonstrates the pond's functions.
65	A close scrutiny of the four scenarios considered in the flood mapping exercise reveals that the “Van Gaal Drain 100 year spring peak” will result in higher flood levels than the summer scenarios. Therefore, Pond 1 is actually located within the spring floodplain of the Van Gaal Drain, nullifying the “backwater from Jock River” argument.	Pond	JFSA	The Rationale for the location is that it is to be between the peak event on the Van Gaal drain and the backwater from the Jock River.

66	This also raises the issue of how Pond I will function during the "Van Gaal Drain 100 year spring peak," event, especially with respect to flood flow obstruction, sediment re-suspension and fish movement.	Pond	DSEL	The stormwater management modeling exercise demonstrates the pond's functions.
67	Placing Pond I within the floodplain implies periodic inundation of the pond by floodwater. How this will affect the water quality function of the pond is not clear. It needs to be demonstrated that the pond can perform its intended function in spite of being flooded from time to time.	Pond	JFSA	The stormwater management modeling exercise demonstrates the pond's functions.
68	According to Section 4.2 of MOE's 2003 Manual, ponds in floodplains are contemplated only as exceptions - and only if they meet certain conditions (e.g., sufficient technical or economic justification, floodplain storage, balanced cut and fill, corridor values, fluvial process, outlet invert above 2 year flood level, overflow elevation above 25 year flood level). It is not clear from the report how these conditions have been satisfied.	Pond	DSEL	MOE recommends that the NWL be at or above the 2-year water level in the receiving water course. Hyraulic modeling contained in Appendix I demonstrate that the proposed ponds function correctly.
69	Of particular interest to RVCA is the control of flooding, pollution, erosion and the conservation of land. The submitted material is not enough for us to adequately evaluate Pond 1 in these respects.	Pond	DSEL	Noted.
	Stormwater and Fish Mitigation:			
70	We need more details on the thermal mitigation analysis for all applicable typical scenarios, in particular for the temperature sensitive months of July and August. Appropriate combinations of flow, temperature and habitat requirements need to be considered.	Pond	Kilgour and Associates	Kilgour and Associates will be provided with updated design drawings and report for review and comment.
71	In order understand the implications of potential fish migration in and out of Pond 1, we need more details with regard to fish migration under various hydrologic scenarios, i.e., summer, Jock spring backwater, and Van Gaal Drain spring flood events. These include frequency of inundation, duration of inundation, typical velocities, flow depth, etc.	Pond	Kilgour and Associates	Kilgour and Associates will be provided with updated design drawings and report for review and comment.
72	There is an anticipated loss of flow to the Moore Branch. We need to know how it will affect fish habitat (e. g., by converting this permanent stream into an intermittent one)? A reduction in flow may be considered a harmful alteration of fish habitat and would require review by DFO.	Pond	Kilgour and Associates	Kilgour and Associates will be provided with updated design drawings and report for review and comment.
	Comments from City of Ottawa - Email dated May 26, 2010 from Darlene Conway			
	Revised grading / level of service:			
73	Water table levels: Reviewing the water table levels monitored this April, I have serious concerns with the proposal to base a grading plan on setting basements at these levels. Specifically:	Sump Pumps	Golder	Golder have collected additional data from 2010, 2011 and 2012 that will be used for the current groundwater modeling assessment. Golder are reviewing the current proposal and will provide a technical memorandum accordingly.
74	This was a dry spring, so in all likelihood, these levels are not reflective of the seasonal high water table - the preparation of a grading plan on this year's level would not appear to demonstrate the feasibility of using sump pumps.	Sump Pumps	Golder	Golder have collected additional data from 2010, 2011 and 2012 that will be used for the current groundwater modeling assessment.
75	As previously commented, when recommending an approach that diverges from the City's standard, the onus is on the developer to defend the approach by providing "justifications in terms of implementation feasibility and economics as well as engineering , environmental, operational, reliability, risk and maintenance issues." This remains to be done in a manner that adequately justifies divergence from the City's standard, i.e., a comparison of options that documents cost, risk, reliability, etc.	Sump Pumps	DSEL	A servicing arrangement has been provided and will be reviewed and commented on by Golder.

76	It is not clear what the level of service provided by setting basements at seasonal high water table would be, however, it would appear to be less than a 100 year level of protection (recognizing the difficulty in assigning a frequency to a water table level and the reliability of dependence on non-gravity drainage); for example, the City's level of service is not just to set basements at the 100 year hydraulic gradeline, but requires a further buffer of 0.30m above that elevation. Such factors in combination with other requirements (i.e., basements above the sanitary HGL) require further examination/confirmation. Ultimately, if the contention is that the site is not developable while meeting an equivalent level of service/protection from basement flooding required in other greenfield developments, then this needs to be clearly acknowledged.	Sump Pumps	DSEL	In traditional City servicing arrangements the underside of footings are typically 0.30m above the sewer obvert, the proposed configuration is a minor modification to the configuration where footings are 0.15m above the storm invert. Situating the underside of footings above the sewer invert will promote the accumulation of groundwater to drain away from the house footings toward the sewer system. The sump pump will be equipped with a swan neck that is 0.30m above the modeled 100-year hydraulic grade line. The elevation of the swan neck provides protection to the homes during significant storm events.
77	While the City does not have a guideline for the widespread use of sump pumps in a Greenfield development of this scale, (that is why the exception criteria has been triggered), two examples from published guidelines are provided below that suggest setting basements at the seasonal high water table may not be sufficient: the City of Barrie requires 0.5m above the seasonal high water table; the MOE SWM Planning and Design Manual suggest sump pumps should not be used where the seasonal high water table is within 1m of foundations.	Sump Pumps	Golder	The proposed servicing arrangement has been provided and will be reviewed and commented on by Golder.
78	The need to protect basements from flooding with sewage in the event of a catastrophic failure of the pumping station needs to be accounted for in the grading plan/setting of basement elevations - a sanitary HGL must be provided for this condition. The 100 year flood elevation at the pumping station is 93.81m - given the water table levels already monitored from 94.87 to 93.78m), setting basements above the resulting sanitary HGL at the site if the pump station fails should be achievable. The revised grading plan needs to confirm this.	Pipes	JFSA	Duley noted. This is the case for the entire Village of Richmond. Backwater valves must be provided for sanitary services.
79	Are there other options? An FDC system was immediately dismissed at the meeting, however, in combination with some additional fill, modified house design, possible use of a pumping station (not preferred but should be looked at), this may be feasible - but it must be considered in light of all factors: basements above high water table + buffer?; basements protected from sewage flooding; ability to surcharge storm sewer to road/use of somewhat smaller pipe?, etc. (Note: In terms of size of pumping station, the City's guideline calls for a flow of 0.45lps/house when no other data is available and this is considerably higher than the high value indicated by Golder; even so, for 2000 homes this would amount to a maximum peak flow of 0.9cms; this would also only be a lift station.	Sump Pumps	DSEL	Revised report provides an evaluation of storm servicing options.
2	**Pond 1:**			
80	The preliminary grading plan provided does not allow for the required minimum 0.3m freeboard above the maximum pond operating levels. This must be provided as previously commented upon, again without filling in the floodplain and meeting all other requirements for locating a pond in the floodplain as noted in the MOE manual.	Sump Pumps	DSEL	The stormwater management modeling exercise demonstrates the pond's functions.
81	I believe it was noted at the meeting that the permanent water level was set at the summer 2 year level, not the spring 2 year level. The revised permanent wet level noted is 92.35m - this is even lower than the previous level of 92.65m which is lower than the spring level of 93.14. The pond being located in the floodplain is already an exception for which the MOE manual provides guidelines which appear not to have been met. What is the justification for exceptions to exceptions?	Pond	DSEL	The stormwater management modeling exercise demonstrates the pond's functions.
82	The invert of the pond outlet has been lowered to 92.0m - where is this in relation to the drain invert?	Pond	DSEL	The invert of Van Gaal Drain at this location was noted to be 91.28m per X-SEC 521.
83	It was noted that sediment storage might be provided on the communal well site? It is not evident there will be sufficient space for this so non-floodplain land must be provided in the pond block for this purpose.	Pond	DSEL	Sediment drying area has been specified on plans.

	Major system capacity:			
84	It was noted that 0.2% from high point to high point was a City guideline for major system capacity. I'm not familiar with this but regardless, a major system analysis that provides flows and depths) must be completed based on the proposed grading that confirms adequate conveyance capacity for the 100 year event (worst case) - if there are situation where the right-of-way capacity is exceeded under a 100 year event, then allowance must be made for major system storage facilities.	Grading Major System	DSEL	Major system analysis demonstrates right of way capacity.
	Comments from City of Ottawa - Memo dated July 6, 2010 from Darlene Conway to Roman Diduch			
85	The developer should refrain from indicating that the use of sump pumps from this development is not an exception from the City's Sewer Design Guidelines. As previously clarified, it is necessary to read the Guideline in its entirety with respect to foundation drainage given there is direction provided in various sections to address specific situations (i.e. infill vs. Greenfield development). Specifically, sections 5.1.4 and 5.7.5 clearly indicate that the level of service expected for Greenfield development is that basement elevations be set at minimum of 0.30m above the 100 year hydraulic grade line. It is because the use of sump pumps in this instance (potentially some 2000 homes in a relatively dense Greenfield development area) is such a departure that sufficient technical and policy analysis must be undertaken to objectively assess whether sump pumps can provide an adequate level of service. Beyond this immediate instance, the implications of such a decision for the remaining (and future, should the urban boundary expand) Greenfield development areas in the City must also be considered.	Sump Pumps	DSEL	Noted.
	In terms of the proposed approach, the following adjustments are required:			
	STEP 1:			
86	i) The initial task, before any consideration of alternatives, must be the determination of the sanitary system hydraulic grade line under conditions of pumping station failure. This represents the minimum elevation below which basements cannot be set and the starting point for any comparison of fill depths resulting form the various alternatives to be considered.	Sump Pumps	DSEL	The entire Village of Richmond is subject to potential sanitary backwater under a catatrophic pump station failure during a 1:100 spring event.
87	ii) The alternatives to be compared should include alternative house design (e.g. reduced basement depth or more basements).	Sump Pumps	DSEL	Slab on grade units have been included in analysis.
88	iii) Prior to assessing Option 4 (foundation drainage via sump pump), there will have to be agreement regarding the minimum level above which basements will be set, at least for the options evaluation (i.e.: in the absence of sufficient field data, consideration will have to be given to a seasonal high water table higher than the April / May 2010 data and will be required to incorporate some buffer or freeboard (both to be determined) above that level.	Sump Pumps	DSEL	Golder to review servicing arrangement.
89	iv) A draft of the proposal evaluation methodology should be provided for review prior to proceeding with comparison of the various options.	Sump Pumps	DSEL	See comments 106 - 110
90	v) The results of Step 1 will be reviewed by the relevant branches within the City and a decision rendered	Sump Pumps	DSEL	See comments 106 - 110
	STEP 2:			
91	i) It is premature to comment on this step until the results from Step 1 are available. However, please note that it is the City's position that a preliminary grading plan cannot be based upon the April/May 2010 monitored groundwater levels. Further to Step 1, item iii), it is almost certain that these levels were measured too late in the season to be representative of the actual seasonal high water table for 2010 (a relatively dry year), let alone a wetter year. Further, it is anticipated there will be a requirement to provide some buffer or freeboard above the (yet to be determined) seasonal high water table.	Sump Pumps	Golder	Golder have collected additional data from 2010, 2011 and 2012 that will be used for the current groundwater modeling assessment.
	STEP 3:			
92	i) To be further discussed / confirmed subject to the outcome of Step 1.			

	Comments from City of Ottawa - Email dated August 5, 2010 from Darlene Conway			
93	Additional items from July 6/10 comments: the sanitary HGL remains to be confirmed and the options should include alternative house design.	Pipes	JFSA	As above.
94	Evaluation approach: see Michel's and Dillon's comments attached (shown below).	Sump Pumps	DSEL	
95	Draft evaluation criteria: In general, it would be helpful if further definition/description of the parameters/indicators were provided. Overall, it is suggested that key issues are not well-captured by the proposed criteria, with some examples provided below:	Sump Pumps	DSEL	Revised criteria matrix to address storm servicing alone.
96	suggest that Natural Environment criteria may be unnecessary/redundant given considerable filling is required for all options (i.e., existing hedgerows may not be preserved under any option?), likewise maintenance of base flow would not appear to differ between options?;	Sump Pumps	DSEL	As above.
97	re: Caring and Healthy Communities: maintaining or improving level of service to existing village residents would not seem relevant to the foundation drainage issue (say, compared to wastewater system upgrades); with respect to impact to private wells – please clarify what is intended by this i.e., are any of the options anticipated to impact private wells?; level of service cannot be maintained or improved (be definition) for *future* residents. Presumably, the intent here is to compare levels of service between options. This needs to be clarified. Clarify what "compatibility with planning and infrastructure policies and guidelines" specifically refers to, i.e., is this intended to capture consistency with the City's Sewer Design Guideline (if yes, weight given to this is very low).	Sump Pumps	DSEL	As above.
98	re: Constructability and Functionality: not clear that the "ability to phase infrastructure to facilitate development phasing" is relevant (i.e., significantly different between options) and/or may need further clarification?;	Sump Pumps	DSEL	As above.
99	re: Cost: what is intended by "cost effective" life cycle and capital costs?	Sump Pumps	DSEL	As above.
100	Overall, the criteria should be tailored to better capture the key issues of risk (consequences of failure), reliability, and impact on existing community (for example, related more explicitly to required fill depths for different options).	Sump Pumps	DSEL	As above.
	Comments from City of Ottawa - Email dated July 30, 2010 from Michael Kearney			
101	I have reviewed the attached Foundation Drainage Evaluation Methodology being proposed by Mattamy. I have considerable issues with Table 1 (Evaluation Decision Matrix). Mattamy proposes to use the same type of grid (with some revisions) that was used for the SMW report and the MSS, but I don't think that these evaluation parameters are appropriate to use in this instance. Furthermore, it is clear that sump pumps present a higher risk to the future residents than the other three options, and this fact is reflected in the Council Motion. What the developer has to demonstrate is that it is "absolutely necessary" to have sump pumps, before we will consider them. Therefore, this places sump pumps is a different category. There should be an evaluation matrix for the first three options; however, only after it has been demonstrated that none of these options are viable can we start looking at the sump pump option. In other words, Mattamy should present a two-step evaluation as follows:	Sump Pumps	DSEL	
102	**Step 1** Evaluation of all the non-sump pump options, which consist of the first three in the attached methodology, plus the alternative house design option. For these options, I recommend that the decision matrix be revised to better reflect Section 1.3 of the City's Sewer Design Guidelines – i.e., the matrix should include "implementation feasibility and economics as well as engineering, environmental, operational, reliability, risk and maintenance issues". The matrix proposed by Mattamy includes some items that are not relevant to the evaluation at hand.	Sump Pumps	DSEL	Various servicing options have been presented with re-submission.

103	**Step 2** Once it has been determined that the first three options are not viable, we will be left with two remaining options: i) Allow the use of sump pumps (only after thorough consideration of risk, and engineering implications) ii) No development (with basements)	Sump Pumps	DSEL	as above.
	I believe that this two-step approach is consistent with the Council Motion.			
	Comments from Dillon Consulting - Memo dated August 3, 2010			
	Basement Elevation Fundamental Design Parameters			
104	We recommend that the City of Ottawa seek clarification from Mattamy relative to several fundamental design parameters affecting basement elevations. These include the proposed basement elevations (including allowance for freeboard) relative to the sanitary system hydraulic gradeline under conditions of pumping station failure, the storm sewer 100 year hydraulic gradeline, and the expected seasonal high water table. All of these represent parameters affecting the minimum basement elevation. We expect that Mattamy's evaluation has already taken these factors into consideration; however, clarification on these matters would assist in any further evaluation of the foundation drainage issue. With respect to the latter factor (seasonal high water table), Mattamy should clarify whether it is intended that the minimum basement elevation be set above the expected high water table (such that foundation drainage would only be required as a failsafe under unusual conditions), or whether the minimum basement elevations would potentially intersect the seasonal high water table (such that foundation drainage systems would be required to function on a routine basis under these conditions).	Sump Pumps	Golder	In traditional City servicing arrangements the underside of footings are typically 0.30m above the sewer obvert, the proposed configuration is a minor modification to the configuration where footings are 0.15m above the storm invert. Situating the underside of footings above the sewer invert will promote the accumulation of groundwater to drain away from the house footings toward the sewer system. The sump pump will be equipped with a swan neck that is 0.30m above the modeled 100-year hydraulic grade line. The elevation of the swan neck provides protection to the homes during significant storm events.
	Foundation Drainage in Areas with Clay Soils			
105	We note that the native overburden materials within most of the area include clay sequences. As such, Mattamy should be requested to include in their evaluation an assessment of the potential for locally elevated groundwater levels adjacent to foundations resulting from more permeable materials comprising the foundation backfill materials (relative to the surrounding native clay materials). These conditions have the potential to result in a "bathtub" effect that can result in significantly higher subsurface water levels (in the absence of effective foundation drainage systems) than would be expected if considering only the normal seasonal high water table.	Sump Pumps	Golder	The volume of water in the “bath tub” would be relatively small. Clay soils are preferable over sandy – more permeable soils in high water table situations, due to the smaller volume of water.
	Evaluation Methodology			
106	With respect to the Evaluation Decision Matrix provided by Mattamy, we question whether this type of evaluation matrix is appropriate for the issue at hand. The evaluation should focus on the issue of the level of service related to the risk of basement flooding as the primary consideration, with consideration of other secondary factors as required. If maintaining this type of matrix approach, the proposed evaluation matrix should be re-evaluated as some of the parameters may not be apt to the review of foundation drainage issues. Specifically, we note the following:	Sump Pumps	DSEL	DSEL has revised this evaulation matrix to consider specifically foundation drainage options only and not placement / situation of stormwater management facilities.
107	The natural environment parameters may not be apt to this evaluation since the only factor being assessed is the means of conveyance of water from the foundations to the storm sewer;	Sump Pumps	DSEL	As requested by the City, Natural enviroment parameters have been excluded from the evaulation of foundation drainage options.
108	Similarly, parameter C4 is of questionable relevance when assessing the means of conveyance of water from the foundations to the storm sewer;	Sump Pumps	DSEL	As requested by the City compatibility to existing community has been removed from the evaluation matrix.
109	Parameter C03 should have significantly higher weighting as this is considered to be a key driver for this issue.	Sump Pumps	DSEL	Weighting of C3 has been increased in the revised evaluation matrix.
110	We also recommend that clarification be sought regarding the parameters related to cost (i.e. that potential costs incurred by all stakeholders would be evaluated, including potential costs under conditions of system failure and an evaluation of the risk of system failure so that the costs can be appropriately discounted).	Sump Pumps	DSEL	Capital cost are considered as those incurred by the developer and ultimately the home owner. Maintenance cost are considered to be those attributed to City of Ottawa and tax payers. Additional attention to maintenance cost has been considered. System failure cost are difficult to assess for each option. Failure is considered under CO6.

111	Lastly, it is recommended that the evaluation methodology be undertaken such that the hierarchy of potential foundation drainage options be taken into account. In this way, the first option to be considered would be that of conventional gravity drainage to the storm sewer (this could include consideration of development options that may permit this to occur, such as development of housing with no basements or crawlspaces only). Other options would only be considered if this option is ruled out. The last option to be considered would be that of foundation drainage using individual sump pumps (if all other options are ruled out). This type of hierarchical evaluation would appear to be consistent with the Council resolution that foundation drainage by sump pumps could comprise a mutually agreeable solution if 'absolutely necessary'.	Sump Pumps	DSEL	The stormwater management report endeavors to review all practical means to provide storm servicing.
	Comments from City of Ottawa - Email from Darlene Conway dated February 3, 2012			
112	Please note that, with respect to C. Major System Capacity and External Drainage, these comments should be addressed as per recent findings/discussions of the Stormwater Subcommittee.	Grading Major System	JFSA	Revised modeling provided accordingly.
113	The final location of the communal well should be confirmed/clearly shown on the revised plans. Also, given the apparent proximity of the well site to Pond 1 and servicing trenches (both of which may extend into the bedrock), recommendations for detailed design should be provided that will ensure the integrity of the well is not compromised (e.g., need for lining, use of pressure pipe for sanitary sewers, etc.).	Pond	DSEL	Design drawings updated accordingly.

APPENDIX B

Geotechnical Report

Jacques Whitford

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PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

Proposed Residential
Subdivision
Perth and Ottawa Streets
Richmond Area
Ottawa, Ontario

Mattamy Homes Ltd.

PROJECT NO. 1026929

Jacques Whitford

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1.0 INTRODUCTION

This report presents the results of the Geotechnical Investigation carried out for the proposed residential subdivision to be located to the west of the Village of Richmond in Ottawa, Ontario. The work was carried out in general accordance with our Proposal Number 1026824, dated June 7, 2007. Authorization to carry out the work was received on June 8, 2007, from Mr. Matthew Kingston of Mattamy Homes – Ottawa Division.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the Geotechnical Investigation and provides preliminary geotechnical recommendations for the design and construction of the residential subdivision.

2.0 PROJECT DESCRIPTION

The project site location is shown on the Key Plan, Drawing No. 1 in Appendix A. The property boundaries are indicated on Drawing No. 2 in Appendix A, and is based on Drawing Reference No. 07-10-724-00 prepared by J.D. Barnes Surveying Limted and dated April 21, 2007.

Although the layout and configuration of the proposed development has not yet been completed, it is anticipated that it will include numerous single family homes and townhouses on a new street network and that the development will be connected to municipal sewer services. Water supply, it is anticipated, will be through individual private wells.

3.0 SITE DESCRIPTION AND BACKGROUND

Geological maps, of the area indicate that the soil conditions vary significantly across the site. Southeast of Ottawa Street, maps indicate that a layer of glacial till is present overlying bedrock at shallow depth. Northwest of Ottawa Street the soil map profile includes sand (beach and reworked glaciofluvial origin) over silts and clays (marine origin) over glacial till. The thickness of the silt and clay layer increase along with depth to bedrock from southeast to northwest with total overburden thickness estimated to be as much as 10 m at the northwest limit of the site.

The subject site is approximately 300 acres in area and includes nine parcels of land. The site is roughly rectangular, 600 m wide and 2500 m long, with the long axis oriented northwest to southeast. The eight parcels include PINS 0062 and 0061 to the north of Perth Street, 0285, 0286, 0287 and 0714 between Perth and Ottawa Street and the Jock River and PIN 0075 on the southeast side of the Jock River.

The site is primarily used as an agricultural field. The Jock River crosses the southern end of the site. The layout of the site is shown on Drawing No. 2 in Appendix A.

The slopes adjacent to the Jock River are indicated in Ontario Geological Society Paper MP68 to have a Factor of Safety of 2.0 to 2.5 which indicates that only routine inspection will be necessary to determine the need and extent of a geotechnical investigation.

4.0 SCOPE OF WORK

Due to time constraints the scope of work for the project is divided into two phases; the Due Diligence Phase (Preliminary Phase) and Detailed Design Phase. The work completed for this report was conducted as part of the Due Diligence Phase. The scope of for each phase is summarized below:

Due Diligence Phase (Preliminary Phase)

- Field investigation
- Laboratory testing
- Prepare an initial due diligence report which will includes a test hole location plan, draft test hole logs and discussion of the geotechnical constraints to residential development of the site.

Detailed Design Phase

- Design discussions with the project team.
- Prepare a detailed geotechnical design report for the project. The report will include test hole location plan, test hole logs and recommendations for the detailed design of the development. The report will reflect the discussions from the other members of the design team including the proposed grading and layout of the subdivision.

The present report is the due diligence report. Further discussion and analysis will be carried out prior to presenting a final report for the proposed development.

Jacques Whitford is also conducting a Phase I Environmental Site Assessment (ESA) for the site. The results of the Phase I ESA are reported separately.

5.0 METHOD OF INVESTIGATION

5.1 Geotechnical Field Investigation

Prior to carrying out the investigation, Jacques Whitford staked out the proposed borehole locations and made arrangements to identify and clear the locations of underground utilities. The drain tile system that is present on the site could not be accurately located in the field. The drain tile system was encountered and may have been damaged at test pit locations TP07-10, TP07-22 and TP07-23.

Between June 14 and 20, 2007, test holes numbered BH 07-1 to TP 07-72 were advanced at the approximate locations shown on Drawing No. 2 in Appendix A. Several parcel's of the originally planned project site were eliminated from the scope of work, therefore test holes at locations BH 07-4, CPT 07-8, TP 07-12 and BH 07-16 were dropped after initiation of the project.

The test holes consisted of boreholes, Seismic Piezocone Penetration Tests, test pits and hand auger holes.

Boreholes

The boreholes were advanced using a track mounted CME power drill and hollow stem augers. Soil samples were collected at close intervals using a split spoon sampler while conducting standard penetration testing (SPT). Several relatively undisturbed samples of cohesive materials were acquired by pushing thin-walled samplers (Shelby tubes). The undrained shear strength of cohesive soils was measured in the boreholes by carrying out vane shear and pocket penetration tests. The boreholes were backfilled with auger cuttings.

Seismic Piezocone Penetration Test (SCPTu)

The Seismic Piezocone (SCPTu) tests consisted of pushing an instrumented rod with a cone-shaped tip into the ground at a controlled rate (20 mm/s) using the hydraulics of the CME power auger drill. The device contains electronic sensors that measure tip resistance, sleeve friction and pore .water pressure at very short intervals in order to provide a near continuous profile. These measurements can be used to assess a wide variety of engineering properties of the subsurface soils. The equipment standards and test procedures are outlined in ASTM D5779-95. Seismic cone tests were also conducted at 1.0 m intervals to estimate the shear wave velocity of the soil.

When performing a seismic evaluation, the cone contains a built in geophone to measure compression and shear wave velocities in addition to the standard piezocone parameters. The seismic soundings were performed approximately at 1 m intervals.

During the seismic soundings, shear waves are generated by striking the seismic beam using a sledgehammer. The seismic beam is placed under the rear stabilizers of the drill rig and secured to the ground surface by using the weight of the drill. Seismic triggers are attached to this seismic beam, which initiate the recording of the seismic wave trace.

Geophones in the body of the piezocone recognize the arriving waves generated at the ground surface. Any waves received by the geophones on the cone penetrometer are sent back up to the control unit to be displayed on an oscilloscope. On site software then plots the wave amplitude versus time to calculate wave velocities.

For this assignment the piezocone testing also included several pore water pressure dissipation tests.

Test Pits

The test pits were excavated with rubber tired backhoes. Samples of all soil types were acquired from test pit walls. The test pits were backfilled with the excavated materials.

Hand Auger Holes

Access restrictions in the south east corner of the site prevented the use of mechanized equipment. Soil conditions were evaluated based on hand auger holes.

The subsurface stratigraphy encountered in each test hole was recorded in the field by our personnel. All samples recovered were stored in moisture-proof bags and were returned to our laboratory for detailed classification and testing.

Monitoring wells and standpipes were installed in several locations to allow for the measurement of groundwater levels. Groundwater levels were measured on June 20, 2007.

5.2 Survey

Prior to the fieldwork, the borehole locations were established in the field by Jacques Whitford personnel. The ground surface elevations at the test hole locations were surveyed relative to a temporary benchmark with an assigned elevation of 100.00 m Local. The temporary benchmark was established on the top of the concrete base of a light pole located on the north side of Perth Street. The location of the temporary benchmark is shown on Drawing 2 in Appendix A.

5.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual examination and additional classification by a geotechnical engineer. Selected samples were tested for moisture content, organic content, particle size gradation and Atterberg Limits. Results of this testing are shown on the Borehole Records and in Appendix D. Consolidation testing on two relatively undisturbed samples and some classification testing is currently underway. The results will be forwarded when they become available.

Samples will be stored for a period of one (1) month after issuance of this report unless we are otherwise directed by the client.

6.0 RESULTS OF INVESTIGATION

6.1 Site Description

The site is primarily used as an agricultural field. Some trees and brush were noted at localized areas throughout the site. Denser trees and brush are present in the vicinity of Jock River. A fill pile was observed near the south side of Ottawa Street. The approximate location of the fill pile, trees and brush are indicated on Drawing No. 2 in Appendix A.

A large drainage ditch is located near the northeast corner of the site. Steel corrugated pipe culvert provides access over the drainage ditch. A second drainage ditch which outlets to the Jock River runs through the southern parcel of land. The approximate locations of the ditches are indicated on Drawing No. 2 in Appendix A.

The slopes adjacent to the Jock River are heavily covered in trees and brush. The slopes heights were visually estimated to be less than 3 m in height and are sloped at angles shallower than 2H:1V.

6.2 Subsurface Information

In general, the subsurface profile changes significantly across the site.

Drawings 3 and 4 in Appendix A present plan summaries of the Estimated Thickness of the Clay Deposit and the Estimated Depth to Bedrock Respectively. Drawing No. 5 in Appendix A presents two stratigraphic plots across the site.

PIN 04437-0062, 0061, PIN 03933-0285, 0286

Within these parcels of land, the soils consist of a thick deposit of clay overlying a till deposit overlying inferred bedrock. Bedrock is anticipated at depths in excess of 6 m below ground surface to the north of Perth Street and becoming shallower to the south of Perth Street. The estimated thickness of the clay deposit and the depth to inferred bedrock are shown on Drawings No. 3 and 4, respectively.

PIN 03933-0287

Within this parcel of land the soils consist of a thin deposit of clay overlying a sandy silt deposit over a till deposit over inferred bedrock. Bedrock is anticipated at depths between 3 m to 4 m below ground surface. The estimated thickness of the clay deposit and the depth to inferred bedrock are shown on Drawings No. 3 and 4, respectively.

PIN 03933-0714 and PIN 03933-0746, 0047, 0075

Within these parcel's of land the soils consist of a deposit sandy silt over a till deposit over inferred bedrock. Bedrock is anticipated at depths greater than 4 m to less than 1 m below ground surface. The depth to inferred bedrock is shown on Drawing No. 4.

The subsurface conditions observed in the test holes are presented in detail on the Test Hole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided. The result of the Seismic Piezocone Tests is provided in Appendix C.

A summary of the observed subsurface conditions is presented below.

6.2.1 Surficial Materials

Topsoil was encountered in the majority of the test pits and boreholes and was observed to range from 0 mm to 300 mm in thickness. Two organic content tests were conducted on grab sample from test pits the results will be provided when testing is complete.

6.3 Clay (CL)

Borehole and Test Pit Results

Beneath the surficial materials a clay deposit was encountered across the majority of the northern half of the site. The upper 2 m to 3 m of clay was greyish brown and had a stiff to firm consistency. This upper clay layer is commonly referred to as a "crust". Several pocket penetration tests and in-situ shear tests were conducted on the clay crust; the result indicated shear strength between 48 kPa to greater than 160 kPa. The moisture content of the crust samples tested ranged from 23% to 53%.

Beneath the crust, the clay was grey and firm as indicated by the measured in-situ shear strength which varied from 20 kPa to 53 kPa. The moisture content of the clay samples tested ranged from 38% to 65%. Soil gradation test results are presented in Appendix D.

The clay can be classified as a lean clay (CL) in accordance with the Unified Soil Classification System (USCS).

The results of consolidation testing are not yet available and will be forwarded upon completion of the tests.

Seismic Piezocone Penetration Test (SCPTu)

The SPCTu tests classify the deposit as clays and organics. The results are presented in Appendix C.

Pore pressure dissipation tests were conducted within the SCPTu. The results of the pressure dissipation tests will be presented at the detailed design stage. The results of the SCPTu tests are presented in Appendix C.

6.4 Sandy Silt (ML)

Borehole and Test Pit Results

Beneath the surficial materials or clay a deposit of sandy silt with variable quantities of gravel was encountered. The deposit was generally encountered to the south of Perth Street. The color of the deposit was brown changing to grey with depth. The deposit was generally loose to compact as indicated by the SPT 'N" values which ranged from 1 to 37.

The moisture content of the samples tested ranged from 13 % to 37%. Soil gradation test results are presented in Appendix D. This material can be classified as sandy silt (ML) in accordance with the Unified Soil Classification System (USCS).

Seismic Piezocone Penetration Test

The SCPTu test classifies the deposit as sands and silt mix. The test results are presented in Appendix C.

6.5 Silty Sand (SM)

Borehole and Test Pit Results

A deposit of silty sand with variable quantities of sand and silt was encountered. The deposit was generally encountered near the Jock River. The color of the deposit was brown changing to grey with depth. The deposit was generally compact based on visual observation during the excavation of the test pits.

Soil gradation test results are presented in Appendix D. This material can be classified as sandy silt (SM) in accordance with the Unified Soil Classification System (USCS).

Seismic Piezocone Penetration Test

The SCPTu test was not conducted in this deposit.

6.6 Glacial Till

Borehole and Test Pit Results

Beneath the sandy silt and silty sand deposits a glacial till was observed. The till consists of a variable mixture of silt, sand and gravel with frequent cobbles and boulders. The deposit was generally compact to dense based on visual observation during the excavation of the test pits.

The moisture content of the samples tested ranged from 8 % to 20%. Wash sieve analysis are presented in Appendix D. This material can be classified as sandy silt (ML) in accordance with the Unified Soil Classification System (USCS).

Seismic Piezocone Penetration Test

The SCPTu was not conducted in this deposit.

6.6.1 Inferred Bedrock

Inferred bedrock was encountered at multiple test locations. The inferred bedrock was based on auger refusal, refusal of the back hoe bucket and refusal of the SCPTu. Table 6.1 summarizes the depth to inferred bedrock and Drawing No. 4 in Appendix A visually presents the bedrock depths inferred across the site.

Table 6.1: Summary of Depth to Bedrock

Test Hole Location	Depth to Inferred Bedrock Measured from Ground Surface (m)
MW 07-18	5.9
BH 07-21	5.3
TP 07-23	4.2
TP 07-24	4.3
MW 07-25	4.8
TP 07-26	4.4
BH 07-27	3.6
BH 07-28	3.9
TP 07-29	3.8
MW 07-30	3.9
TP 07-31	3.8
TP 07-32	3.5
TP 07-33	4.0
TP 07-34	3.6
MW 07-37	3.4
TP 07-36	2.9
TP 07-39	2.9
TP 07-40	1.9
TP 07-41	2.2
TP 07-42	3.3
TP 07-44	2.3
TP 07-45	2.9
TP 07-46	4.0
TP 07-48	3.6
TP 07-49	2.0
TP 07-50	3.8
TP 07-57	0.2
TP 07-58	0.9
TP 07-59	0.5
TP 07-60	1.9
TP 07-61	0.6
TP 07-62	0.7
TP 07-63	0.4
TP 07-64	3.5
TP 07-65	2.9
TP 07-67	1.6
TP 07-71	0.6
TP 07-75	3.5

Table 7.1: Preliminary Grade Raise Restrictions

Site Area	Maximum Grade Raise above Existing Site Grades (m)
0062, 0061; north of Perth Street	1.0
PIN 0285, 0286; parcel to the south of Perth Street	1.5
PIN 0287; parcel north of Ottawa St.	2.0
PIN 0714, 0746, 0047, 0075; parcel north and south of Ottawa St.	4.0

- Shallow bedrock was encountered within the southern half of the site. It is anticipated that bedrock excavation for underground services and building foundations will be required in the area south of Ottawa Street. Estimated depths to inferred bedrock are presented on Drawing No. 4 in Appendix A.

- The soil conditions encountered are suitable for the use of conventional spread and strip footings for the support of structures. Table 7.2 provides Geotechnical Bearing Resistance Values for Preliminary Design purposes. The values have been calculated assuming no modifications to existing grades, a footing depth of 2.4 m below finished grade with an embedment of 0.5 m and a footing width of 0.8 m.

Table 7.2: Geotechnical Resistance for Shallow Foundations

Site Area	Founding Material	ULS (kPa)	SLS (kPa)
PIN 0062, 0061	Firm Clay	125	100
PIN 0285, 0286	Firm Clay	125	100
PIN 0287	Dense sandy silt	300	150
PIN 0714, 0746, 0047, 0075	Dense sandy silt, glacial till	300	150
PIN 0714, 0746, 0047, 0075	Bedrock	500	NA

The Ultimate Limit State (ULS) bearing resistance includes a resistance factor of 0.5. The Serviceability Limit State (SLS) bearing resistance corresponds to total settlement of 25 mm. Differential settlements between footings are expected to be less than 19 mm.

Note that settlement estimates are highly dependent on grade changes. The geotechnical resistance values will need to be reviewed in conjunction with the proposed grading plan.

- The groundwater table was observed to be relatively high. Grade reductions may lead to drainage concerns.

- Several test pits were terminated between 3 m to 4 m below ground surface within the sandy silt deposit due to side wall collapse and groundwater seepage. Excavations below the groundwater level may require shoring protection or special dewatering treatments.
- Several ditch's may require backfilling and the water courses may need diverting.
- In accordance with Table 4.1.8.4.A. of the 2006 Ontario Building Code, the project site is considered to be classified under several site classifications for seismic site response. Table 7.3 summarizes the appropriate site classification for the various parcels of land.

Table 7.3: Site Classification for Seismic Site Response

Parcel of Land	Ground Profile Name	Site Class
PIN 0062, 0061,0285, 0286	Soft Soil	E
PIN 0287, 0714	Stiff Soil	D
PIN 0746, 0047, 0075	Very Dense Soil and Soft Rock	C

- Table 7.4 summarizes the possible re-uses of site generated materials.

Table 7.4: Suitable Re-uses for Site Generated Materials

Soil Deposit	Exterior Foundation Wall Backfill	Subgrade Fill	Landscaping Fill
Clay Crust		X	X
Clay			X
Sandy Silt, Silt,			X
Glacial Till, Silty Sand	X	X	X
Crushed Bedrock	X	X	X

8.0 CLOSURE

This report has been prepared for the sole benefit of Mattamy Homes Ltd and its agents, and may not be used by any third party without the express written consent of Jacques Whitford Limited and Mattamy Homes Ltd. Any use which a third party makes of this report is the responsibility of such third party.

The recommendations made in this report are in accordance with our present understanding of your project. We request that we be permitted to review our recommendations when your drawings and specifications are complete.

This report is based on the site conditions encountered by Jacques Whitford at the time of the work, and at the specific testing and/or sampling locations, and can only be extrapolated to a limited extent around these locations. The extent depends on the variability of soil and groundwater conditions as influenced by geological processes, construction activities and site use. Should any conditions at the site be encountered which differ from those at the test locations, we require that we be notified immediately in order to permit reassessment of our findings.

We trust the above meets your present requirements. Should you require any further information please do not hesitate to contact us.

Yours very truly,

JACQUES WHITFORD LIMITED

DRAFT

Christopher McGrath, P.Eng.
Project Manager

DRAFT

Fred J. Griffiths, Ph.D., P.Eng.
Principal and Group Leader
Geotechnical and Materials Engineering

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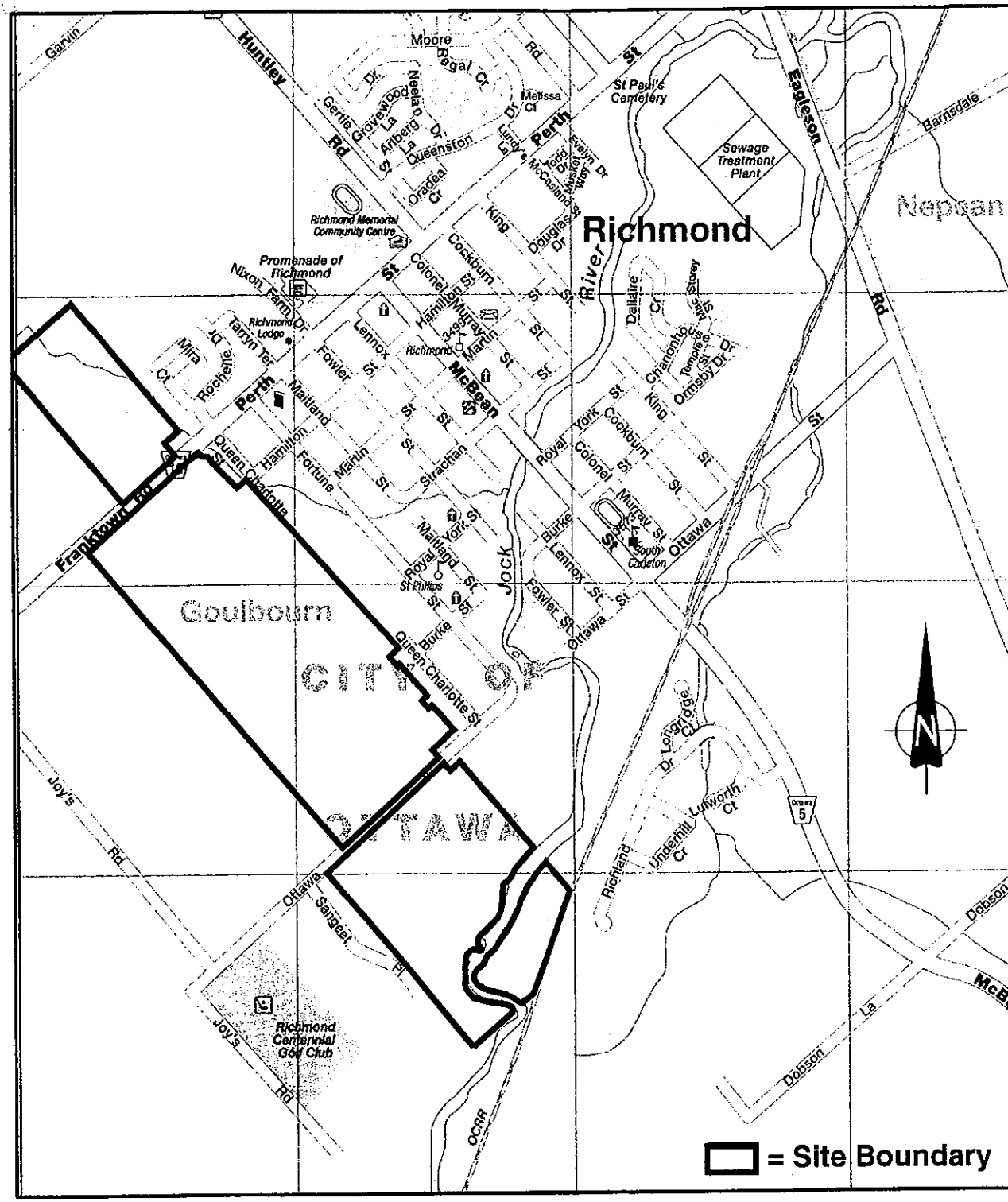
APPENDIX A

Drawing No. 1 - Key Plan
Drawing No. 2 - Test Hole Location Plan
Drawing No. 3 - Estimated Thickness of Clay Deposit
Drawing No. 4 - Inferred Depth to Bedrock
Drawing No. 5 – Stratigraphic Plot
Drawing No. 6 – Stratigraphic Plot

Jacques Whitford



REFERENCE: MAPART

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A JACQUES WHITFORD LIMITED REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

KEY PLAN GEOTECHNICAL INVESTIGATION FOR RESIDENTIAL SUBDIVISION PERTH & OTTAWA STREETS, OTTAWA, ON.	Job No.: 1026929	Dwg. No.:	Jacques Whitford
	Scale: 1 : 20 000	1	
	Date: 07/06/21		
	Dwn. By: GBB		
Client: MATTAMY HOMES	App'd By:		

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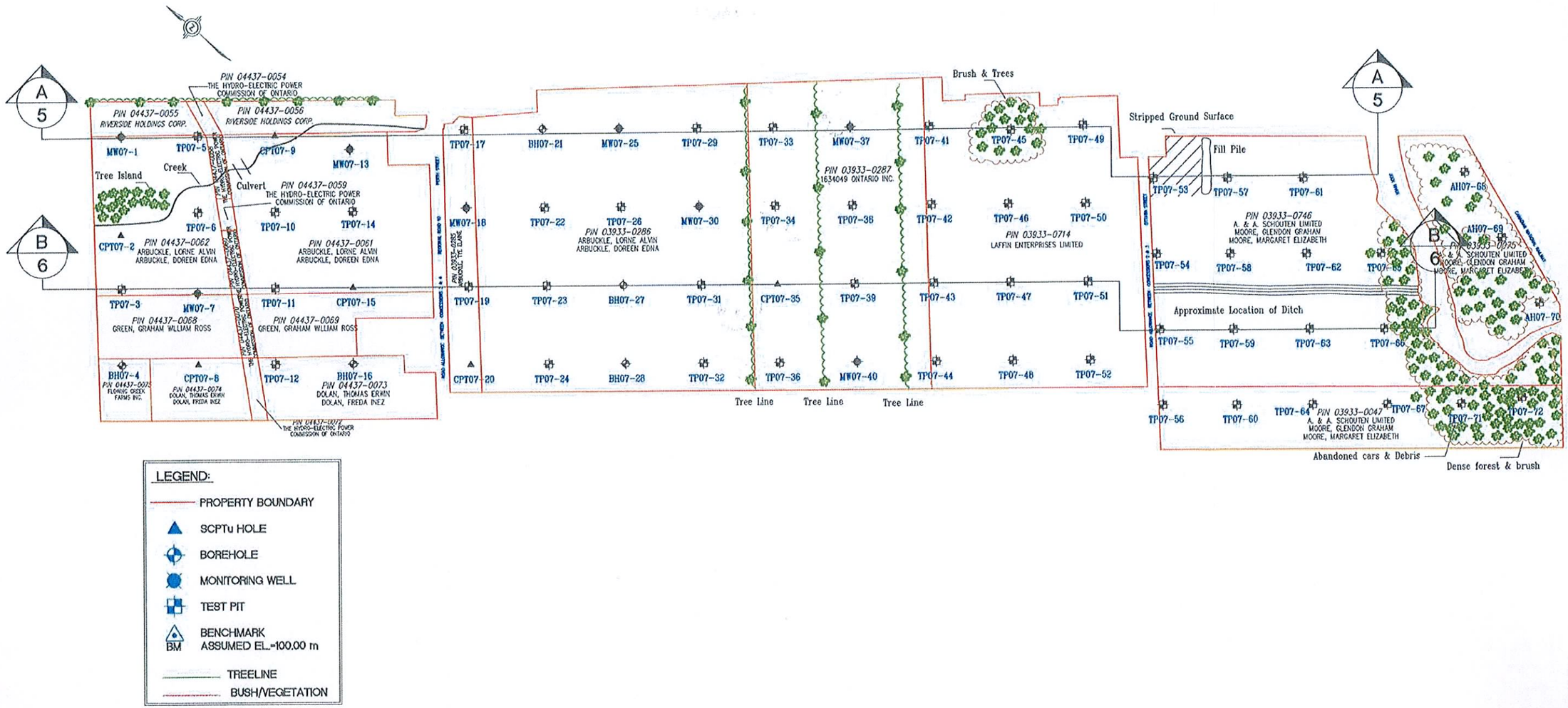

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Reference:	Job No.:	1026929	Client:	GEOTECHNICAL INVESTIGATION FOR RESIDENTIAL SUBDIVISION	TEST HOLE LOCATION	Dwg. No.:
Baseline Provided by J.D. Barnes Ltd. Dwg. No. 07-10-724-00 Date: April 21, 2007	Scale:	1 : 8000	MATTAMY HOMES			2
	Date:	07/06/22	Site Address VILLAGE OF RICHMOND OTTAWA, ONTARIO			
	Dwn. By:	EAG				
	App'd By:					

Jacques Whitford

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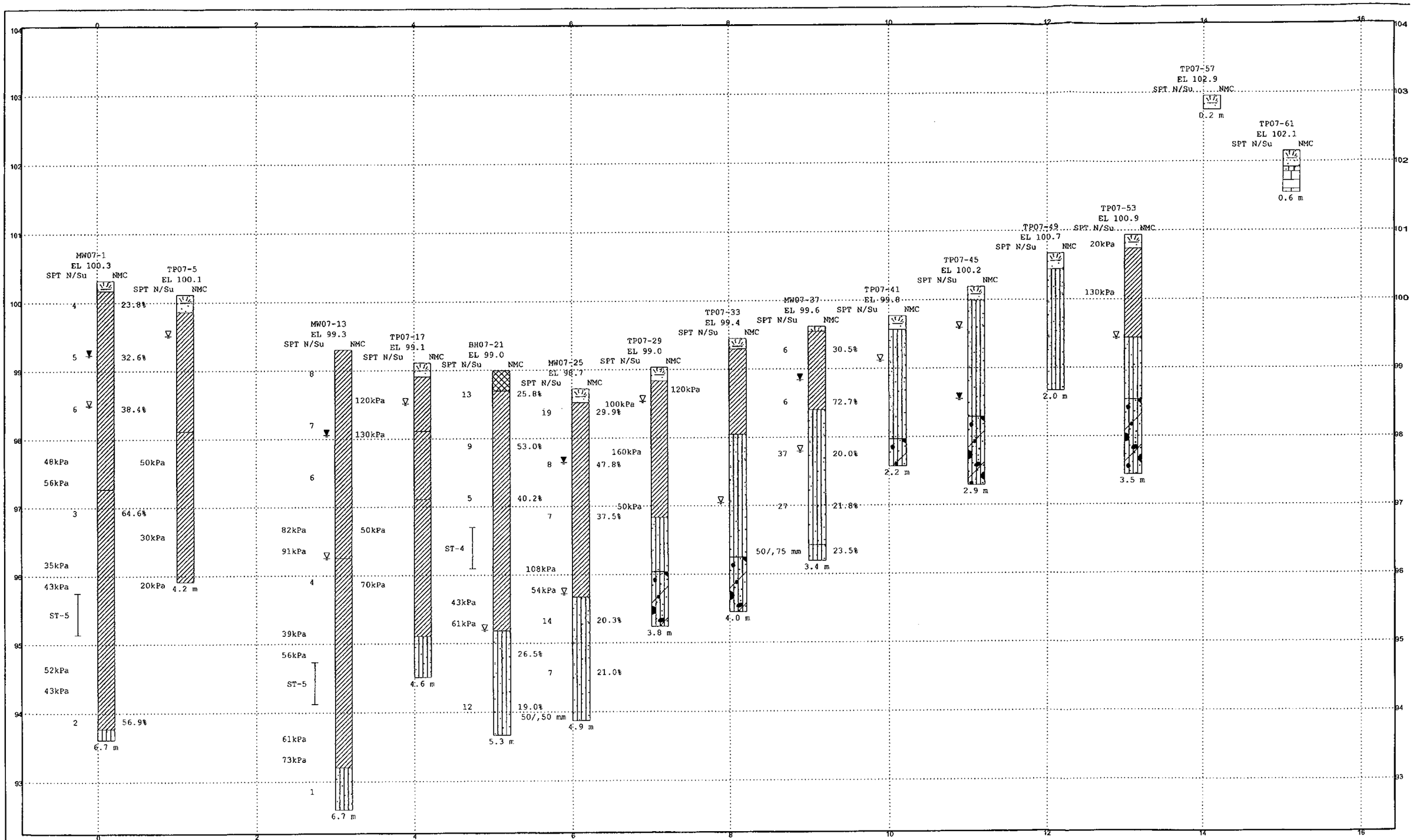


SOIL & ROCK KEY

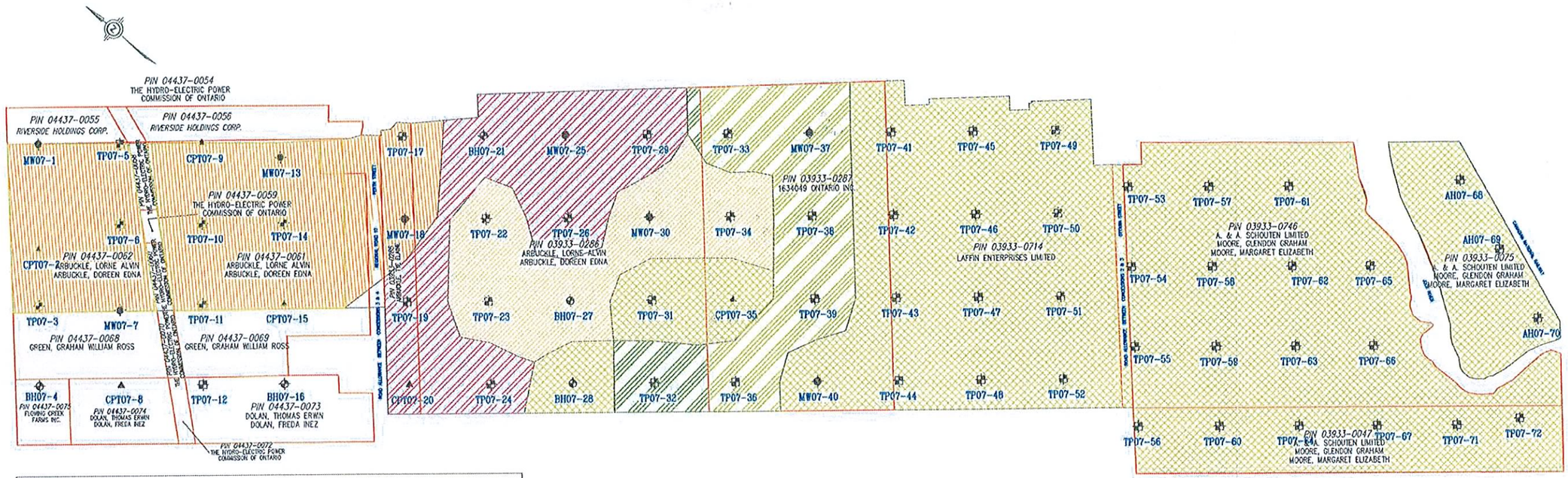
BOULDERS, COBBLES & GRAVELS | SAND & GRAVEL | SAND | SILTY SAND | SILT | CLAY | SILTY CLAY | TILL | FILL | ORGANICS | SHALE BEDROCK | LIMESTONE BEDROCK | SANDSTONE BEDROCK

Jacques Whitford
2781 Lancaster Road,
Ottawa, Ontario K1B 1A7

Title: Summary of Test Hole Data
Mattamy Homes, Village of Richmond
Cross Section A

Figure No. 5

Drawn: BDG | Approved: FG | Date: 07/06/22 | Job No. 1026929



LEGEND:

ESTIMATED THICKNESS OF CLAY DEPOSIT	
> 4 m in thickness	
3 m to 4 m	
2 m to 3 m	
1 m to 2 m	
No clay	

PROPERTY BOUNDARY
BCPTu HOLE
BOREHOLE
MONITORING WELL
TEST PIT
BENCHMARK (TOP OF FIRE HYDRANT) ASSUMED EL.=100.00 m

Notes :

-The thicknesses are inferred from the test hole results.

-Conditions between test holes could very from those encountered at the test hole.

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A JACQUES WHITFORD LIMITED REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:	Job No.: 1026929	Client: MATTAMY HOMES	GEOTECHNICAL INVESTIGATION FOR RESIDENTIAL SUBDIVISION	ESTIMATED THICKNESS OF CLAY DEPOSIT	Dwg. No.: 3	Jacques Whitford
Baseline provided by J.D. Barnes Ltd. Dwg No. 07-10-724-00 Date: April 21, 2007	Scale: 1 : 8000					
	Date: 07/06/22	Site Address VILLAGE OF RICHMOND OTTAWA, ONTARIO				
	Dwn. By: EAG					
	App'd By:					

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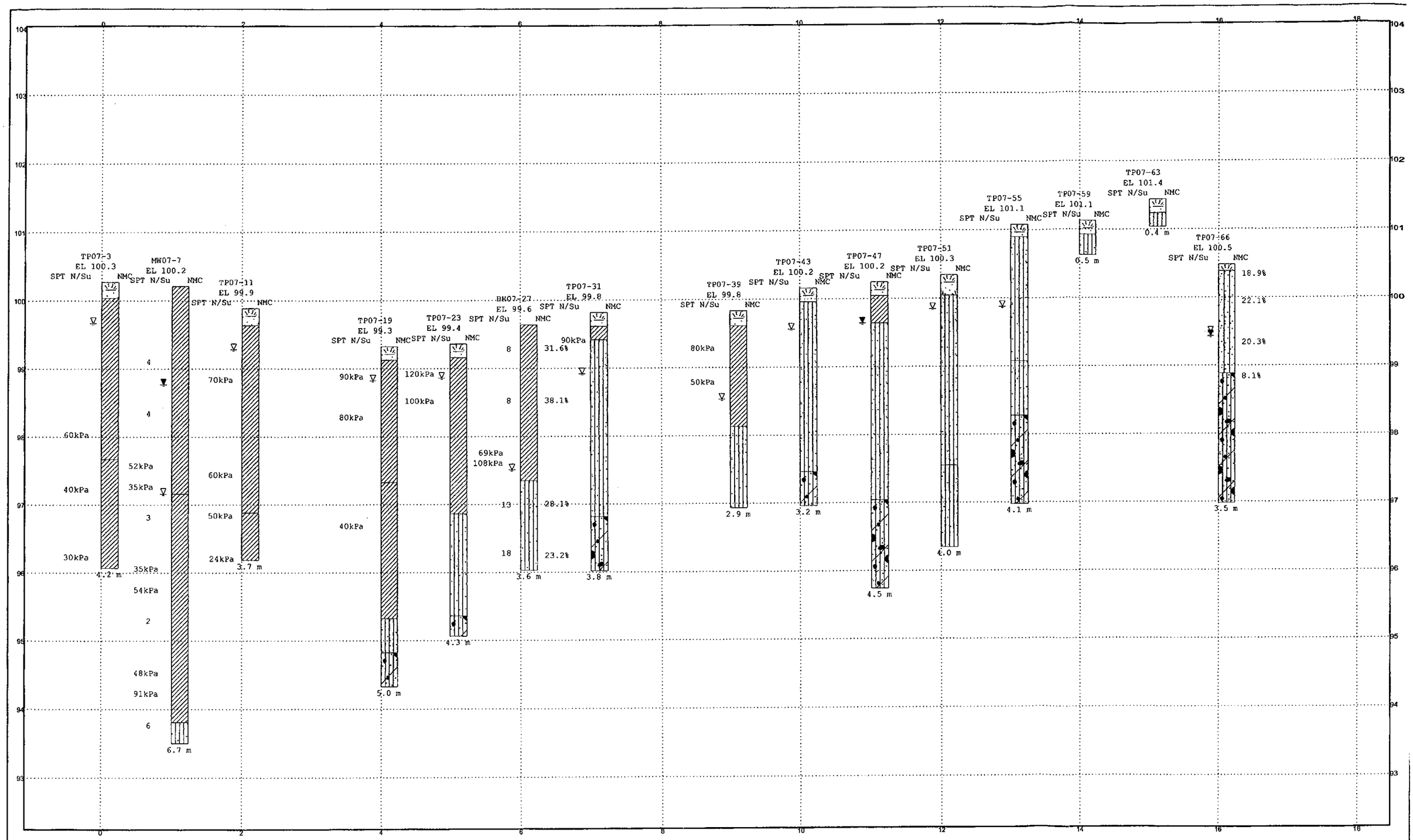


SOIL & ROCK KEY

BOULDERS, COBBLES & GRAVELS	SILTY SAND	TILL	SHALE BEDROCK
SAND & GRAVEL	SILT	FILL	LIMESTONE BEDROCK
SAND	CLAY		SANDSTONE BEDROCK
	SILTY CLAY	ORGANICS	

Jacques Whitford
2781 Lancaster Road,
Ottawa, Ontario K1B 1A7

Title: Summary of Test Hole Data
Mattamy Homes, Village of Richmond
Cross Section B

Figure No. 6

Drawn: BDG | Approved: FG | Date: 07/06/22 | Job No. 1026929

APPENDIX B

Symbols and Terms Used on the Borehole Records
Borehole and Test Pit Records

Jacques Whitford

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE / RQD

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log. RQD is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability. Soil type may be inferred from adjacent boreholes and test pits.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

Jacques Whitford

MONITORING WELL RECORD

MW07-1

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-1

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.32							
	100.2	150 mm TOPSOIL						
		Firm to stiff, greyish brown lean CLAY (CL)			SS	1	300	4
1				▼	SS	2	610	5
2				▽	SS	3	610	6
3	97.3							
		Firm to stiff, grey lean CLAY			SS	4	610	3
4								
5					ST	5	610	
6								
	93.8				SS	6	610	2
	93.6	Very loose, grey SANDY SILT (ML)						
7		End of Borehole						
		Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

Jacques Whitford

TEST PIT RECORD

TP07-3

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-3

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	100.27							
0	100.0	230 mm TOPSOIL						
		Stiff, greyish brown lean CLAY (CL)		∇				
1					BS	1		
2					BS	2		
	97.7							
		Firm, grey lean CLAY (CL)						
3					BS	3		
4	96.1				BS	4		
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

BOREHOLE RECORD

BH07-4

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING _____ WATER LEVEL _____

BOREHOLE No. BH07-4

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		Borehole was not drilled						
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

Jacques Whitford

TEST PIT RECORD

TP07-5

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-5
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	100.11							
0	99.9	250 mm TOPSOIL			BS	1		
		Stiff, greyish brown lean CLAY (CL)		▽				
1					BS	2		
	98.1				BS	3		
2		Firm, grey lean CLAY (CL)						
					BS	4		
3					BS	5		
4	95.9				BS	6		
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-6

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-6
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.85							
	99.6	250 mm TOPSOIL						
		Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	1		
1					BS	2		
2	97.9	Firm, grey lean CLAY (CL)			BS	3		
3					BS	4		
4	95.6				BS	5		
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-7

CLIENT Mattamy Homes

BOREHOLE No. MW07-7

LOCATION Proposed Subdivision, Richmond, ON

PROJECT No. 1026929

DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.21							
		Firm to stiff, greyish brown lean CLAY (CL)						
1					SS	1	610	4
				▼				
2					SS	2	610	4
3	97.2			▽				
		Firm to stiff, grey lean CLAY			SS	3	610	3
4								
5					SS	4	610	2
6	93.8							
	93.5	Loose, grey SANDY SILT (ML)			SS	5	150	6
7		End of Borehole Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-10

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-10
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.69							
	99.4	250 mm TOPSOIL			BS	1		
		Stiff, greyish brown to grey lean CLAY (CL)		▽	BS	2		
1					BS	3		
2	97.7	Firm, grey lean CLAY (CL)			BS	4		
3					BS	5		
4					BS	6		
	95.0				BS	7		
5		End of Borehole						
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-11

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-11
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	99.89							
0	99.6	250 mm TOPSOIL						
		Stiff, brown and grey lean CLAY (CL)		∇	BS	1		
1					BS	2		
2					BS	3		
	96.9				BS	4		
3		Firm, grey lean CLAY (CL)						
	96.2				BS	5		
		End of Borehole						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-12

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING _____ WATER LEVEL _____

BOREHOLE No. TP07-12

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD	UNDRAINED SHEAR STRENGTH - kPa (50, 100, 150, 200) / WATER CONTENT & ATTERBERG LIMITS (W_P W W_L) / DYNAMIC PENETRATION TEST, BLOWS/0.3m (★) / STANDARD PENETRATION TEST, BLOWS/0.3m (●) (10, 20, 30, 40, 50, 60, 70, 80, 90)
0		Test pit was not excavated							
1									
2									
3									
4									
5									
6									

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

Jacques Whitford

MONITORING WELL RECORD

MW07-13

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-13
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.30	Stiff, greyish brown lean CLAY (CL)			SS	1	120	8
1				▼	SS	2	75	7
2					SS	3	610	6
3	96.3	Firm to stiff, grey lean CLAY		▽	SS	4	40	4
5					ST	5	610	
6	93.2							
		Very loose, grey SANDY SILT (ML)			SS	6	300	1
	92.6	End of Borehole						
7		Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-14

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-14
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.65							
	99.4	230 mm TOPSOIL						
	99.3	Compact to dense, greyish brown clayey silty sand		▽	BS	1		
		Stiff, greyish brown lean CLAY (CL)			BS	2		
1					BS	3		
	97.7							
2		Firm, grey lean CLAY (CL)			BS	4		
3					BS	5		
4					BS	6		
	95.5							
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

BOREHOLE RECORD

BH07-16

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING _____ WATER LEVEL _____

BOREHOLE No. BH07-16
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		Borehole was not drilled						
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd _____
Date _____

Jacques Whitford

TEST PIT RECORD

TP07-17

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-17
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.11							
	98.9	200 mm TOPSOIL						
		Very stiff, brown lean CLAY (CL)		▽	BS	1		
					BS	2		
1	98.1	Stiff, greyish brown lean CLAY (CL)			BS	3		
	97.1				BS	4		
2		Firm, grey lean CLAY (CL)			BS	5		
3					BS	6		
4	95.1	Dense, grey SANDY SILT (ML)			BS	7		
	94.5	End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-18

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-18

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.19							
		Firm to stiff, greyish brown lean CLAY (CL)			SS	1	190	7
1					SS	2	420	9
2	97.1				SS	3	520	8
		Firm to stiff, grey lean CLAY (CL)						
3					SS	4	610	7
4	94.6							
		Loose to compact, grey SANDY SILT (ML)			SS	5	520	12
5	93.4				SS	6	350	6
6	93.2	Loose, grey silty sand with gravel: TILL (SM)						
		End of Borehole						
7		Auger Refusal on Inferred Bedrock						
		Monitorng Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

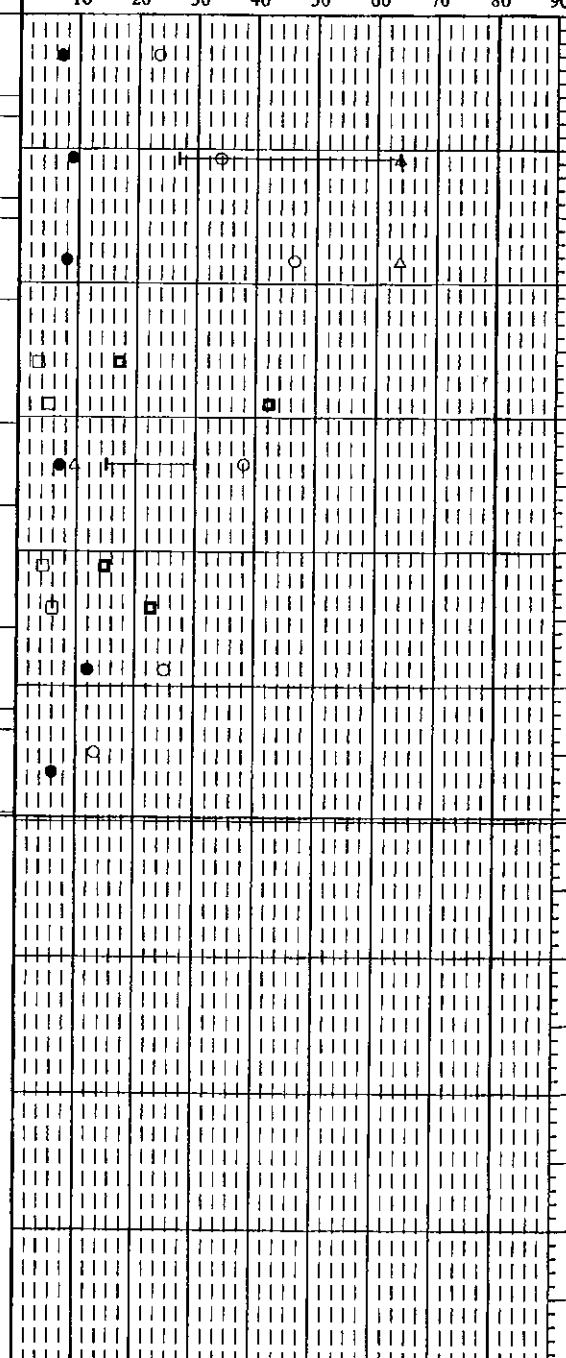
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-19

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-19
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.33							
	99.1	200 mm TOPSOIL						
		Stiff, greyish brown lean CLAY (CL)		▽	BS	1		
1					BS	2		
	97.3				BS	3		
2		Firm, grey lean CLAY (CL)			BS	4		
3					BS	5		
					BS	6		
4	95.3	Dense, grey SANDY SILT (ML)			BS	7		
	94.8	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	8		
5	94.3	End of Borehole						
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

BOREHOLE RECORD

BH07-21

CLIENT Mattamy Homes — BOREHOLE No. BH07-21

LOCATION Proposed Subdivision, Richmond, ON — PROJECT No. 1026929

DATES: BORING June 15, 2007 — WATER LEVEL — DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	98.99							
0	98.7	Loose brown sandy silt, some gravel, occasional cobbles: FILL			SS	1	100	13
		Firm to stiff, greyish brown lean CLAY (CL)			SS	2	280	9
1					SS	3	610	5
2					ST	4	620	
3	95.2			▽				
		Compact, grey SANDY SILT (ML)			SS	5	150	
4					SS	6	360	12
5	93.7							
		End of Borehole Auger Refusal on Inferred Bedrock						
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa — App'd

△ Pocket Penetrometer Test, kPa — Date

Jacques Whitford

TEST PIT RECORD

TP07-22

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-22
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.23							
	99.0	200 mm TOPSOIL			BS	1		
		Stiff, greyish brown lean CLAY (CL)			BS	2		
1					BS	3		
2	97.0			▽				
		Dense, grey SANDY SILT (ML)			BS	4		
3					BS	5		
					BS	6		
4	95.2	End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-23

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-23
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.36							
	99.2	200 mm TOPSOIL						
		Very stiff, greyish brown lean CLAY (CL)		▽	BS	1		
					BS	2		
1								
					BS	3		
2								
	96.9							
		Compact to dense, grey and brown SANDY SILT (ML)			BS	4		
3					BS	5		
					BS	6		
4	95.4							
	95.1	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	7		
		End of Borehole						
		Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

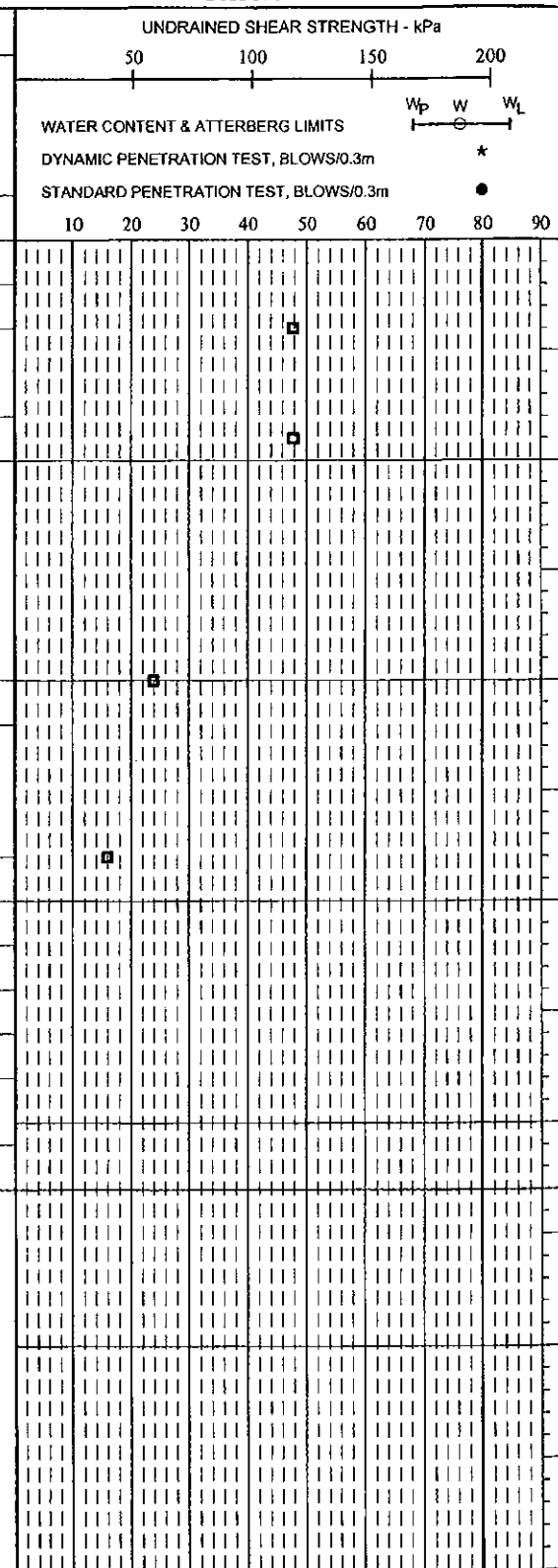
TEST PIT RECORD

TP07-24

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-24
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	99.94							
0	99.7	200 mm TOPSOIL			BS	1		
		Very stiff to stiff, greyish brown lean CLAY (CL)		▽	BS	2		
					BS	3		
1								
2					BS	4		
	97.4	Firm, grey lean CLAY (CL)			BS	5		
3	96.9	Compact to dense, grey SANDY SILT (ML)						
	96.6	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
					BS	7		
4	95.6				BS	8		
		End of Borehole Refusal on Inferred Bedrock						
5								
6								



▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-25

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-25

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	98.72							
0	98.5	200 mm TOPSOIL						
		Firm to stiff, greyish brown lean CLAY (CL)			SS	1	320	19
1				▼	SS	2	610	8
					SS	3	610	7
2								
3	95.7			▽				
		Loose to compact, SANDY SILT (ML)			SS	4	610	14
4					SS	5	450	7
	93.9				SS	6	150	50/ 50 mm
5		End of Borehole						
		Auger Refusal on Inferred Bedrock						
6		Monitoring Well Installed						
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-26

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-26
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.46							
	99.3	200 mm TOPSOIL						
		Very stiff to stiff, greyish brown lean CLAY (CL)			BS	1		
1				▽	BS	2		
2					BS	3		
					BS	4		
	96.6							
3		Dense, grey SANDY SILT (ML)			BS	5		
	95.5							
4		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
	95.1							
		End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

BOREHOLE RECORD

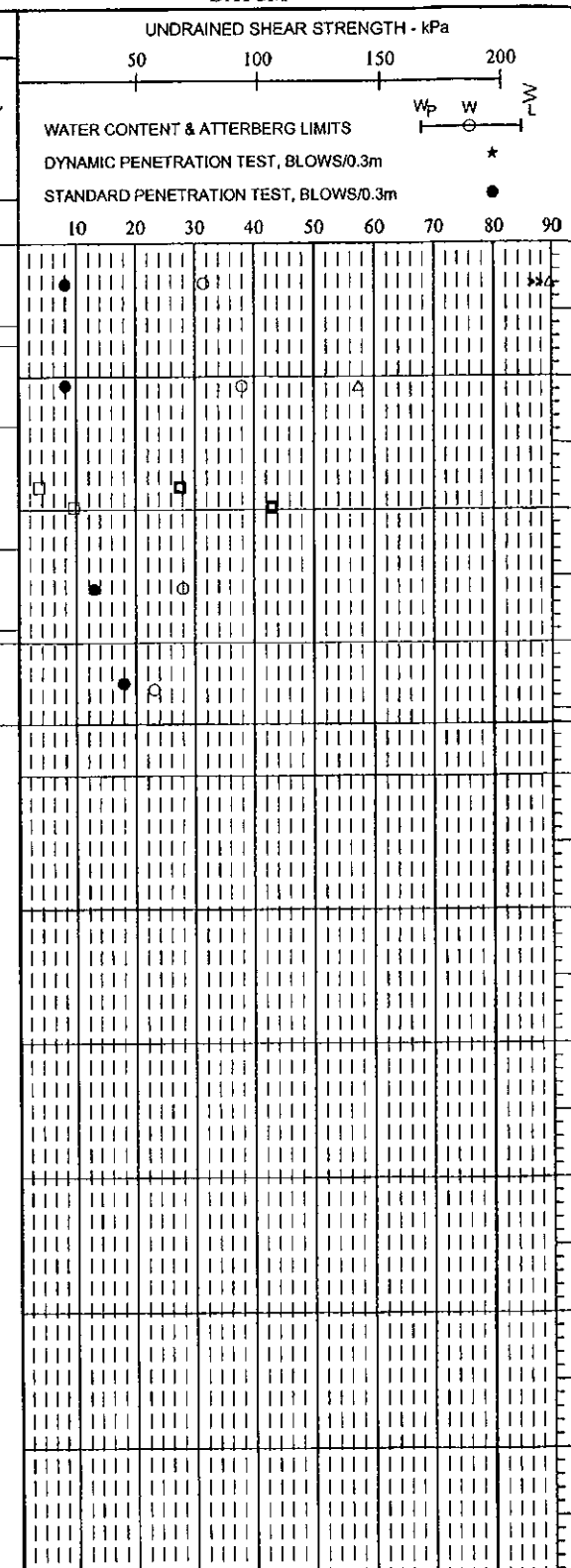
BH07-27

CLIENT Mattamy Homes — BOREHOLE No. BH07-27

LOCATION Proposed Subdivision, Richmond, ON — PROJECT No. 1026929

DATES: BORING June 15, 2007 — WATER LEVEL — DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	99.64							
0		Stiff to very stiff, greyish brown lean CLAY (CL)			SS	1	280	8
1					SS	2	30	8
2	97.3			▽				
		Compact, brown SANDY SILT (ML)			SS	3	320	13
3	96.0				SS	4	350	18
		End of Borehole Auger Refusal on Inferred Bedrock						
4								
5								
6								
7								
8								
9								
10								



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

BOREHOLE RECORD

BH07-28

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. BH07-28
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.04							
	99.9	100 mm TOPSOIL						
		Compact, greyish brown SANDY SILT (ML)			SS	1	150	7
1					SS	2	420	29
2				∇	SS	3	520	26
	97.8							
		Compact, brown SILTY SAND (SM)			SS	4	500	27
3	97.0							
		Compact, grey SILTY SAND (SM)			SS	5	420	25
	96.2				SS		100	50/ 0 mm
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-29

CLIENT Mattamy Homes
BOREHOLE No. TP07-29
LOCATION Proposed Subdivision, Richmond, ON
PROJECT No. 1026929
DATES: BORING June 15, 2007 WATER LEVEL
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	99.04							
0	98.8	200 mm TOPSOIL						
		Very stiff to stiff, greyish brown lean CLAY (CL)		▽	BS	1		
1					BS	2		
2	96.8				BS	3		
		Dense, grey SANDY SILT (ML)			BS	4		
3	96.0	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	5		
	95.2				BS	6		
4		End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-30

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-30

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	99.52							
0	99.4	150 mm TOPSOIL						
		Firm to stiff, greyish brown lean CLAY (CL)			SS	1	100	13
1				▼	SS	2	500	7
	97.5							
2		Compact, brown to grey SANDY SILT (ML)			SS	3	320	13
3				∇	SS	4	420	17
	95.6				SS	5	150	50/ 100 mm
4		End of Borehole						
		Auger Refusal on Inferred Bedrock						
5		Monitoring Well Installed						
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-31

CLIENT Mattamy Homes
BOREHOLE No. TP07-31
LOCATION Proposed Subdivision, Richmond, ON
PROJECT No. 1026929
DATES: BORING June 15, 2007 WATER LEVEL
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.82							
	99.6	200 mm TOPSOIL						
	99.4	Stiff, greyish brown lean CLAY (CL)			BS	1		
		Dense, grey SANDY SILT (ML)			BS	2		
1					BS	3		
2					BS	4		
	96.8				BS	5		
3		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
	96.0							
4		End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-32

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-32
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.92							
	99.8	150 mm TOPSOIL						
		Stiff, greyish brown lean CLAY (CL)		∇	BS	1		
1					BS	2		
	98.1							
2		Compact to dense, grey SANDY SILT (ML)			BS	3		
					BS	4		
	96.9				BS	5		
3		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
	96.4							
		End of Borehole Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-33

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-33
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.45							
	99.3	150 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)						
					BS	2		
1								
					BS	3		
	98.0	Dense, brown SANDY SILT (ML)						
2					BS	4		
				▽				
					BS	5		
3	96.2							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
					BS	7		
4	95.4	End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-34

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-34
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.56							
	99.3	250 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)			BS	2		
1				▽	BS	3		
	97.6							
2		Dense, brown to grey SANDY SILT (ML)			BS	4		
					BS	5		
3	96.3				BS	6		
	96.0	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	7		
		End of Borehole						
4		Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-36

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-36
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.16							
	100.0	200 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)			BS	2		
1	99.1							
		Dense, brown SANDY SILT (ML)		▽	BS	3		
2					BS	4		
	97.3				BS	5		
3		End of Borehole Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-37

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

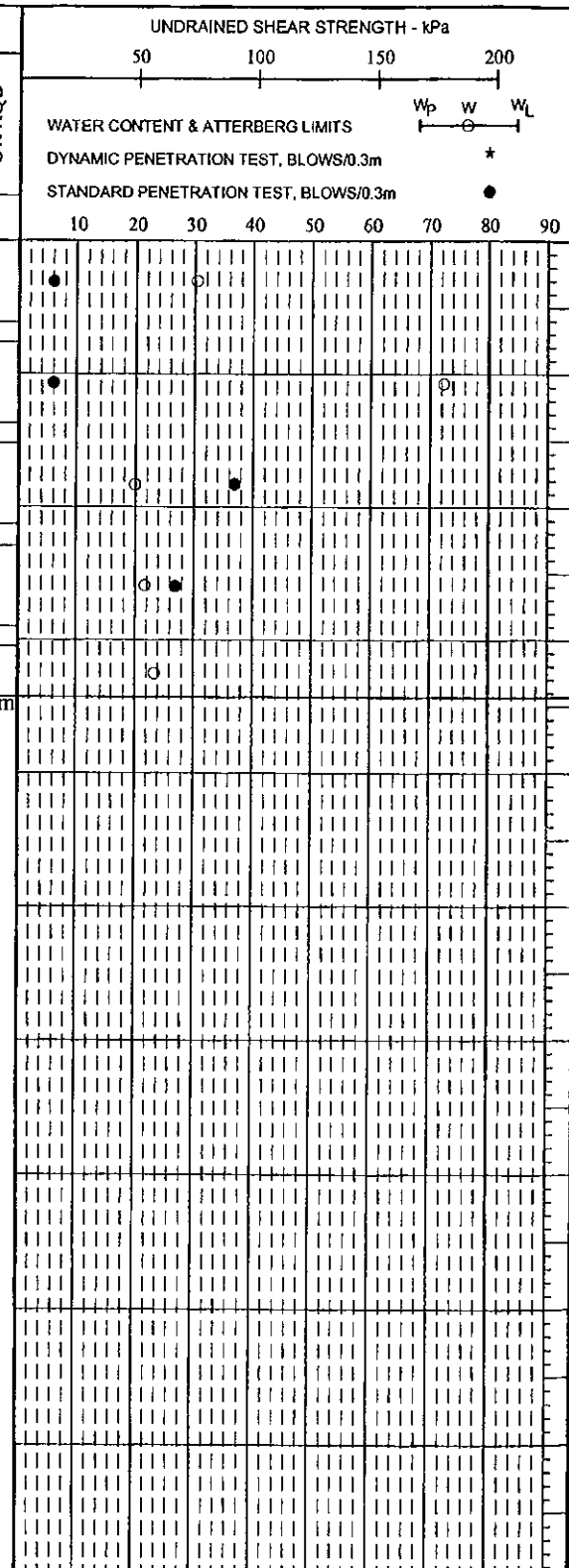
DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-37

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.62							
	99.5	75 mm TOPSOIL						
		Firm, greyish brown lean CLAY (CL)		▼	SS	1	150	6
1	98.4				SS	2	300	6
		Compact to dense, greyish brown SANDY SILT (ML)		∇	SS	3	350	37
2					SS	4	320	27
3	96.4							
	96.2	Compact to dense, grey SANDY SILT (ML)			SS	5	280	50/ 75 mm
4		End of Borehole						
		Auger Refusal on Inferred Bedrock						
5		Monitoring Well Installed						
6								
7								
8								
9								
10								



∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-38

CLIENT Mattamy Homes
BOREHOLE No. TP07-38
LOCATION Proposed Subdivision, Richmond, ON
PROJECT No. 1026929
DATES: BORING June 15, 2007 WATER LEVEL
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	99.75							
0	99.6	200 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)			BS	2		
1					BS	3		
	98.2	Dense, brown SANDY SILT (ML)			BS	4		
2					BS	5		
3					BS	6		
	96.4	Dense, brown sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	7		
4	95.8	End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level
Groundwater Level Measured in Standpipe

Field Vane Test, kPa
Remoulded Vane Test, kPa
Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-39

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-39
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	99.83							
0	99.6	220 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)			BS	2		
1				∇	BS	3		
	98.1	Dense, brown SANDY SILT (ML)			BS	4		
2					BS	5		
	96.9				BS	6		
3		End of Borehole Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

MONITORING WELL RECORD

MW07-40

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. MW07-40
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	100.26							
0	100.1	150 mm TOPSOIL						
		Compact to dense, brownish grey SANDY SILT (ML)			SS	1	320	7
1				▽	SS	2	420	17
	98.3				SS	3	300	50/ 50 mm
2		End of Borehole						
		Auger Refusal on Inferred Bedrock						
3		Monitoring Well Installed						
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-41

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-41
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.77							
	99.6	200 mm TOPSOIL						
		Compact to dense, grey and brown SANDY SILT (ML)		∇	BS	1		
1					BS	2		
	98.0				BS	3		
2	97.6	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	4		
		End of Borehole Refusal on Inferred Bedrock						
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-42

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-42
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.05							
	99.8	200 mm TOPSOIL						
		Compact to dense, brown to grey SANDY SILT (ML)		▽	BS	1		
					BS	2		
1								
	98.0							
2		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	3		
					BS	4		
3					BS	5		
	96.7							
		End of Borehole Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-43

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-43
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.16							
	100.0	200 mm TOPSOIL			BS	1		
		Compact to dense, brown to grey SANDY SILT (ML)		∇	BS	2		
1					BS	3		
2					BS	4		
	97.5							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	5		
3	97.0				BS	6		
		End of Borehole						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-44

CLIENT Mattamy Homes
BOREHOLE No. TP07-44
LOCATION Proposed Subdivision, Richmond, ON
PROJECT No. 1026929
DATES: BORING June 15, 2007 WATER LEVEL
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.41							
	100.2	200 mm TOPSOIL						
		Compact to dense, brown to grey SANDY SILT (ML)		▽	BS	1		
					BS	2		
1					BS	3		
	98.8							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	4		
2	98.1				BS	5		
		End of Borehole Refusal on Inferred Bedrock						
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-45

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 15, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. TP07-45

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.19							
	100.0	200 mm TOPSOIL						
		Compact to dense, brown to grey SANDY SILT (ML)		▽	BS	1		
1					BS	2		
				▼	BS	3		
	98.3							
2		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)						
	97.3				BS	4		
3		End of Borehole Refusal on Inferred Bedrock Standpipe Installed						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-46

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-46
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.16							
	99.9	300 mm TOPSOIL						
		Compact to dense, brown to grey SANDY SILT (ML)		▽	BS	1		
					BS	2		
1					BS	3		
2					BS	4		
3					BS	5		
	96.8							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
	96.2				BS	7		
4		End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-47

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. TP07-47
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.24							
	100.0	200 mm TOPSOIL			BS	1		
		Stiff, brown lean CLAY (CL)						
	99.6			▼	BS	2		
		Compact to dense, brown and grey SANDY SILT (ML)						
1					BS	3		
					BS	4		
2					BS	5		
					BS	6		
3	97.0							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	7		
4					BS	8		
	95.7				BS	9		
		End of Borehole Standpipe Installed						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS: W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m: *
STANDARD PENETRATION TEST, BLOWS/0.3m: ●
10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd _____
Date _____

Jacques Whitford

TEST PIT RECORD

TP07-48

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-48
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.51							
	100.4	150 mm TOPSOIL						
		Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	1		
					BS	2		
1					BS	3		
					BS	4		
2					BS	5		
	98.0							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
3								
	96.9				BS	7		
		End of Borehole						
		Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-49

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-49
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.67							
	100.4	230 mm TOPSOIL						
		Compact to dense, brown and grey SANDY SILT (ML)			BS	1		
1					BS	2		
	98.7				BS	3		
2		End of Borehole Refusal on Inferred Bedrock						
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level

Groundwater Level Measured in Standpipe

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-50

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-50
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.42							
		300 mm TOPSOIL			BS	1		
	100.1	Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	2		
					BS	3		
1					BS	4		
					BS	5		
2					BS	6		
3					BS	7		
	96.9							
	96.6	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	8		
4		End of Borehole Refusal on Inferred Bedrock						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-51

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-51
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.34							
		300 mm TOPSOIL						
	100.0							
		Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	1		
1					BS	2		
					BS	3		
2					BS	4		
	97.5							
		Dense, grey SANDY SILT			BS	5		
3					BS	6		
					BS	7		
4	96.3	End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-52

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-52
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.59							
	100.3	280 mm TOPSOIL			BS	1		
		Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	2		
1					BS	3		
2					BS	4		
	98.1							
		Dense, grey SANDY SILT			BS	5		
3	97.4							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
4					BS	7		
	96.1				BS	8		
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa App'd
△ Pocket Penetrometer Test, kPa Date

Jacques Whitford

TEST PIT RECORD

TP07-53

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-53
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.94							
	100.7	200 mm TOPSOIL			BS	1		
		Firm, brown lean CLAY (CL)						
1					BS	2		
	99.4			▽				
		Compact to dense, brown and grey SANDY SILT (ML)			BS	3		
2					BS	4		
	98.5							
		Dense, grey sandy silt, trace gravel, occasional cobbles and boulders: TILL (ML)			BS	5		
3					BS	6		
	97.4							
		End of Borehole Refusal on Inferred Boulders						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-54

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-54
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	101.37							
	101.2	200 mm TOPSOIL			BS	1		
		Compact to dense, brown and grey SANDY SILT (ML)			BS	2		
1					BS	3		
				▽	BS	4		
2					BS	5		
	98.4							
3		Dense, grey SANDY SILT (ML)			BS	6		
4					BS	7		
	96.9							
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-55

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-55
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	101.07					
	100.9	180 mm TOPSOIL	BS	1		
		Compact to dense, brown and grey SANDY SILT (ML)	BS	2		
			BS	3		
1			BS	4		
	99.1					
2		Dense, grey SANDY SILT (ML)	BS	5		
	98.3					
3		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)	BS	6		
			BS	7		
4	97.0					
		End of Borehole				
		Refusal on Inferred Bedrock				
		Standpipe Installed				
5						
6						

STRATA PLOT

WATER LEVEL

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-56

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-56
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	101.21							
0	101.0	200 mm TOPSOIL			BS	1		
		Compact to dense, brown and grey SANDY SILT (ML)		▽	BS	2		
1					BS	3		
2	99.2	Dense, grey SANDY SILT (ML)			BS	4		
3					BS	5		
	98.0	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	6		
	97.6	End of Borehole						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-57

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-57
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	102.95							
	102.7	200 mm TOPSOIL			BS	1		
		End of Borehole						
		Refusal on Inferred Bedrock						
1								
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa App'd
△ Pocket Penetrometer Test, kPa Date

Jacques Whitford

TEST PIT RECORD

TP07-58

CLIENT Mattamy Homes

BOREHOLE No. TP07-58

LOCATION Proposed Subdivision, Richmond, ON

PROJECT No. 1026929

DATES: BORING June 15, 2007 WATER LEVEL

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	101.39							
	101.2	200 mm TOPSOIL			BS	1		
	100.9	Compact to dense, brown and grey SILTY SAND (SM)			BS	2		
	100.5	Dense, grey sandy silt, trace gravel: TILL (ML)			BS	3		
1		End of Borehole Refusal on Inferred Bedrock						
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-59

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-59
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	101.13							
	100.9	200 mm TOPSOIL			BS	1		
	100.6	Compact to dense, brown SANDY SILT (ML)			BS	2		
		End of Borehole Refusal on Inferred Bedrock						
1								
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level

Groundwater Level Measured in Standpipe

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-60

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-60
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	101.36							
0	101.2	200 mm TOPSOIL			BS	1		
		Compact to dense, brown and grey SANDY SILT (ML)			BS	2		
	100.5				BS	3		
1		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	4		
	99.5				BS	5		
2		End of Borehole Refusal on Inferred Bedrock						
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level

Groundwater Level Measured in Standpipe

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-61

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-61
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	102.15							
	101.9	230 mm TOPSOIL			BS	1		
	101.8	Compact to dense, brown SILTY SAND (SM)			BS	2		
	101.5	Fractured Bedrock						
		End of Borehole						
1		Refusal on Inferred Bedrock						
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

Jacques Whitford

TEST PIT RECORD

TP07-62

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-62
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	101.68							
	101.4	200 mm TOPSOIL			BS	1		
	101.2	Compact to dense, brown and grey SANDY SILT (ML)			BS	2		
	101.0	Dense, brown sandy silt, trace gravel, occasional cobbles: TILL (ML)			BS	3		
1		End of Borehole Refusal on Inferred Bedrock						
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-63

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-63
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	101.44							
	101.2	200 mm TOPSOIL			BS	1		
	101.0	Compact to dense, brown SANDY SILT (ML)			BS	2		
		End of Borehole Refusal on Inferred Bedrock						
1								
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level
Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-64

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-64
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	101.32							
	101.1	230 mm TOPSOIL			BS	1		
		Compact to dense, brown SILTY SAND (SM)			BS	2		
1	100.2							
		Dense, grey SILTY SAND (SM)		▽	BS	3		
					BS	4		
2	98.9							
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (SM)			BS	5		
3					BS	6		
	97.8							
		End of Borehole						
		Refusal on Inferred Bedrock						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-65

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 15, 2007 WATER LEVEL

BOREHOLE No. TP07-65
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	100.15							
0	99.9	250 mm TOPSOIL			BS	1		
	99.3	Compact to dense, brown SILTY SAND (SM)			BS	2		
1		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (SM)		∇	BS	3		
					BS	4		
2					BS	5		
	97.2							
3		End of Borehole Refusal on Inferred Bedrock or Boulders						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa App'd
△ Pocket Penetrometer Test, kPa Date

Jacques Whitford

TEST PIT RECORD

TP07-66

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. TP07-66
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	100.48							
0	100.4	100 mm TOPSOIL			BS	1		
		Compact to dense, brown to grey SILTY SAND (SM)						
					BS	2		
1				▽	BS	3		
	98.9				BS	4		
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (SM)						
2					BS	5		
					BS	6		
3	97.0							
		End of Borehole						
		Refusal on Inferred Boulders						
4		Standpipe Installed						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-67

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-67
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	101.50							
	101.3	200 mm TOPSOIL			BS	1		
		Compact, brown SILTY SAND (SM)		▽	BS	2		
1					BS	3		
	100.2							
	99.9	Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (SM)			BS	4		
		End of Borehole						
2		Refusal on Inferred Bedrock						
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-68

CLIENT Mattamy Homes

BOREHOLE No. TP07-68

LOCATION Proposed Subdivision, Richmond, ON

PROJECT No. 1026929

DATES: BORING June 20, 2007 WATER LEVEL

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		130 mm TOPSOIL			BS	1		
		Compact, brown SILTY SAND (SM)			BS	2		
		Compact to dense, brown and grey SANDY SILT (ML)			BS	3		
					BS	4		
1		End of Hand Auger Hole						
		Hand Auger Refusal						
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level

Groundwater Level Measured in Standpipe

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-69

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 20, 2007 WATER LEVEL

BOREHOLE No. TP07-69
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		150 mm TOPSOIL			BS	1		
		Compact, brown silty sand, trace gravel, occasional cobbles: TILL			BS	2		
		End of Hand Auger Hole						
1		Hand Auger Refusal						
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: ★

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

Inferred Groundwater Level
Groundwater Level Measured in Standpipe

Field Vane Test, kPa
Remoulded Vane Test, kPa
Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

TEST PIT RECORD

TP07-70

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 20, 2007 WATER LEVEL

BOREHOLE No. TP07-70

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD	UNDRAINED SHEAR STRENGTH - kPa (50, 100, 150, 200) / WATER CONTENT & ATTERBERG LIMITS (W_P W W_L) / DYNAMIC PENETRATION TEST, BLOWS/0.3m (*) / STANDARD PENETRATION TEST, BLOWS/0.3m (●) (10 20 30 40 50 60 70 80 90)
0		30 mm TOPSOIL Compact, brown SILTY SAND (SM)							
		End of Hand Auger Hole							
1		Hand Auger Refusal							
2									
3									
4									
5									
6									

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Jacques Whitford

TEST PIT RECORD

TP07-71

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 14, 2007 WATER LEVEL

BOREHOLE No. TP07-71

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	102.71							
	102.5	230 mm TOPSOIL			BS	1		
	102.1	Fractured Bedrock						
		End of Borehole Refusal on Inferred Bedrock						
1								
2								
3								
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

Jacques Whitford

TEST PIT RECORD

TP07-72

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 14, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. TP07-72
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	102.44							
	102.2	200 mm TOPSOIL			BS	1		
		Dense, grey sandy silt, trace gravel, occasional cobbles: TILL (SM)			BS	2		
1				▽				
				▼	BS	3		
2					BS	4		
					BS	5		
3								
	98.9							
		End of Borehole						
		Refusal on Inferred Bedrock						
4		Standpipe Installed						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd _____
Date _____

APPENDIX C

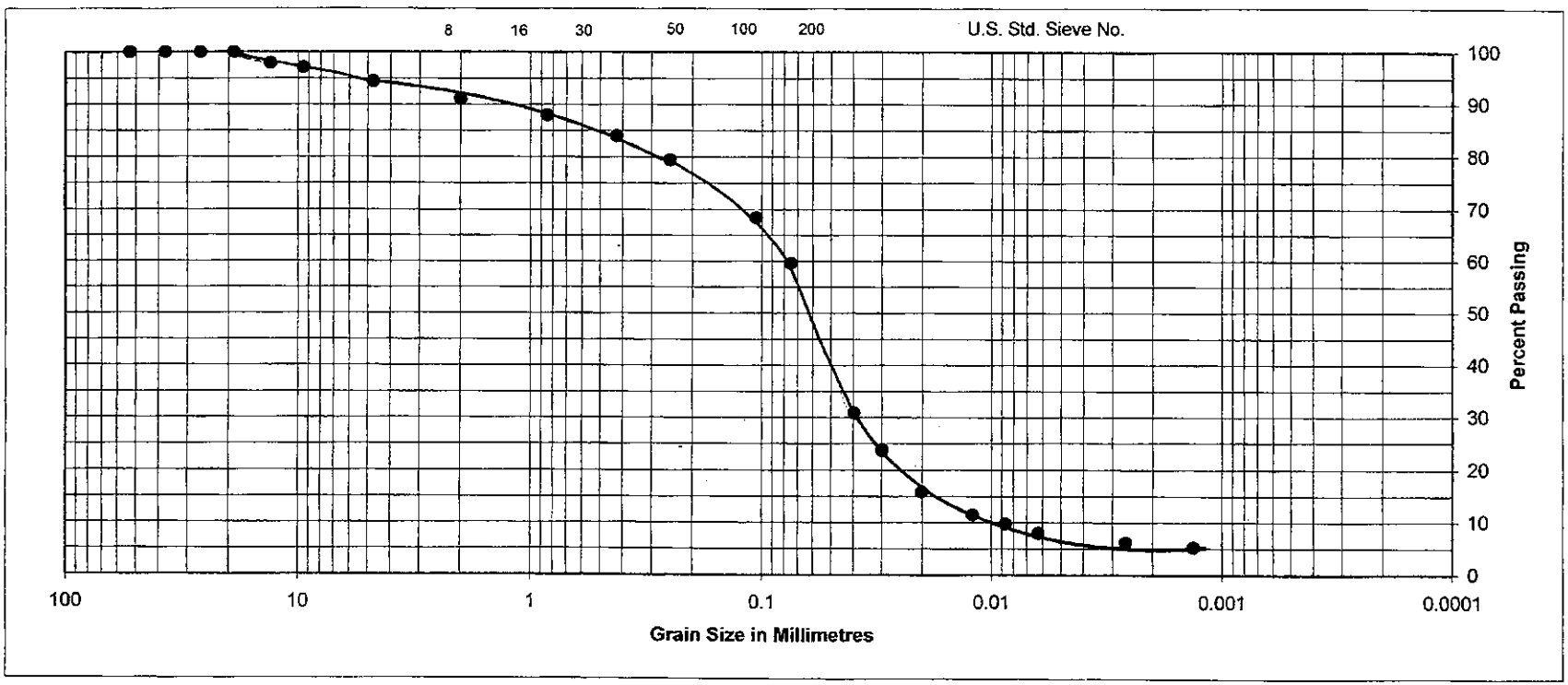
Soil Grain Size Distribution Test Results

Jacques Whitford

2781 Lancaster Rd. Tel: 613 738-0708
Ottawa, Ontario K1B 1A7 Fax: 613 738-0721

Hydrometer Analysis

Client:	**Mattamy Homes**	Project No.:	**1026929**
Project:	**Mattamy Homes, Rickmond**	Test Method:	**LS702**
Material Type:		Sample No.:	**N/A**
Source:	**BH07-18, SS-6**	Date Sampled:	**14-Jun-07**
Sampled From:	**17.5' to 19.5'**	Tested By:	**Blaine Miller**
Sampled By:	**Jeff Forrester**	Date Tested:	**21-Jun-07**



Remarks:

Reviewed By: Brian Powell
Date: June 22/2007

2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**BH07-25**		
Sampled From :	**SS-5, 12.5' to 14.5'**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**20-Jun-07**

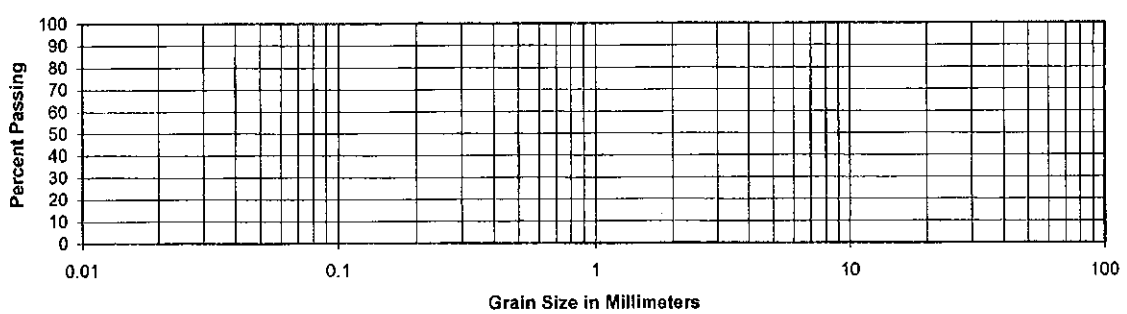
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	266.5	
Sample Weight Aftter Sieve :		Sample Weight After Wash :	37	**Corrected**
% Loss In Sieve :		% Passing No.200	86.1	N/A

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	76.2					
	2	53.0					
	1	26.5					
	3/4	19.0					
	5/8	16.0					
	1/2	13.2					
	3/8	9.5					
+4	0.187	4.75		3.2	98.8		
		- 4.75		37.0			
8	0.0937	2.36					
16	0.0469	1.18					
30	0.234	0.600					
50	0.0117	0.300					
100	0.0059	0.150					
200	0.0029	0.075					
		Pan					

Classification of sample : % Gravel : **1.2** % Sand : **12.7** % Silt and Clay : **86.1**



Remarks :

Laboratory Supervisor : Brian Perrot **Date:** June 21/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**TP-75**		
Sampled From :	**SS-4**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**20-Jun-07**

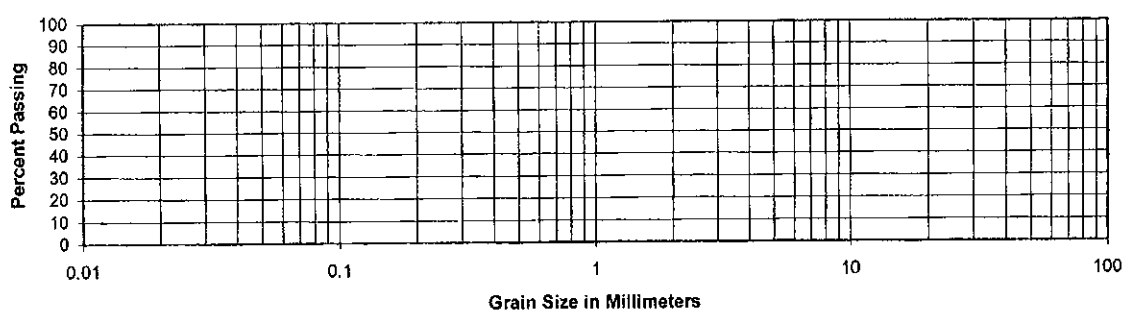
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	**2454.1**	
Sample Weight After Sieve :		Sample Weight After Wash :	**1688.2**	**Corrected**
% Loss In Sieve :		% Passing No.200	**31.2**	**N/A**

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	**76.2**					
	2	**53.0**					
	1	**26.5**					
	3/4	**19.0**					
	5/8	**16.0**					
	1/2	**13.2**					
	3/8	**9.5**					
+4	**0.187**	**4.75**		**669.2**	**72.7**		
		- 4.75		**1688.1**			
8	**0.0937**	**2.36**					
16	**0.0469**	**1.18**					
30	**0.234**	**0.600**					
50	**0.0117**	**0.300**					
100	**0.0059**	**0.150**					
200	**0.0029**	**0.075**					
		Pan					

Classification of sample : % Gravel : **27.3** % Sand : **41.5** % Silt and Clay : **31.2**



Remarks :

Laboratory Supervisor : Brian Rennet **Date:** June 21/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**BH07-28**		
Sampled From :	**SS-3, 5' to 7'**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**15-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**20-Jun-07**

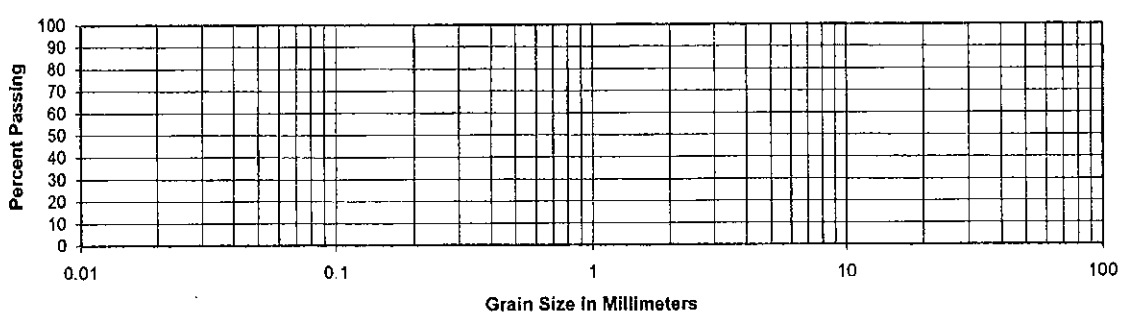
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	325.3	
Sample Weight Aftter Sieve :		Sample Weight After Wash :	180.6	Corrected
% Loss In Sieve :		% Passing No.200	44.5	N/A

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	76.2					
	2	53.0					
	1	26.5					
	3/4	19.0					
	5/8	16.0					
	1/2	13.2					
	3/8	9.5					
+4	0.187	4.75		1.0	99.7		
		- 4.75		180.5			
8	0.0937	2.36					
16	0.0469	1.18					
30	0.234	0.600					
50	0.0117	0.300					
100	0.0059	0.150					
200	0.0029	0.075					
		Pan					

Classification of sample :	% Gravel :	0.3	% Sand :	55.2	% Silt and Clay :	44.5	



Remarks :

Laboratory Supervisor : Brian Rivard **Date:** June 21/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**TP-48**		
Sampled From :	**BS-3**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**21-Jun-07**

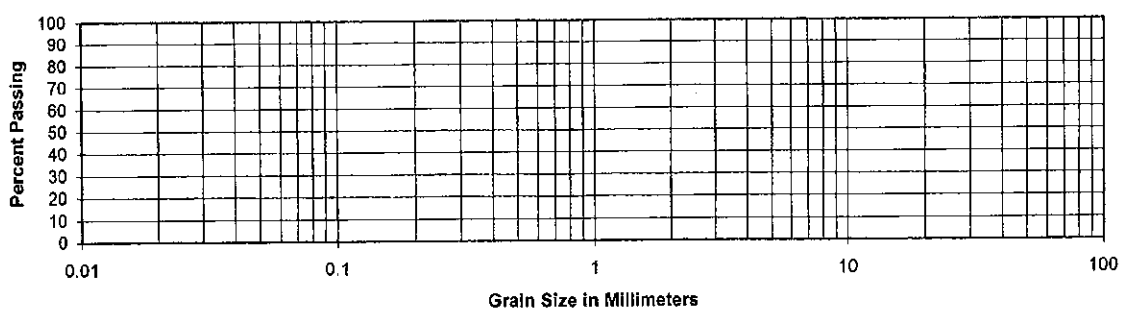
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	254.2	
Sample Weight After Sieve :		Sample Weight After Wash :	8.3	**Corrected**
% Loss In Sieve :		% Passing No.200	96.7	N/A

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	76.2					
	2	53.0					
	1	26.5					
	3/4	19.0					
	5/8	16.0					
	1/2	13.2					
	3/8	9.5					
+4	0.187	4.75		1.6	99.4		
		- 4.75		6.7			
8	0.0937	2.36					
16	0.0469	1.18					
30	0.234	0.600					
50	0.0117	0.300					
100	0.0059	0.150					
200	0.0029	0.075					
		Pan					

Classification of sample : % Gravel : 0.6 % Sand : 2.6 % Silt and Clay : 96.7



Remarks :

Laboratory Supervisor : Brian Rewt **Date:** June 22/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**TP-48**		
Sampled From :	**BS-7**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**20-Jun-07**

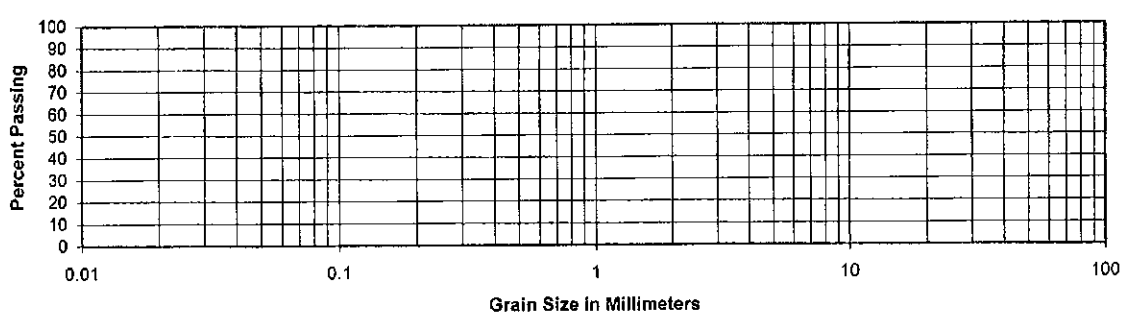
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	385	
Sample Weight After Sieve :		Sample Weight After Wash :	232	**Corrected**
% Loss In Sieve :		% Passing No.200	39.7	N/A

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	76.2					
	2	53.0					
	1	26.5					
	3/4	19.0					
	5/8	16.0					
	1/2	13.2					
	3/8	9.5					
+4	0.187	4.75		44.7	88.4		
		- 4.75		231.9			
8	0.0937	2.36					
16	0.0469	1.18					
30	0.234	0.600					
50	0.0117	0.300					
100	0.0059	0.150					
200	0.0029	0.075					
		Pan					

Classification of sample : % Gravel : 11.6 % Sand : 48.6 % Silt and Clay : 39.7



Remarks :

Laboratory Supervisor : Brian Rennet **Date:** June 21/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	LS 602 (ASTM C136)
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**TP-54**		
Sampled From :	**BS-3**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**21-Jun-07**

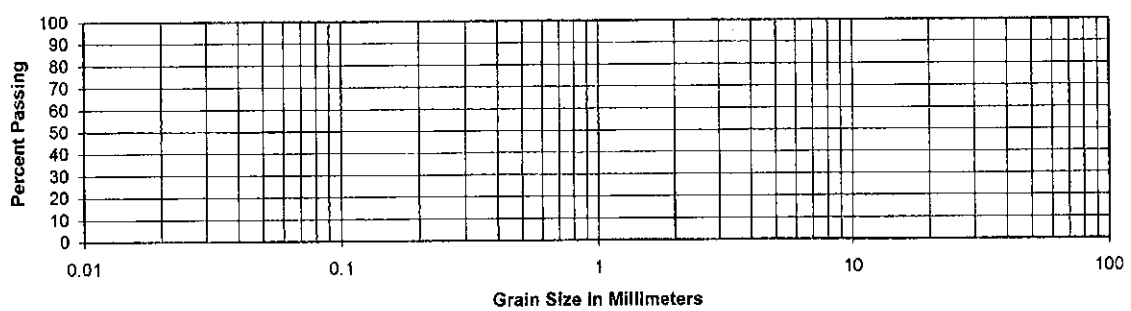
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	**259.3**	
Sample Weight Aftter Sieve :		Sample Weight After Wash :	**9.5**	**Corrected**
% Loss In Sieve :		% Passing No.200	**96.3**	**N/A**

Sieve Analysis

Sieve No.	Size of Opening Inches	Size of Opening mm	Wt. Retained grams	Cum Wt. Retained grams	% Passing	Specifications Min	Specifications Max
	3	**76.2**					
	2	**53.0**					
	1	**26.5**					
	3/4	**19.0**					
	5/8	**16.0**					
	1/2	**13.2**					
	3/8	**9.5**					
+4	**0.187**	**4.75**		**0.0**	**100.0**		
		- 4.75					
8	**0.0937**	**2.36**					
16	**0.0469**	**1.18**					
30	**0.234**	**0.600**					
50	**0.0117**	**0.300**					
100	**0.0059**	**0.150**					
200	**0.0029**	**0.075**					
		Pan					

Classification of sample : % Gravel : **0.0** % Sand : **3.7** % Silt and Clay : **96.3**



Remarks :

Laboratory Supervisor : Brian Russell **Date:** June 22/2007

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2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Wash Sieve Analysis

Client :	**Mattamy Homes**	Project No. :	**1026929**
Project :	**Mattamy Homes, Richmond**	Test Method :	**LS 602 (ASTM C136)**
Material Type :	**Soils / Aggregate:**		
Proposed Use :	**Fill / Granulars:**	Sample No. :	**N/A**
Supplier :	**N/A**		
Source :	**TP-66**		
Sampled From :	**SS-4**		
Sampled By :	**Jeff Forrester**	Date Sampled :	**14-Jun-07**
Tested By :	**Eric Naylor**	Date Tested :	**20-Jun-07**

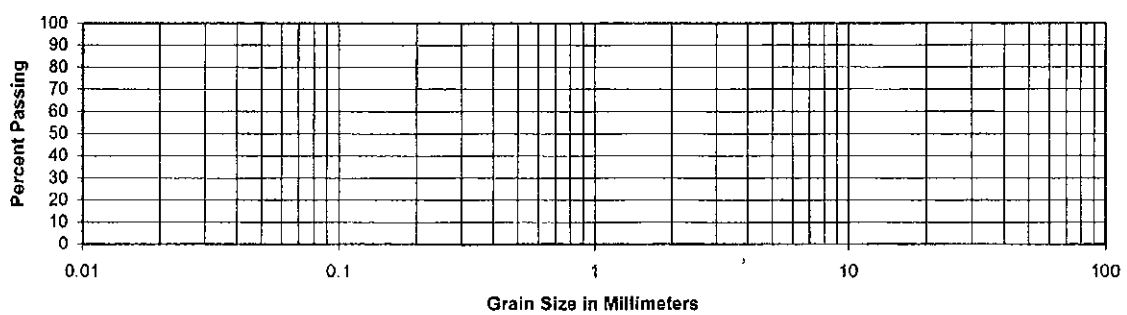
Wash Test Data

Sample Weight Before Sieve :		Sample Weight Before Wash :	**2163.8**	
Sample Weight Aftter Sieve :		Sample Weight After Wash :	**1424.5**	**Corrected**
% Loss In Sieve :		% Passing No.200	**34.2**	**N/A**

Sieve Analysis

Sieve No.	Size of Opening		Wt. Retained	Cum Wt. Retained	% Passing	Specifications	
	Inches	mm	grams	grams		Min	Max
	3	**76.2**					
	2	**53.0**					
	1	**26.5**					
	3/4	**19.0**					
	5/8	**16.0**					
	1/2	**13.2**					
	3/8	**9.5**					
+4	**0.187**	**4.75**		**392.4**	**81.9**		
		- 4.75		**1424.3**			
8	**0.0937**	**2.36**					
16	**0.0469**	**1.18**					
30	**0.234**	**0.600**					
50	**0.0117**	**0.300**					
100	**0.0059**	**0.150**					
200	**0.0029**	**0.075**					
		Pan					

Classification of sample : % Gravel : **18.1** % Sand : **47.7** % Silt and Clay : **34.2**



Remarks :

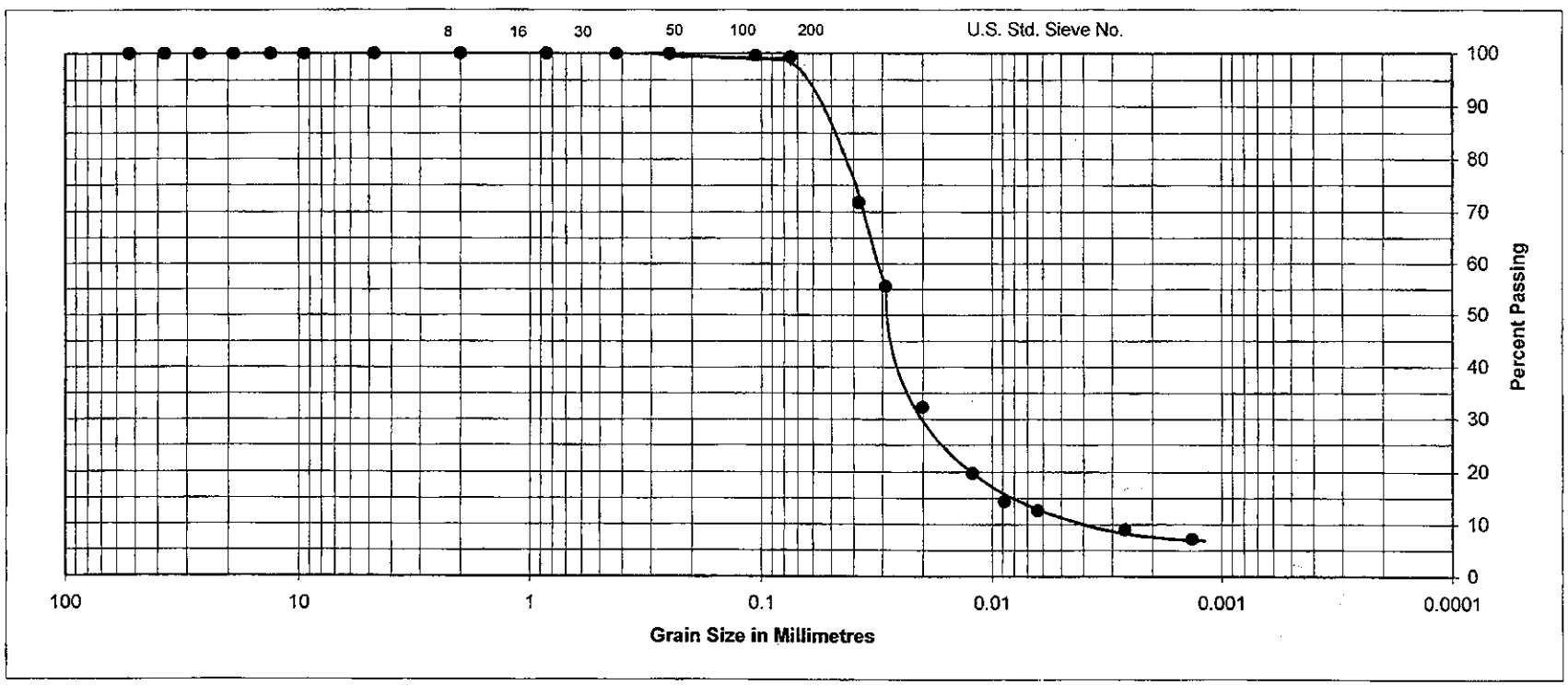
Laboratory Supervisor : Brian Rewt **Date:** June 21/2007

P:\2007\1026929\Lab Testing\Wash Sieve, TP66, SS-4.xls

2781 Lancaster Rd. Tel: 613 738-0708
Ottawa, Ontario K1B 1A7 Fax: 613 738-0721

Hydrometer Analysis

Client:	**Mattamy Homes**	Project No.:	**1026929**
Project:	**Mattamy Homes, Rickmond**	Test Method:	**LS702**
Material Type:		Sample No.:	**N/A**
Source:	**BH07-37, SS-3**	Date Sampled:	**14-Jun-07**
Sampled From:	**5' to 7'**	Tested By:	**Blaine Miller**
Sampled By:	**Jeff Forrester**	Date Tested:	**21-Jun-07**



Remarks:

Reviewed By: Brian Powell
Date: June 22/2007

APPENDIX D

Symbols and Terms Used on the SCPTu Records
SCPTu Probe Records

Jacques Whitford

Terminology Used on SCPTu Records

Key Terminology and Principles

SCPTu:
- Seismic Piezocone (SCPTu);
- A piezocone (CPTu) is an enhanced cone penetration test (CPT) probe that is able to measure porewater pressure (u);
- A seismic piezocone (SCPTu) is further enhanced to measure surface generated compression and shear waves at depth; used to define the shear wave velocity of soils.

Equipment Type and Governing Standard:
- 10 cm^2 seismic piezocone;
- 150 cm^2 friction sleeve;
- manufactured by Applied Research Associates, Inc.;
- ASTM Specification D3441.

PCPT Investigation Objectives:
- evaluate soil type and soil stratigraphy;
- estimate the relative density of granular soils and in situ undrained shear strength of cohesive soils.

Soil Behaviour Type (SBT):
- The SBT is selected based on a soil's response to cone penetration, which is different from an explicit soil type defined by specified laboratory testing procedures, but is normally what the geotechnical engineer requires for design purposes.
- The SBT can be classified on the basis of the soil friction ratio, f_s; ratio between the side shear on the friction sleeve and cone tip resistance.
- The SBT can also be classified on the basis of the normalized pore pressure, Bq; a function of the pore water response and the cone tip resistance.
- The "CPT Soil Behaviour Type Legend" used for this project is attached.

Canadian Foundation Engineering Manual (3rd Edition) Statement on the CPT
- "The most significant advantage that the electric cone penetrometers offer is their repeatability and accuracy."
- "One of the most important applications of the cone penetration test is to accurately determine the soil profile."

Key References:

T. Lunne, P.K. Robertson, and J.J.M. Powell (1997). "Cone Penetration Testing in Geotechnical Practice"; Spon Press.

P.W. Mayne (1986). "CPT indexing of in situ OCR in Clays"; Proceedings of the ASCE Specialty Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering. Blacksburg, 780-93, ASCE.

P.K. Robertson and R.G. Campanella (1988). "Guidelines for geotechnical design using CPT and CPTU"; University of British Columbia, Vancouver, Department of Civil Engineering, Soil Mechanics Series 120.

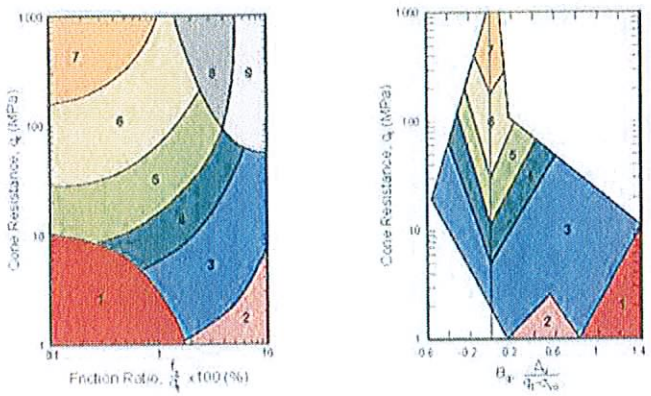
Jacques Whitford

Terminology and Key Engineering Relationships

Parameter	Description	Symbol/Equation	Reference
Depth	Depth of the centroid of the sensor		
Elevation	Elevation of centroid of the sensor	Ground Surface – Depth	
Sleeve Stress	Sleeve Stress – interpolated to the depth of the tip	f_s	
Tip Stress, Uncorrected	Measured Tip Stress	q_c	
Tip Stress COR	Tip Stress, corrected for probe geometry	$q_t = q_c + u_2 x(1-a)$	
Ratio COR	Friction Ratio	$R_f = \frac{f_s}{q_t} x100\%$	
Pore Pressure	Measured Pore Pressure	u_2	
Soil Behaviour Type	Soil Behaviour Type	SBT	Lunne, Roberson and Powell, 1997
Overburden Stress		$\sigma_{vo} = \sum_{i=1}^{n} \gamma_i x h_i$	
Effective Overburden Stress		$\sigma'_{vo} = \sigma_{vo} - u_o$	
Normalized Tip Stress		$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}}$	Lunne, Robertson and Powell, 1997
Normalized Friction Ratio		$F_r = \frac{f_s}{q_t - \sigma_{vo}}$	Lunne, Robertson and Powell, 1997
Normalized Pore Pressure		$B_q = \frac{\Delta u}{q_t - \sigma_{vo}}$ $where\ \Delta u = u_2 - u_0$	Lunne, Robertson and Powell, 1997

Jacques Whitford

CPT Soil Behavior Type Legend
(Robertson et al. 1990)

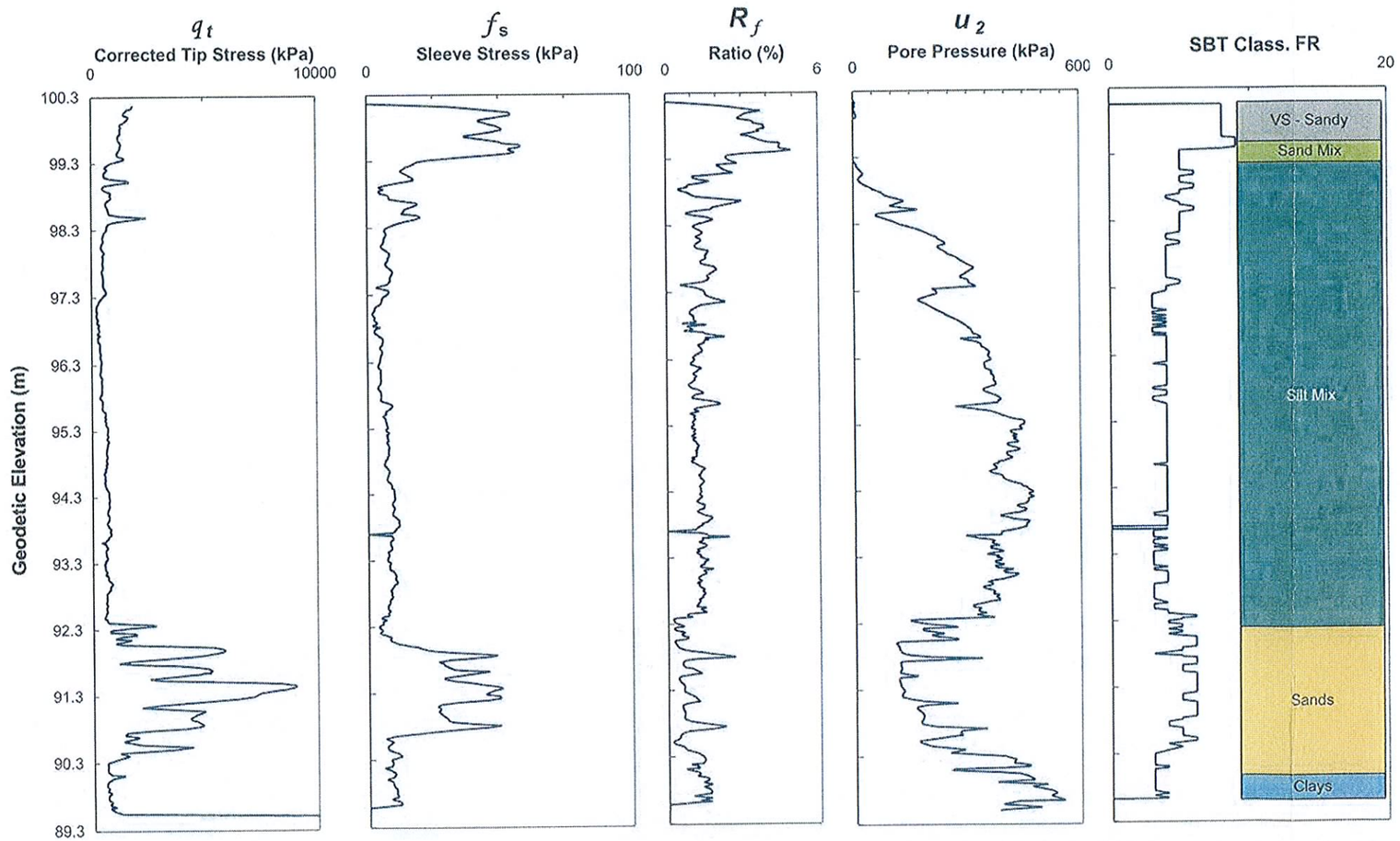


Zone	Soil Behavior Type
1	Sensitive, Fine Grained
2	Organic Soils-Peats
3	Clays; Clay to Silty Clay
4	Silt Mixtures; Clayey Silt to Silty Clay
5	Sand Mixtures; Silty Sand to Sandy Silt
6	Sands; Clean Sands to Silty Sands
7	Gravelly Sand to Sand
8	Very Stiff Sand to Clayey Sand*
9	Very Stiff Fine Grained*

*Overconsolidated or Cemented

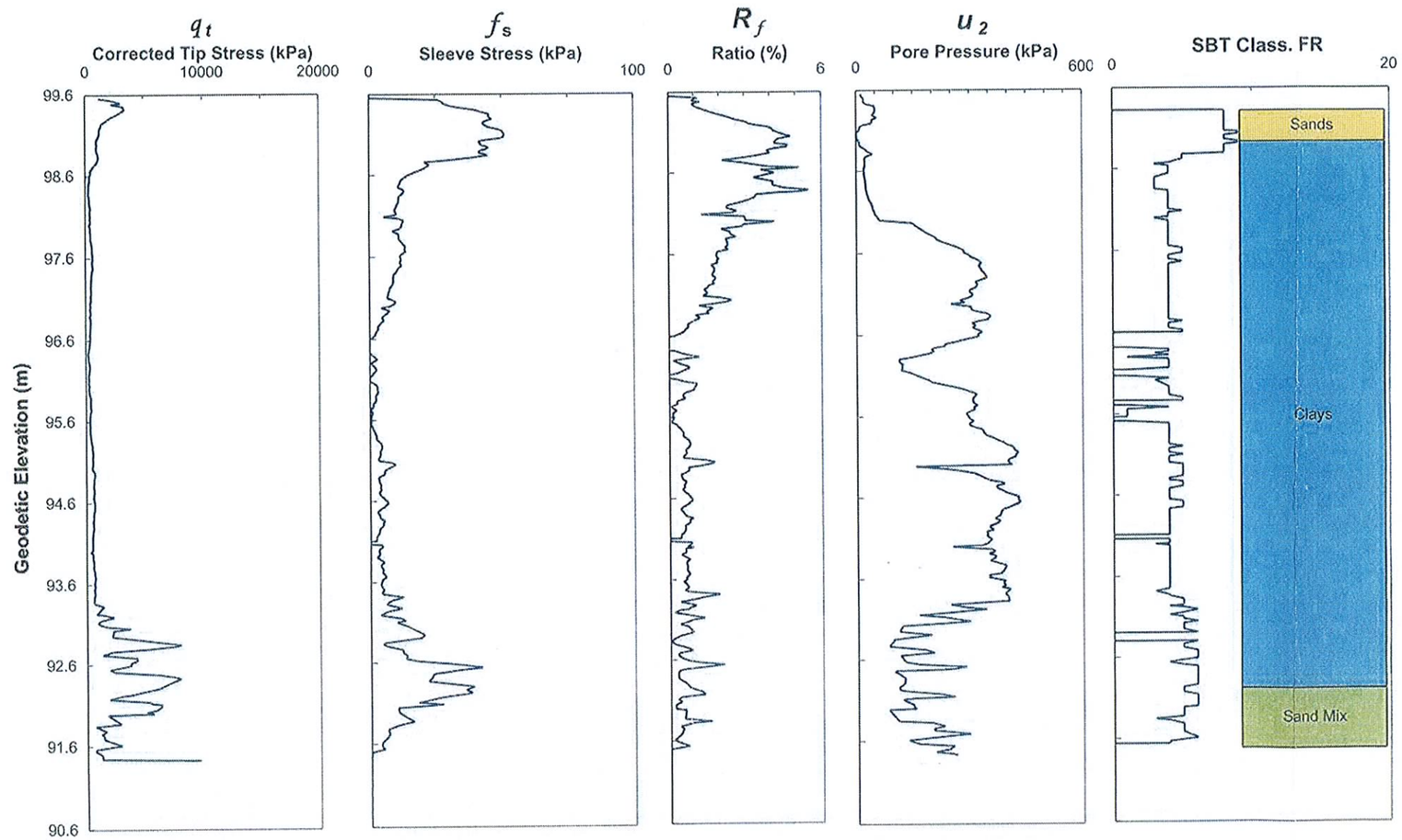
Jacques Whitford

Jacques Whitford	Elevation: 100.23 m SCPTu Start Elevation: 100.23 m Groundwater Elevation: 98.98 m	Test Date: June 15, 2007 Project No. 1026929	CPT 07-2
	Client: Mattamy Homes Project: Proposed Residential Subdivision, Richmond, ON		



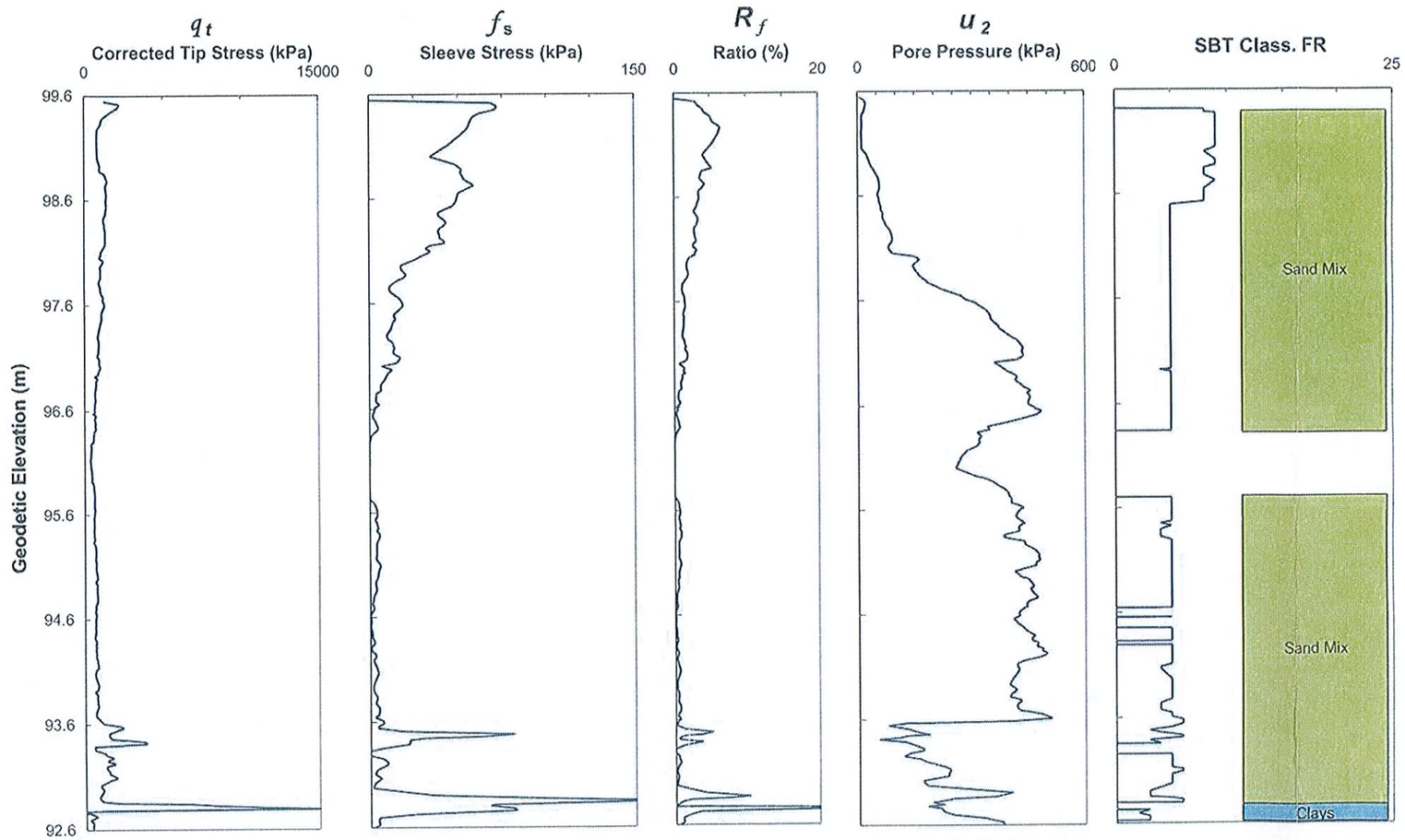
Class FR: Friction Ratio Classification (Robertson, 1990)

Jacques Whitford	Elevation: 99.60 m SCPTu Start Elevation: 99.60 m Groundwater Elevation: 98.51 m	Test Date: June 18, 2007 Project No. 1026929	CPT 07-9
	Client: Mattamy Homes Project: Proposed Residential Subdivision, Richmond, ON		



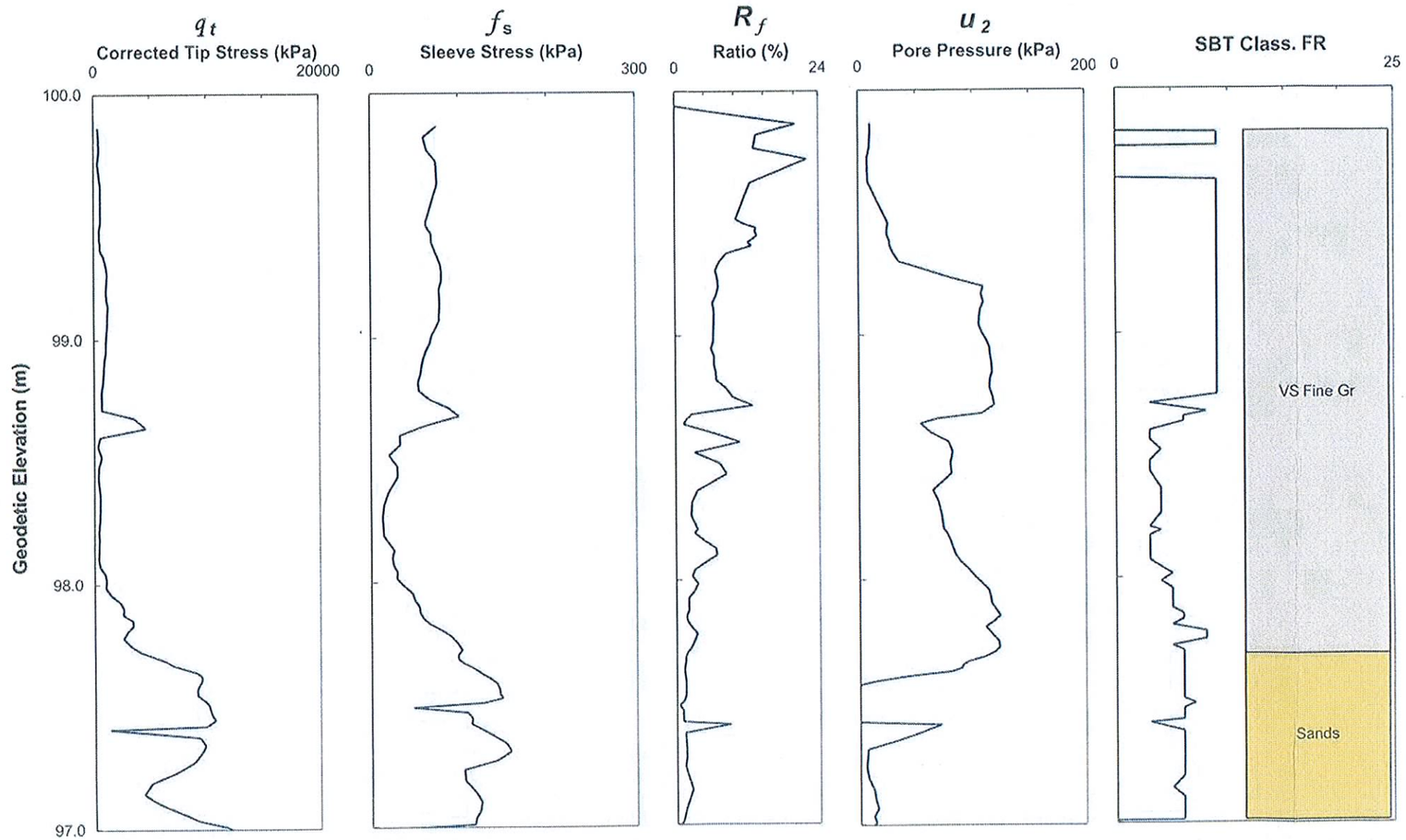
Class FR: Friction Ratio Classification (Robertson, 1990)

Jacques Whitford	Elevation: 99.59 m SCPTu Start Elevation: 99.59 m Groundwater Elevation: 98.38 m	Test Date: June 18, 2007 Project No. 1026929	CPT 07-15
	Client: Mattamy Homes Project: Proposed Residential Subdivision, Richmond, ON		



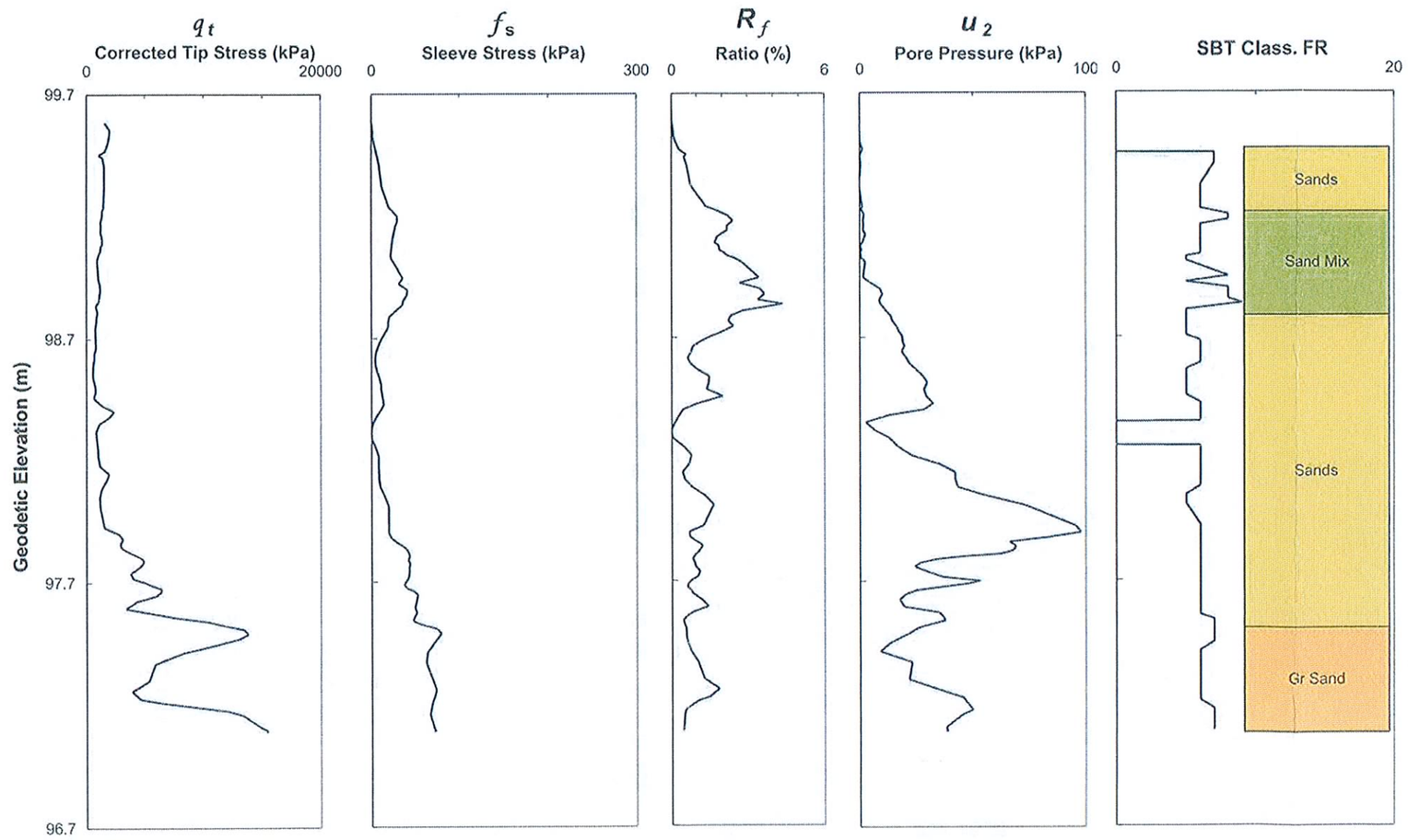
Class FR: Friction Ratio Classification (Robertson, 1990)

Jacques Whitford	Elevation: 99.94 m SCPTu Start Elevation: 99.94 m Groundwater Elevation: 98.62 m	Test Date: June 15, 2007 Project No. 1026929	CPT 07-20
	Client: Mattamy Homes Project: Proposed Residential Subdivision, Richmond, ON		



Class FR: Friction Ratio Classification (Robertson, 1990)

Jacques Whitford	Elevation: 99.64 m SCPTu Start Elevation: 99.64 m Groundwater Elevation: 98.19 m	Test Date: June 15, 2007 Project No. 1026929	CPT 07-35
	Client: Mattamy Homes Project: Proposed Residential Subdivision, Richmond, ON		



Class FR: Friction Ratio Classification (Robertson, 1990)

APPENDIX C

Regulatory Floodplain Supplementary Information

RIDEAU VALLEY
CONSERVATION AUTHORITY

3889 Rideau Valley Drive, P.O. Box 599, Manotick, ON K4M 1A5
tel 613-692-3571 | 1-800-267-3504 | fax 613-692-0831 | www.rvca.ca

A member of Conservation Ontario

RVCA LETTER OF PERMISSION – ONT. REG. 174/06, S. 28 CONSERVATION AUTHORITIES ACT 1990, AS AMENDED.

Revised Date: March 3, 2009
Orig Date: February 17, 2009
File: RV5 0309

Mattamy Ltd. (Jock River)
123 Huntmar Drive
Ottawa, ON
K2S 1B9

Attention: Sean MacFarlane,

Subject: **Application for Development being the establishment of an earth berm on a property at part of Unit 19, Index Plan 4D-23 and part of Lot 2, Concession 2, former Township of Goulbourn, now in the City of Ottawa, bounded by Ottawa Street to the North and the Jock River to the south within the Village of Richmond.**

Dear Mr. MacFarlane,

The Rideau Valley Conservation Authority has reviewed the application submitted on behalf of Mattamy Ltd. and understands the proposal to be for:

1. The removal of fill associated with construction of a berm already on the property.
2. The establishment of a new berm closer to the municipal road and farther from the river.
3. The reinstatement of the land area at the existing/"*original*" berm site.
4. The placement of fill between the new berm and Ottawa Street to match existing surrounding grades.

This proposal was reviewed under Ontario Regulation 174/06, the "*Development, Interference with Wetlands, and Alteration to Watercourse and Shorelines*" regulation, which the Conservation Authority administers as well as the approved "Policies Regarding the Construction of Buildings and Structures, Placing of Fill and Alterations to Waterways" (Adopted by the Executive Committee, October 21, 1993 and last revised and approved by the Board of Directors, April 2006).

History

This proposal relates to two previous regulation application filings on the property, RV5-16/05 submitted and approved by the RVCA on December 9, 2005 under Ont. Regulation 166/90 and RV5-01/08 submitted by Mattamy relating to work undertaken in December 2007.

In 2005, a letter of permission was issued by the RVCA for the construction of a berm "to maintain flood risk mapping land levels as per (the 1980 Acres Floodplain) Mapping Study (96.0 metres)". The application indicated that the berm would be 15 cm to 30 cm in height and on site material would be used to construct the berm at a height of land determined in the field as the natural or high point of land, approximately the 96.0 metre contour. The berm as it exists today is 1-2 metres in height, 10-20 metres in width at the base, 2-100 metres from the Jock River and established more or less at the 95.5 metres contour.

On May 6, 2006, Ontario Regulation 166/90 (Fill, Construction and Alteration to Waterways Regulation) was rescinded and Ontario Regulation 174/06 was enacted. Both regulations were made pursuant to the provisions of Section 28 of the Conservation Authorities Act, and both gave responsibility for administration to the Rideau Valley Conservation Authority. The change in the regulatory legislation in May 2006 resulted in, amongst other things, incorporation of revised and extended hazard delineation along the Jock River (Jock River Floodplain Mapping Study completed in July 2005 by PSR). The new Mapping Study extended the hazard mapping upstream of the previous limit of study and provided for additional lands being subject to RVCA's regulatory jurisdiction; the 1:100 year flood level was considered to be 96.35 metres. A provincially mandated public process was followed in order for this new mapping to take effect.

The purpose of the 2005 application (previous property owner) was to establish a berm at the flood level, (96.0 metres – defined by the pre 2006 Flood Plain Mapping Study) thereby, preventing the remainder of the property from being subject to the floodplain regulations after incorporation of the New Mapping Study into the regulation in May 2006.

Project Scope

This application proposes removing the existing berm [established in Winter/Spring 2006, with further filling and reinforcement in December 2007] and locating it at the 2005 approved location. It is also proposed to remove the flapgate and culvert from the drainage easement until the issues relating to drainage for the property and greater surrounding area can be addressed. The berm will also be extended parallel along both sides of the drainage easement north up to Ottawa Street. The overall function of the drainage ditch/easement will be reviewed as part of a Storm Water Management and Drainage Plan to be completed by Mattamy respecting any future development applications.

The placing of fill for the berm and the associated filling behind the berm up to Ottawa Street is not expected to have a negative impact on the control of flooding. The filling operation and location of the "berm" should not impact the roadside conveyance of water and should not impact the conveyance of water through the Drainage Easement running through the centre of the subject property providing the work in undertaken as proposed.

This permission results in the re-location of the 2005 berm in the originally approved location. The filling between the relocated berm (maximum height 96.4 metres geodetic) and Ottawa Street will be to a maximum level of 96.5 and only to a level to taper to match existing grades.

Permission and Conditions

By this letter the Rideau Valley Conservation Authority hereby grants you permission to undertake the works on this property as outlined in the application, covering letter dated January 23, 2009 from David Schaeffer Engineering Ltd. and Drawings completed by same, Project 303, Figures 1-4, dated January 21, 2009 prepared for Mattamy Ltd. and all subject to the following conditions:

1. The existing berm will be removed from its current site. The material may be used for the construction of the new berm **if** deemed appropriate by a qualified Professional Engineer. Any excess material not required for the construction of the new berm may be used as fill in areas to the north of the relocated berm to a maximum elevation of 96.5 metres, noting the maximum berm height will be 96.4 metres. Any excess material will be disposed of in a suitable location outside all 1:100 year floodplains and regulated areas and not within a wetland.

2. The proposed berm shall be established as noted on the attached plan, (DSEL, Project 303, Figure 1-4 dated January 21, 2009) with the southern most boundary of the berm located no further south than the line denoted on the plan and established at an original grade no lower than 96. 1 metres

as depicted on the plan with the top of the berm at a maximum elevation of 96.4 metres or not greater than 0.3 metres in height. Grades along Ottawa Street will also be no higher than 96.4 metres.

3. The berm is to be located no closer than 3 metres to the drainage watercourse on both sides and/or **not** within the City of Ottawa's Drainage Easement, whichever is greater.

4. The culvert located in the drainage easement will be removed as the earthworks are completed and no fill or other obstruction will be placed in the drainage easement without approval from the City of Ottawa. The flap gate will be removed immediately from the culvert to ensure free flow of water.

5. The area of the original berm will be rehabilitated to original grade with plant material re-established as discussed in DSEL letter dated January 23, 2009.

6. A finished grading plan will be submitted as soon as the work is complete to confirm the height and location of the new berm and the grade height and location of the existing berm reinstated to original grade. A refundable deposit of $3000.00 is required to be submitted prior to commencement of the work.

7. No earthworks shall commence before May 1, 2009 and only if flows in the Jock River are considered at or lower than summer levels. Sediment control will be established as defined on Figure 3 prepared by David Schaeffer Engineering Ltd. (DSEL), dated January 21, 2009 and additional measures will be installed as deemed necessary.

8. Sediment and Erosion control Inspections will take place daily by DSEL or other appropriate and designated engineering staff while work is ongoing, and thereafter prior to and immediately following any forecasted rainfall event until such time as the site is revegetated, to ensure sediment control is operational and functional. This is ultimately the responsibility of the property owner and all persons associated with the construction/earthworks/grading on the property. Failure to comply may result in this permission being revoked and charges under other applicable law.

9. Any material excavated from the property and not required must be removed immediately and disposed of at a suitable disposal site outside the 100 year floodplain and regulated area.

10. The RVCA is to receive 48 hours notice of the proposed commencement of the proposed works to ensure compliance with all conditions.

11. There is to be **no** work at the bank or in the Jock River as part of this approval. The contractor will take all necessary measures to ensure no sediment migration into the river occurs and that no machinery, no grubbing and no further vegetation clearing takes place on the property as part of the proposed rehabilitation work. Failure to comply may result in this permission being revoked and charges under other applicable law.

12. It is acknowledged by all parties that the area of the fill operation between the new berm and Ottawa Street, when completed and confirmed, will be considered outside the 1:100 year flood plain of the Jock River. The Regulated Area of Ontario Regulation 174/06 nevertheless extends 15 metres from the 1:100 flood elevation which will be confirmed as the outer limit of the relocated berm. The portion of the property within the Regulated Area of Ontario Regulation 174/06 remains subject to the RVCA's regulatory jurisdiction regarding the *Development, Interference with Wetlands and Alteration to Watercourses"* regulation and associated implementation policies, as amended from time to time by the RVCA Board of Directors.

The regulatory mapping for Ontario Regulation 174/06 is reviewed once a year and amendments introduced as required. Once the works are completed, the Rideau Valley Conservation Authority agrees to pursue an amendment to the regulatory mapping to reflect the changes to the 1:100 floodplain contemplated in this approval.

Failure to comply with any or all conditions will result in the letter of permission being revoked with associated legal action to remedy the situation to the Conservation Authority's satisfaction.

By this letter, the Rideau Valley Conservation Authority assumes no responsibility or liability for any flood or erosion damage which may occur either to your property or the structures on it, or if any activity undertaken by you adversely affects the property or interests of adjacent landowners. This letter does not relieve you of the necessity or responsibility for obtaining any other federal or provincial permits including, but not limited to, approvals under the Public Lands Act, Ontario Water Resources Act, Building Code Act, Planning Act, Endangered Species Act etc.

Nothing in this letter of permission is intended to imply or confer any right of occupation or use of public land. This permission may not be transferred to any other party.

Should you have any questions, please contact Shelley Macpherson at our office.

Yours truly,

Donald A. Maciver, MCIP, RPP
Director of Planning

SM/DAM/sm

cc: Susan Murphy, Mattamy Ltd.
City of Ottawa, Guy Bourgon
City of Ottawa, Mike Wildman
City of Ottawa, Don Morse MCIP RPP
Helmut Brodmann LL.B. Bell, Baker
DSEL

NOTE: This letter of permission does not come into full force and effect until the attached copy of this letter is signed by the responsible corporate official, dated, and returned to the Authority offices in Manotick.

This letter's **return shall be taken as an acknowledgment and an acceptance of the conditions contained herein, as per the Authority's approval based on the application submitted.**

Pursuant to the provisions of S. 28 (12) of the Conservation Authorities Act (R.S.O. 1990, as amended) any or all of the conditions set out above may be appealed to the Executive Committee of the Conservation Authority in the event that they may be unsatisfactory or can not be met.

Name (printed) _____ **Date**: _____

Corporate position / title: _____

Signed: _____

Supplementary STAFF REPORT

To: **RVCA Board of Directors**

Prepared by: **Bruce A. Reid, P.Eng., Director, Watershed Science and Engineering Services**

Subject: **Van Gaal Drain Flood Plain Mapping – Final Report**

Date: **January 28, 2010**

At it's December 18, 2009 meeting, the Board postponed its decision with respect to the acceptance of the JF Sabourin and Associates Final Report on the Van Gaal Drain Flood Plain Mapping (item 6 on the December 18th agenda), in order to give "staff and proponent engineers a further chance to review and come to agreement on the methodology".

Staff met with representatives the City of Ottawa, and Mattamy Homes and their engineering consultants on January 14th. Minutes of that meeting are attached hereto.

There continues to be difference of opinion between Mattamy's consultants and RVCA's consultant with respect to the selection of the 1:100 year design flow (summer event) on the Van Gaal Drain. RVCA staff continue to be confident that using the JFSA design flows will be defensible before appeal tribunals (Mining and Lands Commissioner, OMB or the Courts) if and when necessary.

At the January 14th meeting we did achieve consensus on a step-by-step process to bring the matter to a successful conclusion, summarized as follows

1. RVCA will accept the JFSA flood plain mapping for original conditions of the land, and begin administering and enforcing O.Reg. 174/06 on the flood hazard areas defined in it.

2. Additional channel modifications will be done to increase the channel's conveyance capacity, compensating for the loss of conveyance capacity in overbank areas due to recent berm construction and returning the 1:100 year water surface profile to its pre-berm position. The work will be done by Mattamy, and will be subject to formal approval by the City's Drainage Superintendent as well as RVCA (under O.Reg. 174/06).

3. Grades will be raised in the areas behind (upland) of the existing berms, such that the finished grades will no longer be lower than the water surface profile

120 Iber Road
Unit 203
Stittsville, Ontario K2S 1E9
Tel (613) 836-0856
Fax (613) 836-7183
www.DSEL.ca

July 7, 2011
Our File: 10-468

Rideau Valley Conservation Authority
Box 599, 3889 Rideau Valley Drive
Manotick, ON
K4M 1A5

Attention: Jocelyn Chandler
Planner

Dear Jocelyn,

Re: Richmond Van Gaal Drain Modifications

Further to our meeting on May 19, 2011 the following is an outline of our proposal for modifications to the Van Gaal Drain:

Submissions which will be required for approval of the widened channel through the Rideau Valley Conservation Authority (RVCA) and the City of Ottawa will include the following:

- Hydrologic and hydraulic modeling to demonstrate that the proposed conceptual channel revision confines the flood plain limits within the corridor to be completed by JF Sabourin and Associates (JFSA). The first draft is included with this letter.
- Summary of previous fish habitat work including design recommendations to support the project to be completed by Kilgour and Associates (Kilgour).
- Stream morphology design to ensure the revised channel is stable in both low flow and high flow situations to be completed by JTB Environmental Systems Inc (JTBES).
- Detailed channel design incorporating the above studies to be completed by David Schaeffer Engineering Ltd (DSEL).

The JFSA memo ***Floodplain Improvements for the Caivan Development / Hydraulic Analysis of the Van Gaal Drain Proposed Modifications*** dated June 30, 2011 is enclosed with this letter. The attached sketch illustrates proposed channel modifications, in context with the currently proposed draft plan. This does not yet incorporate recommendations from Kilgour or JTBES.

At this time we are seeking high level comments before engaging the consultant team to make a full submission to the RVCA and City of Ottawa.

If the concept is deemed appropriate by the RVCA, a meeting will be organized with the City of Ottawa and including the RVCA.

The time line for the project is have the design works completed and approved in this calendar year with construction completed in the 2012 calendar year.

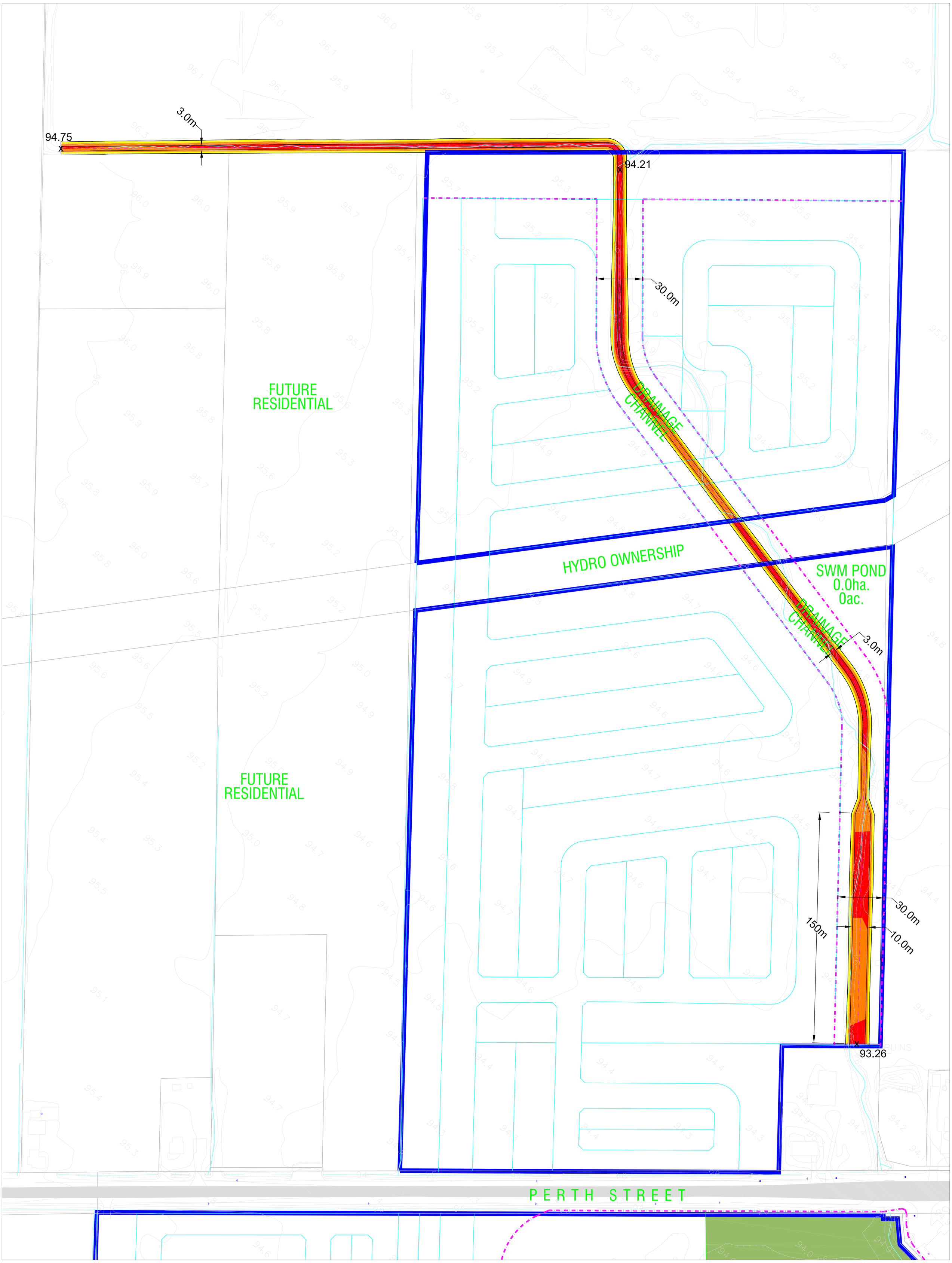
Yours truly,

David Schaeffer Engineering Ltd.

J. Ailey

Per: Jennifer Ailey, P.Eng.

© DSEL



11-468

Scale = 1:1000

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
52 Springbrook Drive, Ottawa, ON K2S 1B9
tel.: 613.836.3884, fax: 613.836.0332, www.jfsa.com

June 30, 2011 *our file: 92211*

David Schaeffer Engineering Limited
120 Iber Road, Unit 203
Stittsville, ON K2S 1E9

Attention: Mr. Steve Pichette

Subject: Floodplain Improvements for the Caivan Development / Hydraulic Analysis of the Van Gaal Drain Proposed Modifications

Dear Sir,

As requested by your office, we have evaluated the 100-year design water levels along the Van Gaal Drain and within the Caivan proposed development site under proposed conditions and compared the results with existing conditions. The proposed conditions include the realignment and partial enlargement of the Van Gaal Drain conveyance channel. *(see Figure 1)*

In undertaking this work, the following information was considered:

1) The HEC-RAS model of the Van Gaal Drain under existing conditions originates from the RVCA Floodplain Mapping (FPM) study of the Jock River submitted by J.F. Sabourin and Associates Inc (JFSA) in November 2009. Only the spring design flows were used for the current analysis. However, note that the summer design flows were found to be critical for the FPM study at the two cross sections upstream of the Perth culvert (1340 and 1364) and should be considered in the final analysis.

2) The hydraulic data used in our evaluation was based on channel alterations proposed by DSEL (see Figure 1). The existing cross-section geometry was modified to include the proposed realignment in the following manner. The channel alignment was modified to a length of 618 m from an original length of 667 m. As the proposed channel is slightly shorter than under existing conditions, the overall channel slope has increased to 0.175% from 0.161%. The channel side slopes were set to 2.5H:1V for the length of proposed modifications. The bottom width of the channel was modified (widened) to contain the 100 year flows at levels that are lower than the existing ground elevations of the subject property. To accomplish this, the channel bottom was widened to 5.0 m (from approximately 2.5 m) from cross-section 2076 to cross-section 1717 inclusively and the channel bottom width was widened 10 m from cross-section 1615 to 1416 (inclusive). Further downstream, all the cross-sections were left as per existing conditions. The Perth culvert was optimized to convey the maximum flows by modifying the style of entrance (flared wing walls with rounded and bevelled corners) and the entrance loss coefficient of 0.2.

Based on the above information, the 100 year water levels for the proposed conditions over the reach of the Van Gaal Drain under study were determined with HEC-RAS and are presented in Attachment 1. Details of the cross-sections for proposed conditions are presented in Attachment 2.

Table 1 summarizes the 100 surface water elevations along the reach crossing the subject property. As may be seen from the results, the 100 year flows from the Van Gaal Drain can be contained within the proposed channel banks from cross-sections 2076 to 1615. Despite the water surface elevation being lowered by up to 0.21 m from existing conditions, the flows will not be fully contained within the proposed channel from cross-sections 1615 to the Perth Culvert. As per our analysis, the water surface elevation is controlled by the Jock River up to cross-section 1615.

Table 1: 100 Year Surface Water Elevations along Van Gaal Drain from cross-section 2157 to Perth Street Under Existing and Proposed Conditions

Cross Section IDs (upstream to downstream)	Existing Water Surface Elevations as per JFSA (2009) (m)	Water Surface Elevations with Proposed Channel Alterations as per DSEL (m)	Difference in Water Surface Elevation between Proposed and Existing Channel (new – existing) (m)
2157	95.48	95.39	-0.09
2076	95.27	95.06	-0.21
1974	95.11	94.86	-0.25
1922	94.99	94.79	-0.20
1833	94.85	94.64	-0.21
1796	94.81	94.58	-0.23
1735	94.72	94.47	-0.25
1728	94.69	94.46	-0.23
1717	94.69	94.44	-0.25
1615	94.61	94.40	-0.21
1555	94.55	94.38	-0.17
1488	94.45	94.37	-0.08
1416	94.41	94.36	-0.05
1400	94.36	94.34	-0.02
1364	94.29	94.25	-0.04
1340	94.19	94.15	-0.04
Perth Street Culvert			

Notes:

Please note that to contain the 100 year flows within the Drain, between cross-section 2157 and 2478, the channel width would also need to be widened along this reach. Additional improvements (ie. removing the existing secondary building to the residence on the north side of Perth Street and the west side of the Drain from the floodplain) could also be achieved between the Perth Street culvert and cross-section 1416 if the channel, along this reach, was widened to 10 m.

Sincerely yours,

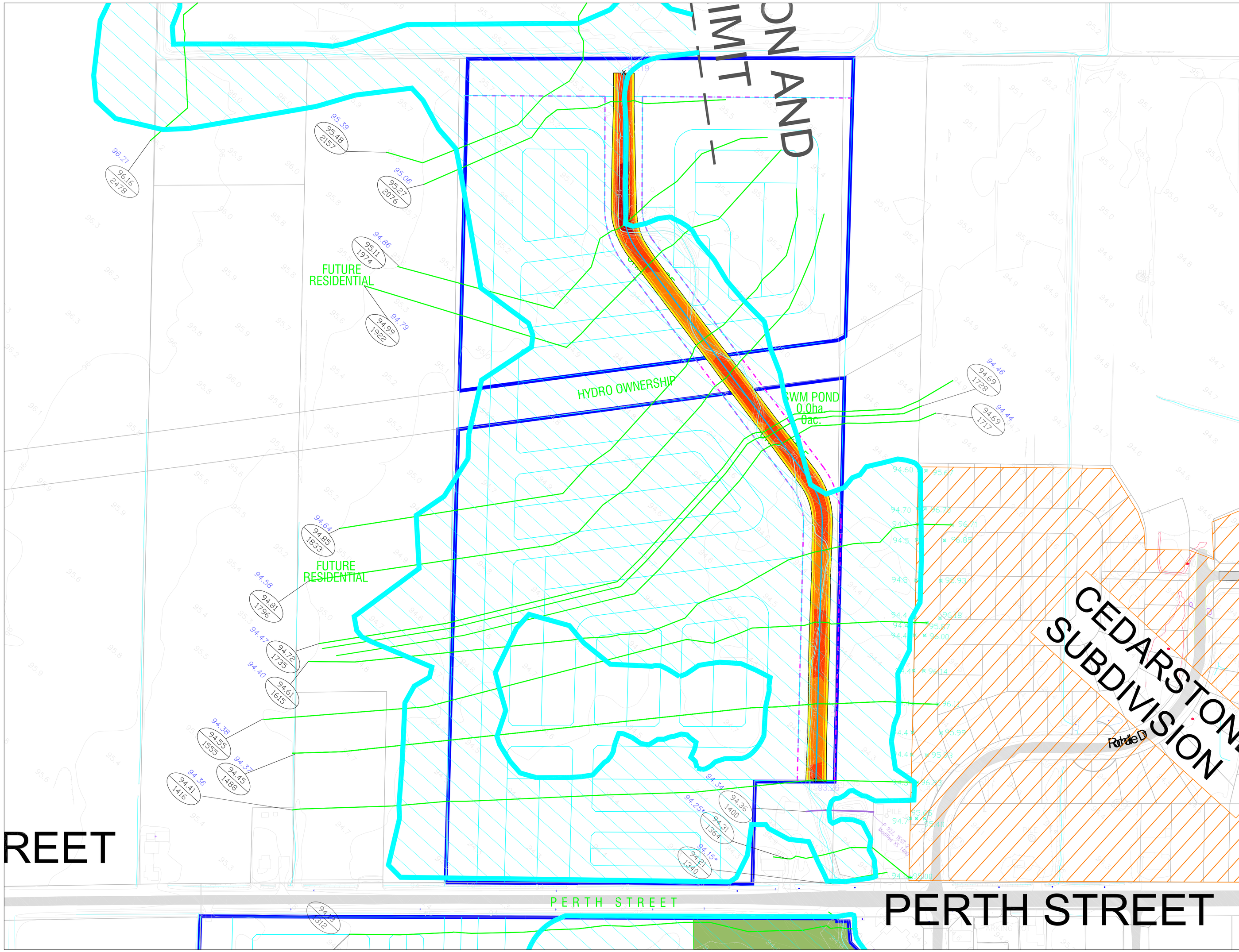
J.F. Sabourin and Associates Inc.

for Jean-François Sabourin, M.Eng., P.Eng.
Director of Water Resources Projects

Table 1: 100 Year Surface Water Elevations along Van Gaal Drain from cross-section 2157 to Perth Street Under Existing and Proposed Conditions

Figure 1: Proposed Channel Realignment Along the Caivan Proposed Development

Appendix 1: HEC-RAS Model Results for the for the Van Gaal Drain Under Existing and Proposed Conditions
Appendix 2: HEC-RAS Model Cross Sections Details Under Existing and Proposed Conditions



LEGEND :

JFSA Floodlines Original

Cross Sections

Property Line

Cedarstone Subdivision

94.51 — WSEL after channel realignment

94.23 — WSEL at Cross Section

10.73 — Cross Section ID

FOR DISCUSSION PURPOSES ONLY

NOTES:

* Water surface elevation should be assessed with the summer flows for these cross-sections

SCALE : NTS

0 25 50 75 100 125 m

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836-3884
GATINEAU (819) 243-6858

CLIENT :

CAIVAN

PROJECT :

Van Gaal Drain
Floodplain Improvements

No.	BY	DATE	DESCRIPTION	BY

Proposed Channel Realignment

Figure 1

DRAWING REF.

DESIGNED:
DRAWN: JHF
VERIFIED:
APPROVED: JFS

DATE	PROJECT No.
Jul/11	922-11

Attachment 1

HEC RAS Model Results for the Van Gaal Drain Under Existing and Proposed Conditions

Table 2: HEC-RAS Model Results for Reach 2 of the Van Gaal Drain under Existing Conditions [1]

HEC-RAS River Station	Flow (m3/s)	Invert Channel Elevation (m)	Water Surface Elevation (m)	Maximum Channel Depth (m)	Energy Gradeline Elevation (m)	Channel Velocity (m/s)	Flow Area (m2)
2554	8.32	94.75	96.28	1.53	96.31	0.82	20.36
2478	8.32	94.75	96.15	1.40	96.21	1.14	12.66
2157	8.32	94.31	95.48	1.17	95.51	1.03	21.89
2076	10.81	93.86	95.27	1.41	95.33	1.19	16.76
1974	10.81	93.68	95.11	1.43	95.14	0.92	26.22
1922	10.81	93.59	94.99	1.40	95.05	1.17	18.34
1833	10.81	93.44	94.85	1.42	94.88	0.85	31.98
1796	10.81	93.37	94.81	1.44	94.83	0.81	35.52
1735	10.81	93.26	94.72	1.46	94.76	0.97	25.42
1728	10.81	93.25	94.69	1.45	94.75	1.08	19.56
1727	Culvert						
1717	10.81	93.24	94.69	1.45	94.74	1.09	18.39
1615	10.81	93.05	94.61	1.56	94.62	0.65	48.35
1555	10.81	92.94	94.55	1.61	94.58	0.92	22.64
1488	10.81	92.82	94.45	1.63	94.50	1.03	14.41
1416	10.81	92.71	94.41	1.70	94.42	0.71	46.09
1400	10.81	92.68	94.36	1.68	94.40	0.96	12.27
1364	10.81	92.62	94.29	1.67	94.35	1.06	11.24
1340	11.62	92.61	94.19	1.58	94.31	1.50	7.76
1339	Culvert						
1312	12.20	92.47	94.12	1.65	94.23	1.51	8.08
1302	12.20	92.57	94.14	1.57	94.18	1.07	26.40
1268	12.20	92.47	94.13	1.67	94.14	0.45	52.44
1212	12.20	92.36	94.11	1.75	94.12	0.56	55.17
1169	12.20	92.30	94.08	1.78	94.09	0.73	43.06
1091	12.20	92.15	94.04	1.89	94.05	0.57	51.99
1002	12.20	92.06	94.02	1.96	94.03	0.41	68.99
961	12.20	91.96	94.02	2.07	94.02	0.24	90.16
910	12.20	91.93	94.02	2.09	94.02	0.20	161.29
840	12.20	91.86	94.02	2.16	94.02	0.18	126.14

[1] Results obtained from Existing Conditions HEC RAS model (originally from P709 Richmond FP Analysis)

..\201106 Channel realignment\Design\HEC RAS\Original Run HEC RAS 4.1.0\Richmond_Nov27_2009_SPR.prj

Table 3: HEC-RAS Model 100 year Flow Results for Reach 2 of the Van Gaal Drain under Proposed Conditions [1]

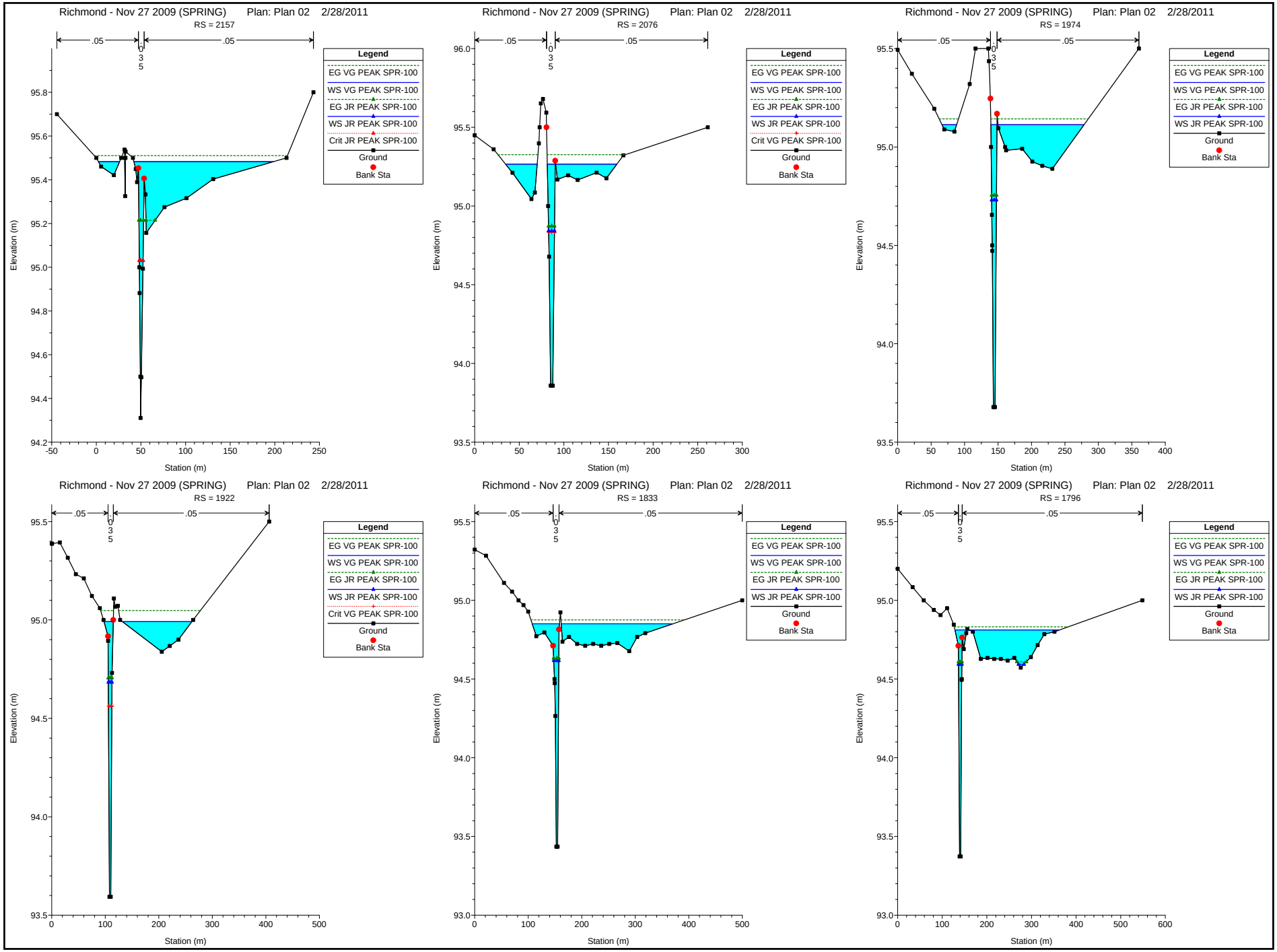
HEC-RAS River Station	Flow (m3/s)	Invert Channel Elevation (m)	Water Surface Elevation (m)	Maximum Channel Depth (m)	Energy Gradeline Elevation (m)	Channel Velocity (m/s)	Flow Area (m2)
2554	8.32	94.75	96.30	1.55	96.32	0.78	21.89
2478	8.32	94.75	96.21	1.46	96.24	0.93	19.88
2157	8.32	94.31	95.39	1.08	95.49	1.64	10.66
2076	10.81	93.86	95.06	1.20	95.13	1.12	9.65
1974	10.81	93.68	94.86	1.18	94.93	1.15	9.44
1922	10.81	93.59	94.79	1.20	94.85	1.13	9.56
1833	10.81	93.44	94.64	1.20	94.71	1.12	9.62
1796	10.81	93.37	94.58	1.21	94.64	1.12	9.66
1735	10.81	93.26	94.47	1.21	94.53	1.11	9.72
1728	10.81	93.25	94.46	1.21	94.52	1.11	9.73
1717	10.81	93.24	94.44	1.20	94.51	1.12	9.62
1615	10.81	93.05	94.40	1.35	94.42	0.59	20.21
1555	10.81	92.94	94.38	1.44	94.40	0.55	20.11
1488	10.81	92.82	94.37	1.55	94.38	0.50	23.51
1416	10.81	92.71	94.36	1.65	94.37	0.42	38.57
1400	10.81	92.68	94.34	1.66	94.36	0.72	23.20
1364	10.81	92.62	94.25	1.63	94.32	1.11	10.26
1340	11.62	92.61	94.15	1.54	94.27	1.54	7.54
1339	Culvert						
1312	12.20	92.47	94.12	1.65	94.23	1.51	8.08
1302	12.20	92.57	94.14	1.57	94.18	1.07	26.40
1268	12.20	92.47	94.13	1.67	94.14	0.45	52.44
1212	12.20	92.36	94.11	1.75	94.12	0.56	55.17
1169	12.20	92.30	94.08	1.78	94.09	0.73	43.06
1091	12.20	92.15	94.04	1.89	94.05	0.57	51.99
1002	12.20	92.06	94.02	1.96	94.03	0.41	68.99
961	12.20	91.96	94.02	2.07	94.02	0.24	90.16
910	12.20	91.93	94.02	2.09	94.02	0.20	161.29
840	12.20	91.86	94.02	2.16	94.02	0.18	126.14

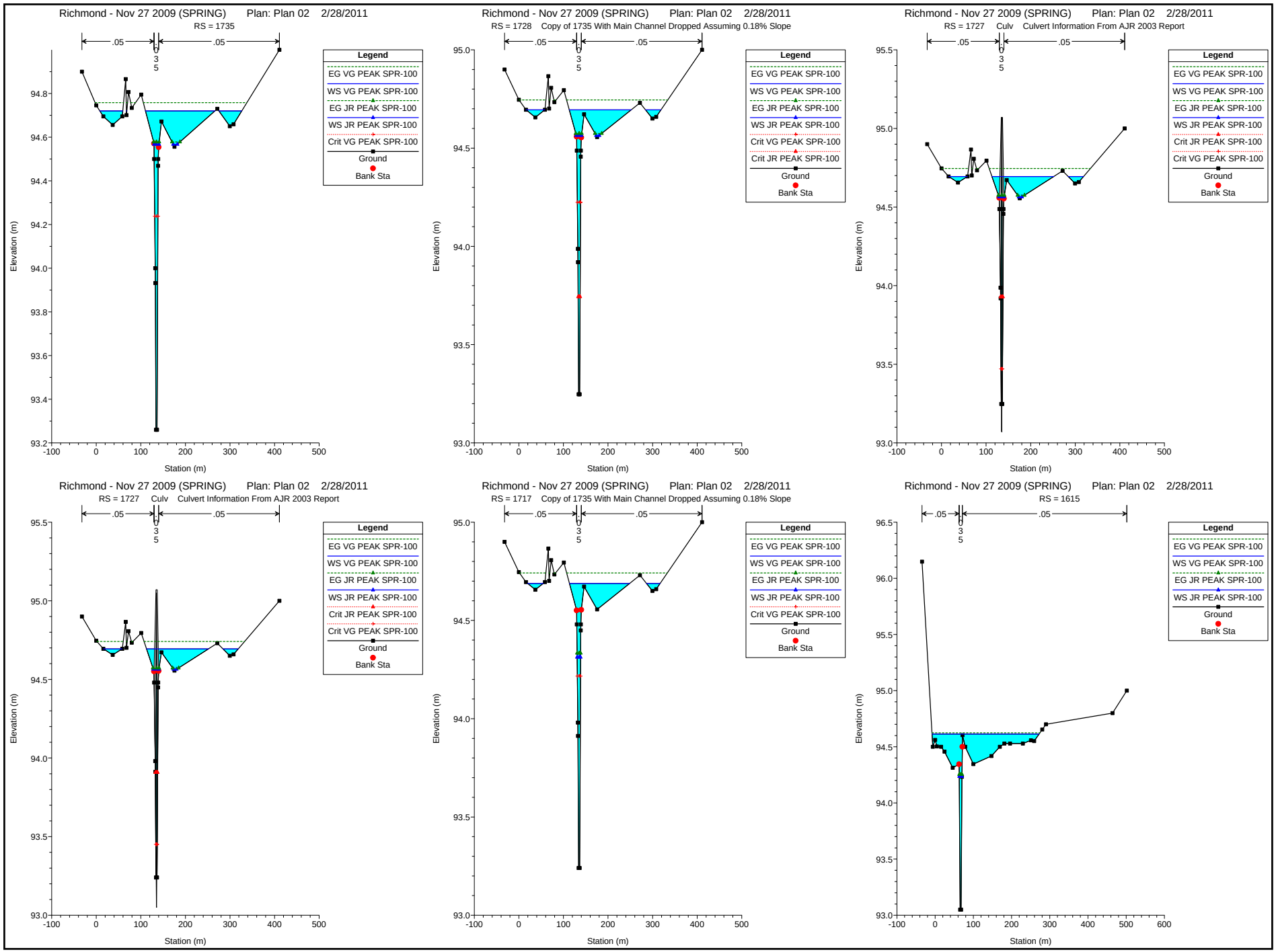
[1] Results obtained from Proposed Conditions HEC RAS model in

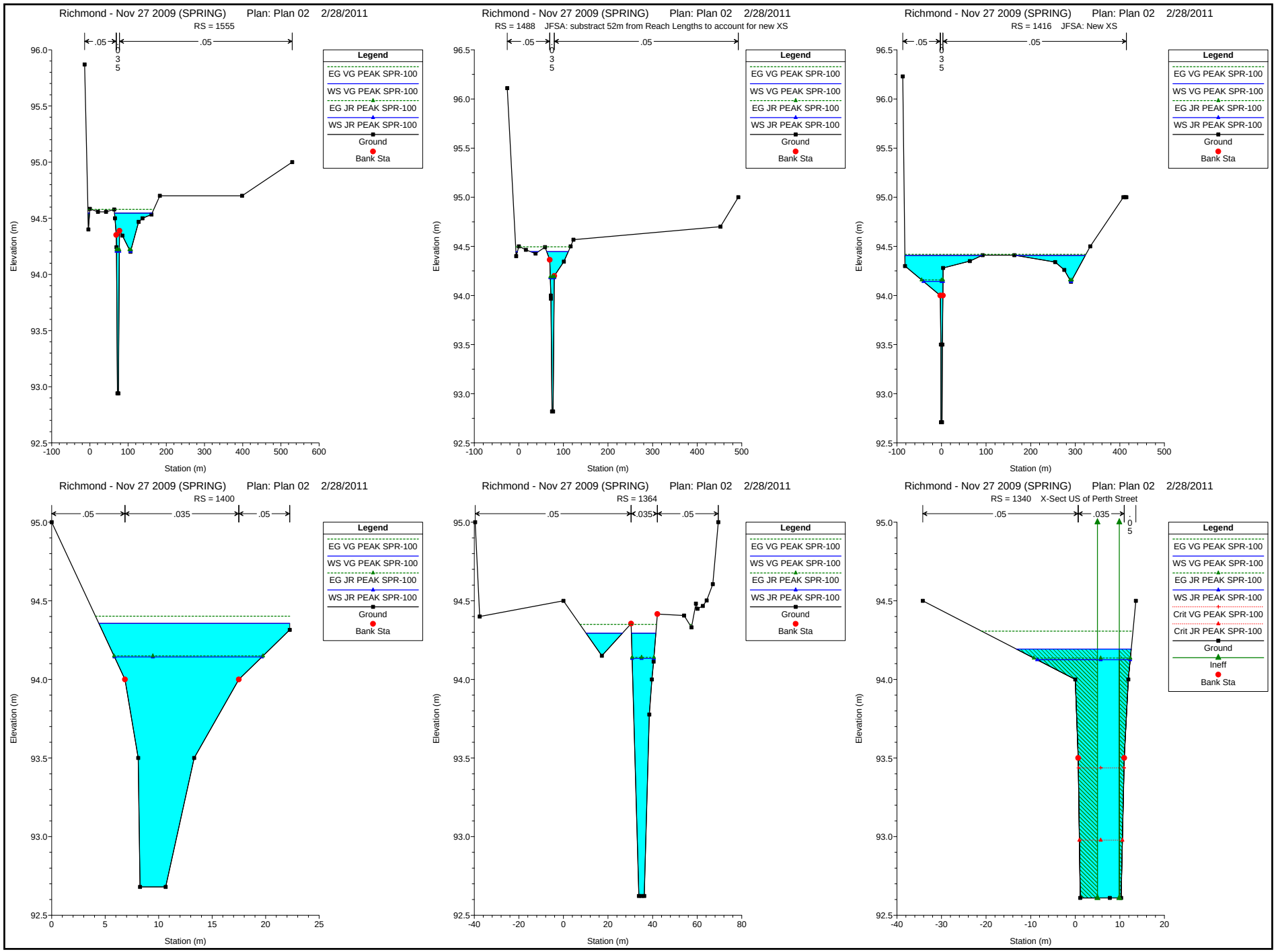
..\201106 Channel realignment\Design\HEC RAS\Scenario 7b\Richmond_Nov27_2009_SPR.prj

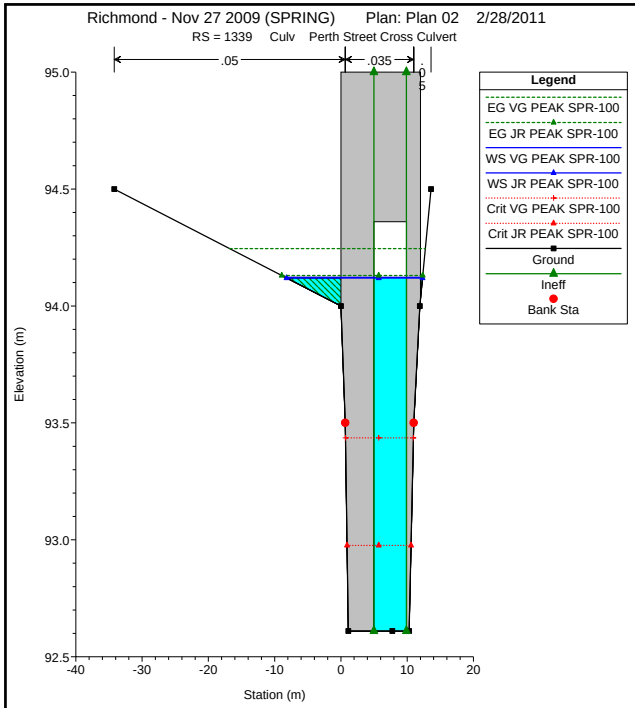
Attachment 2

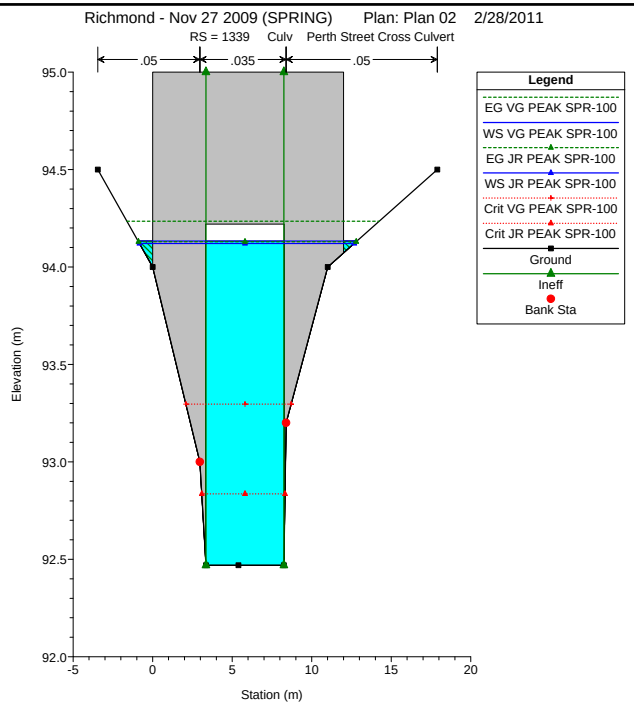
HEC RAS Model Cross-Sections for the Van Gaal Drain Under Existing and Proposed Conditions

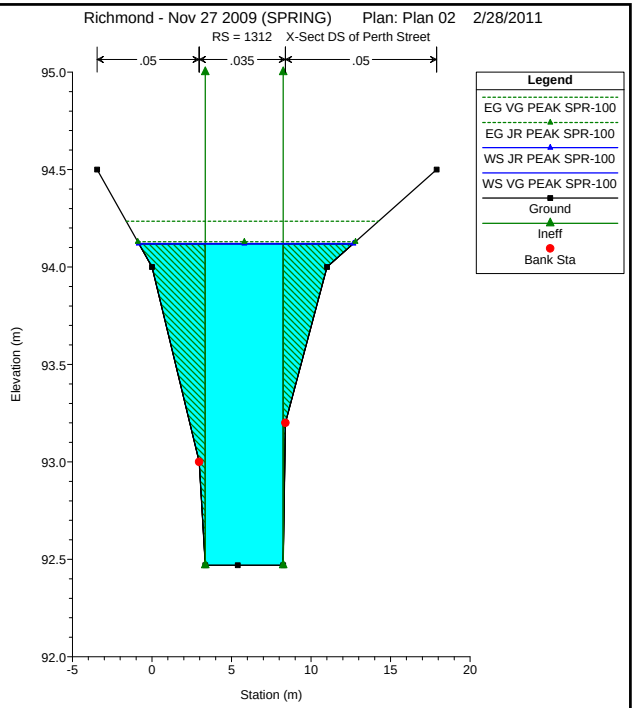

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 2157
RS = 2076
RS = 1974
RS = 1922
RS = 1833
RS = 1796
.05
0
3
5
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit JR PEAK SPR-100
Crit VG PEAK SPR-100
Ground
Bank Sta
Elevation (m)
Station (m)

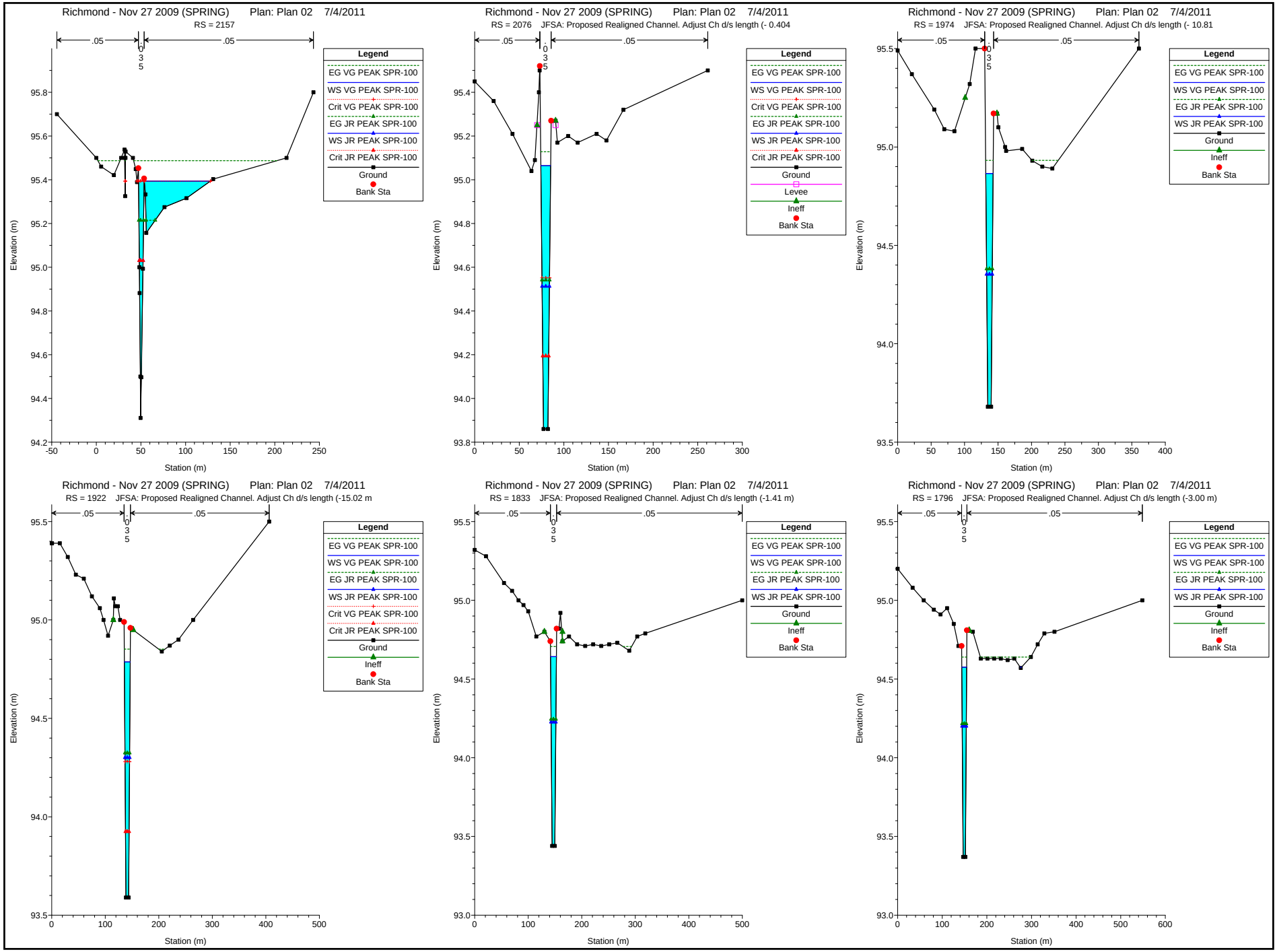

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 1735
RS = 1728 Copy of 1735 With Main Channel Dropped Assuming 0.18% Slope
RS = 1727 Culv Culvert Information From AJR 2003 Report
RS = 1727 Culv Culvert Information From AJR 2003 Report
RS = 1717 Copy of 1735 With Main Channel Dropped Assuming 0.18% Slope
RS = 1615
.05
0
3
5
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit VG PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Bank Sta
Elevation (m)
Station (m)

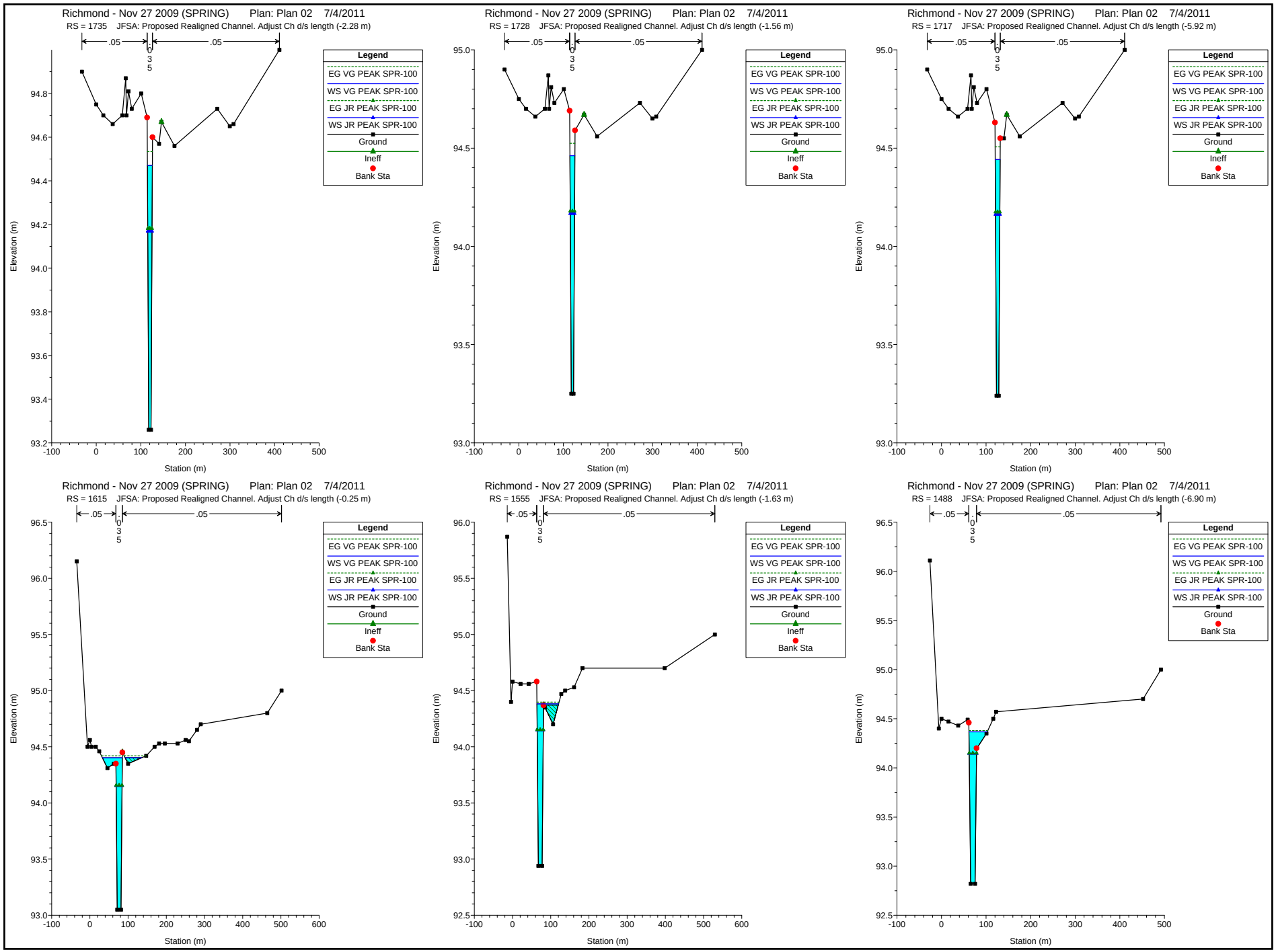

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 1555
RS = 1488 JFSA: substract 52m from Reach Lengths to account for new XS
RS = 1416 JFSA: New XS
RS = 1400
RS = 1364
RS = 1340 X-Sect US of Perth Street
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit VG PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

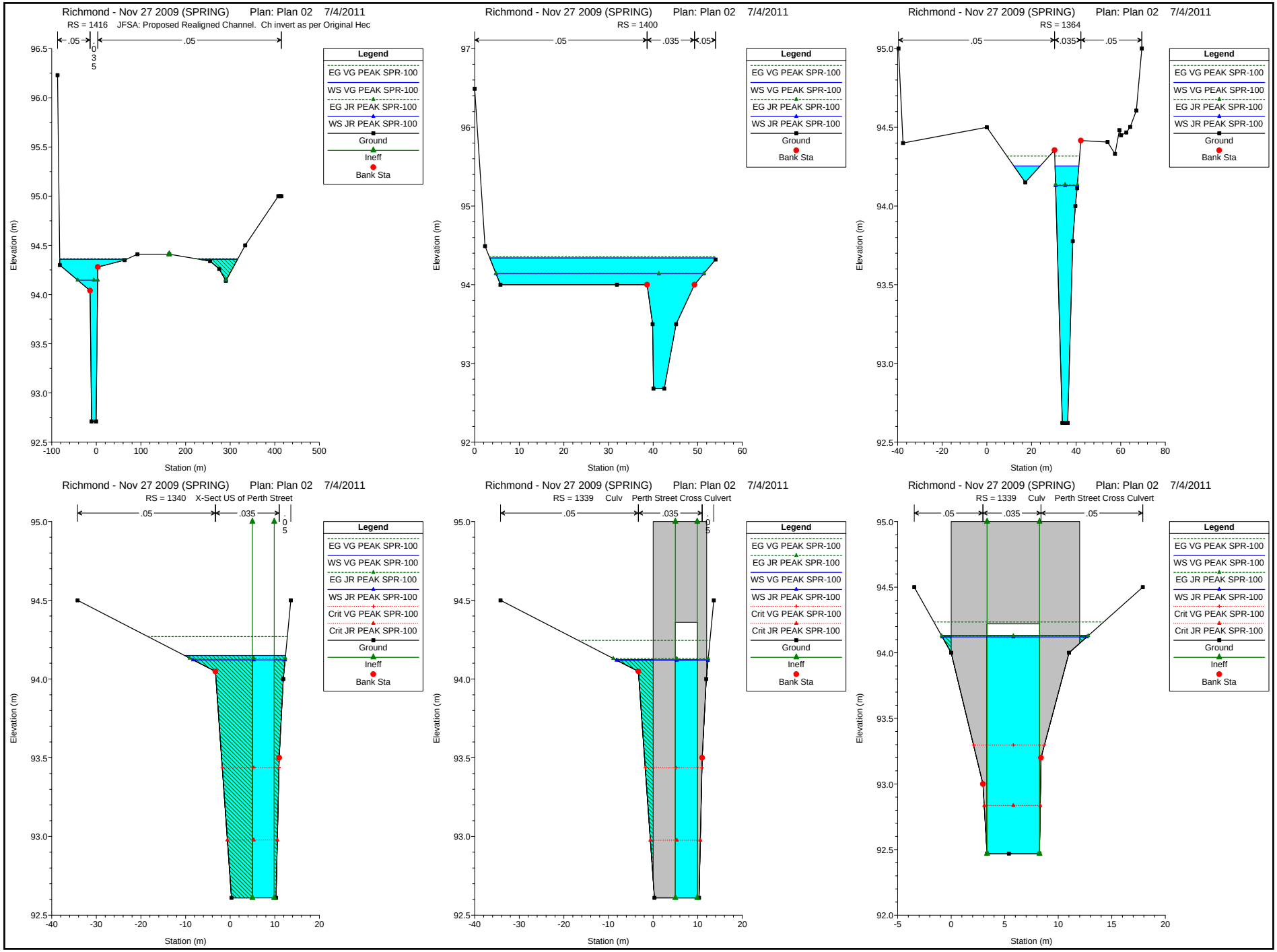

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 1339 Culv Perth Street Cross Culvert
.05
.035
.05
Legend
EG VG PEAK SPR-100
EG JR PEAK SPR-100
WS VG PEAK SPR-100
WS JR PEAK SPR-100
Crit VG PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 1339 Culv Perth Street Cross Culvert
.05
.035
.05
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit VG PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 2/28/2011
RS = 1312 X-Sect DS of Perth Street
.05
.035
.05
Legend
EG VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
WS VG PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

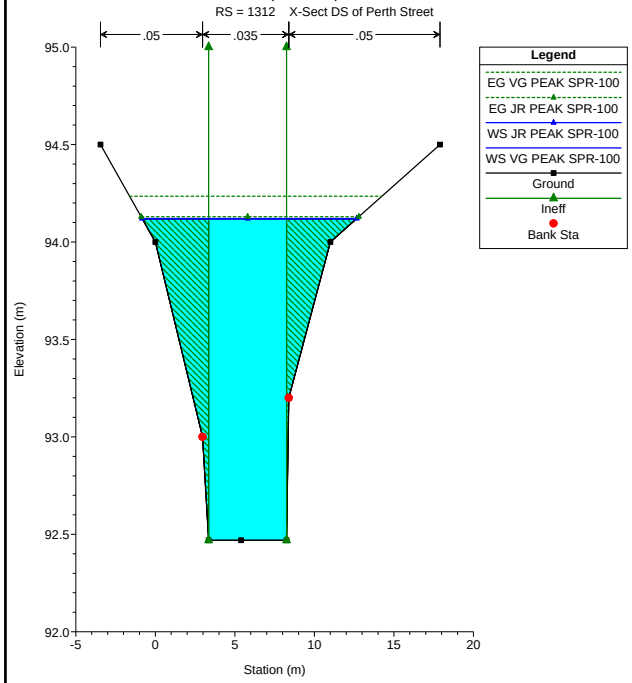

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 2157
RS = 2076 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (- 0.404
RS = 1974 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (- 10.81
RS = 1922 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-15.02 m
RS = 1833 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-1.41 m)
RS = 1796 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-3.00 m)
.05
0.035
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
Crit VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)


Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1735 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-2.28 m)
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1728 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-1.56 m)
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1717 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-5.92 m)
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1615 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-0.25 m)
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1555 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-1.63 m)
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1488 JFSA: Proposed Realigned Channel. Adjust Ch d/s length (-6.90 m)
.05
0
3
5
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1416 JFSA: Proposed Realigned Channel. Ch invert as per Original Hec
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1400
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1364
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1340 X-Sect US of Perth Street
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1339 Culv Perth Street Cross Culvert
Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011
RS = 1339 Culv Perth Street Cross Culvert
Legend
EG VG PEAK SPR-100
WS VG PEAK SPR-100
EG JR PEAK SPR-100
WS JR PEAK SPR-100
Crit VG PEAK SPR-100
Crit JR PEAK SPR-100
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

Richmond - Nov 27 2009 (SPRING) Plan: Plan 02 7/4/2011

RS = 1312 X-Sect DS of Perth Street



Adam Fobert

Subject: FW: RVCA comments regarding submission by DSEL and JFSA on RE: Richmond - Van Gaal Improvements

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From: Jocelyn Chandler
Sent: August 5, 2011 3:32 PM
To: 'Jennifer Ailey'
Cc: Jennifer Lamoureux; Stephanie Schreiner; Glen McDonald
Subject: RVCA comments regarding submission by DSEL and JFSA on RE: Richmond - Van Gaal Improvements

Hello Jennifer,
RVCA Watershed Science and Engineering staff have reviewed the documents submitted in support of the proposal to modify the Van Gaal Drain on the subject lands. The review has identified the following information and concerns that should be addressed in order for us to provide conceptual support for the proposal and ultimately a complete application to be submitted under O.Reg 174/06 of the Conservation Authorities Act.

1. Based on the provided cross sections, the 1:100 year floodplain is not contained throughout the entire subdivision lands, only between x-sections 2076 and 1615.
2. A drawing should be provided that shows the location of the new 1:100 year floodplain boundaries both within and beyond (up and downstream) the subject property.
3. The drawing shows a straightened and channelized watercourse. Discussion of opportunities through the detailed design phase for natural channel design with a focus of improving sinuosity and varied fluvial geomorphology should be included.
4. What is the effect of this proposal on erosion and velocities?
5. What are the projected impacts on the upstream and downstream properties from geomorphologic, hydraulic and biological perspective?
6. Information regarding the ability to tie the proposed modifications into the natural channel and floodplain on the upstream and downstream properties needs to be provided in order to address fish barriers and stream processes.
7. A calculation showing the actual reduction in minor flows must be provided.
8. Drawings showing x-sections along the channel with water level elevations for, at a minimum, the low flow, 2, 5, 10 and 1:100 year events must be provided. How will these function in riffle, pool and run sections of the channel?
9. An RMF must be completed regarding the development proposal and the predicted impacts to fish habitat will be required, although at this time a general statement from the biologist will suffice the achieve some degree of assurance that this will remain a Level II approval under the Federal Fisheries Act.

Additional information for future consideration:

10. This feature is direct fish habitat with several species of fish (known northern pike spawning and nursery habitat) in a greenfield development, greatest maximum setbacks from the watercourse, as per the OP will apply.
11. Any pathway required by the City of Ottawa must remain outside the setbacks.
12. The natural channel design should be prepared with input from the geomorphologist, biologist and engineers.

13. A Landscape Plan showing the naturalization of the lands within the watercourse setback will be required. It should include trees and tall shrub species to provide some shade affect for the watercourse to maintain and protect cool thermal conditions that exist.

Jocelyn Chandler M.Pl. MCIP, RPP.
Planner, RVCA
613.692.3571 x1137
jocelyn.chandler@rvca.ca
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mail: Box 599 3889 Rideau Valley Dr., Manotick, ON K4M 1A5
courier: 3889 Rideau Valley Dr., Nepean, ON K2C 3H1
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From: Jennifer Ailey [mailto:jailey@dsel.ca]
Sent: July 7, 2011 11:48 AM
To: Jocelyn Chandler
Cc: spichette@dsel.ca
Subject: Richmond - Van Gaal Improvements

<<...>>

Jocelyn,

Please review the attached letter, which includes an outline of our proposal for modifications to the Van Gaal Drain.

Please let me know if you have any questions.

Jennifer

Jennifer Ailey, P.Eng.
Senior Design Engineer

DSEL
david schaeffer engineering ltd.
120 Iber Road, Unit 203
Stittsville, ON K2S 1E9
Phone: (613) 836-0856 ext. 226
Fax: (613) 836-7183
Cell: (613) 222-6476
Email: jailey@dsel.ca
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APPENDIX D

Geomorphology

APPENDIX E

Existing Hydrology / Hydraulics

Adam Fobert

From: Bryan Willcott <bwillcott@jfsa.com>
Sent: March-26-10 9:58 AM
To: spichette@dsel.ca; Adam Fobert; Conway, Darlene
Cc: jfsabourin@jfsa.com
Subject: P709(02) Richmond 2,5, 10, 25 Year WSEL Results
Attachments: Spring Storm WSEL Table.pdf; Summer Storm WSEL Table.pdf; Village of Richmond (2, 5, 10, 25, 100 Yr WSEL).pdf

Good day,

Please find the attached plan showing water surface elevations for the 2, 5, 10, 25 and 100 year Spring and Summer events. WSEL tables are also attached.

The calculated flows shown on the attached tables were prepared based upon the same methodology used for the 2009 Richmond Floodplain Mapping study, taking into consideration the timing of peak flows of the Van Gaal drain and Jock River. The calculcated WSELs were determined using the 2009 Richmond Floodplain HEC-RAS spring and summer models, which do not include features including the berm that has been constructed upstream of Perth Street or any modification to Fortune Street culvert.

Best Regards,

Bryan P. Willcott, B.Eng.
Water Resources EIT

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
52 Springbrook Drive, Ottawa, ON K2S 1B9
tel.: 613.836.3884 ext. 223, fax: 613.836.0332, **www.jfsa.com**

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 3	3165	2.59	96.65
5 Year	Van Gaal Drain	Reach 3	3165	3.31	96.70
10 Year	Van Gaal Drain	Reach 3	3165	3.79	96.72
25 year	Van Gaal Drain	Reach 3	3165	4.37	96.74
100 year	Van Gaal Drain	Reach 3	3165	5.24	96.75
2 Year	Van Gaal Drain	Reach 3	3149	2.59	96.60
5 Year	Van Gaal Drain	Reach 3	3149	3.31	96.64
10 Year	Van Gaal Drain	Reach 3	3149	3.79	96.66
25 year	Van Gaal Drain	Reach 3	3149	4.37	96.68
100 year	Van Gaal Drain	Reach 3	3149	5.24	96.72
2 Year	Van Gaal Drain	Reach 3	3086	2.59	96.50
5 Year	Van Gaal Drain	Reach 3	3086	3.31	96.55
10 Year	Van Gaal Drain	Reach 3	3086	3.79	96.58
25 year	Van Gaal Drain	Reach 3	3086	4.37	96.60
100 year	Van Gaal Drain	Reach 3	3086	5.24	96.64
2 Year	Van Gaal Drain	Reach 3	3016	2.59	96.46
5 Year	Van Gaal Drain	Reach 3	3016	3.31	96.52
10 Year	Van Gaal Drain	Reach 3	3016	3.79	96.54
25 year	Van Gaal Drain	Reach 3	3016	4.37	96.56
100 year	Van Gaal Drain	Reach 3	3016	5.24	96.61
2 Year	Van Gaal Drain	Reach 3	2980	2.59	96.42
5 Year	Van Gaal Drain	Reach 3	2980	3.31	96.49
10 Year	Van Gaal Drain	Reach 3	2980	3.79	96.51
25 year	Van Gaal Drain	Reach 3	2980	4.37	96.54
100 year	Van Gaal Drain	Reach 3	2980	5.24	96.57
2 Year	Van Gaal Drain	Reach 3	2851	2.59	96.21
5 Year	Van Gaal Drain	Reach 3	2851	3.31	96.30
10 Year	Van Gaal Drain	Reach 3	2851	3.79	96.34
25 year	Van Gaal Drain	Reach 3	2851	4.37	96.38
100 year	Van Gaal Drain	Reach 3	2851	5.24	96.42
2 Year	Van Gaal Drain	Reach 3	2808	2.59	96.18
5 Year	Van Gaal Drain	Reach 3	2808	3.31	96.27
10 Year	Van Gaal Drain	Reach 3	2808	3.79	96.31
25 year	Van Gaal Drain	Reach 3	2808	4.37	96.35
100 year	Van Gaal Drain	Reach 3	2808	5.24	96.39
2 Year	Van Gaal Drain	Reach 3	2658	2.59	96.11
5 Year	Van Gaal Drain	Reach 3	2658	3.31	96.19
10 Year	Van Gaal Drain	Reach 3	2658	3.79	96.22
25 year	Van Gaal Drain	Reach 3	2658	4.37	96.25
100 year	Van Gaal Drain	Reach 3	2658	5.24	96.29

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	2554	4.13	96.10
5 Year	Van Gaal Drain	Reach 2	2554	5.24	96.18
10 Year	Van Gaal Drain	Reach 2	2554	6.01	96.21
25 year	Van Gaal Drain	Reach 2	2554	6.94	96.24
100 year	Van Gaal Drain	Reach 2	2554	8.32	96.28
2 Year	Van Gaal Drain	Reach 2	2478	4.13	96.03
5 Year	Van Gaal Drain	Reach 2	2478	5.24	96.09
10 Year	Van Gaal Drain	Reach 2	2478	6.01	96.11
25 year	Van Gaal Drain	Reach 2	2478	6.94	96.13
100 year	Van Gaal Drain	Reach 2	2478	8.32	96.16
2 Year	Van Gaal Drain	Reach 2	2157	4.13	95.19
5 Year	Van Gaal Drain	Reach 2	2157	5.24	95.32
10 Year	Van Gaal Drain	Reach 2	2157	6.01	95.38
25 year	Van Gaal Drain	Reach 2	2157	6.94	95.43
100 year	Van Gaal Drain	Reach 2	2157	8.32	95.48
2 Year	Van Gaal Drain	Reach 2	2076	5.00	95.03
5 Year	Van Gaal Drain	Reach 2	2076	6.32	95.13
10 Year	Van Gaal Drain	Reach 2	2076	7.24	95.17
25 year	Van Gaal Drain	Reach 2	2076	8.38	95.21
100 year	Van Gaal Drain	Reach 2	2076	10.81	95.27
2 Year	Van Gaal Drain	Reach 2	1974	5.00	94.89
5 Year	Van Gaal Drain	Reach 2	1974	6.32	94.97
10 Year	Van Gaal Drain	Reach 2	1974	7.24	95.02
25 year	Van Gaal Drain	Reach 2	1974	8.38	95.06
100 year	Van Gaal Drain	Reach 2	1974	10.81	95.11
2 Year	Van Gaal Drain	Reach 2	1922	5.00	94.82
5 Year	Van Gaal Drain	Reach 2	1922	6.32	94.89
10 Year	Van Gaal Drain	Reach 2	1922	7.24	94.92
25 year	Van Gaal Drain	Reach 2	1922	8.38	94.95
100 year	Van Gaal Drain	Reach 2	1922	10.81	94.99
2 Year	Van Gaal Drain	Reach 2	1833	5.00	94.71
5 Year	Van Gaal Drain	Reach 2	1833	6.32	94.76
10 Year	Van Gaal Drain	Reach 2	1833	7.24	94.78
25 year	Van Gaal Drain	Reach 2	1833	8.38	94.80
100 year	Van Gaal Drain	Reach 2	1833	10.81	94.85
2 Year	Van Gaal Drain	Reach 2	1796	5.00	94.68
5 Year	Van Gaal Drain	Reach 2	1796	6.32	94.73
10 Year	Van Gaal Drain	Reach 2	1796	7.24	94.75
25 year	Van Gaal Drain	Reach 2	1796	8.38	94.77
100 year	Van Gaal Drain	Reach 2	1796	10.81	94.81

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1735	5.00	94.64
5 Year	Van Gaal Drain	Reach 2	1735	6.32	94.68
10 Year	Van Gaal Drain	Reach 2	1735	7.24	94.69
25 year	Van Gaal Drain	Reach 2	1735	8.38	94.70
100 year	Van Gaal Drain	Reach 2	1735	10.81	94.72
2 Year	Van Gaal Drain	Reach 2	1728	5.00	94.64
5 Year	Van Gaal Drain	Reach 2	1728	6.32	94.67
10 Year	Van Gaal Drain	Reach 2	1728	7.24	94.68
25 year	Van Gaal Drain	Reach 2	1728	8.38	94.68
100 year	Van Gaal Drain	Reach 2	1728	10.81	94.69
2 Year	Van Gaal Drain	Reach 2	1717	5.00	94.42
5 Year	Van Gaal Drain	Reach 2	1717	6.32	94.55
10 Year	Van Gaal Drain	Reach 2	1717	7.24	94.59
25 year	Van Gaal Drain	Reach 2	1717	8.38	94.63
100 year	Van Gaal Drain	Reach 2	1717	10.81	94.69
2 Year	Van Gaal Drain	Reach 2	1615	5.00	94.29
5 Year	Van Gaal Drain	Reach 2	1615	6.32	94.40
10 Year	Van Gaal Drain	Reach 2	1615	7.24	94.46
25 year	Van Gaal Drain	Reach 2	1615	8.38	94.52
100 year	Van Gaal Drain	Reach 2	1615	10.81	94.61
2 Year	Van Gaal Drain	Reach 2	1555	5.00	94.22
5 Year	Van Gaal Drain	Reach 2	1555	6.32	94.33
10 Year	Van Gaal Drain	Reach 2	1555	7.24	94.39
25 year	Van Gaal Drain	Reach 2	1555	8.38	94.45
100 year	Van Gaal Drain	Reach 2	1555	10.81	94.55
2 Year	Van Gaal Drain	Reach 2	1488	5.00	94.16
5 Year	Van Gaal Drain	Reach 2	1488	6.32	94.26
10 Year	Van Gaal Drain	Reach 2	1488	7.24	94.31
25 year	Van Gaal Drain	Reach 2	1488	8.38	94.36
100 year	Van Gaal Drain	Reach 2	1488	10.81	94.45
2 Year	Van Gaal Drain	Reach 2	1416	5.00	94.02
5 Year	Van Gaal Drain	Reach 2	1416	6.32	94.10
10 Year	Van Gaal Drain	Reach 2	1416	7.24	94.17
25 year	Van Gaal Drain	Reach 2	1416	8.38	94.25
100 year	Van Gaal Drain	Reach 2	1416	10.81	94.41
2 Year	Van Gaal Drain	Reach 2	1400	5.00	94.02
5 Year	Van Gaal Drain	Reach 2	1400	6.32	94.11
10 Year	Van Gaal Drain	Reach 2	1400	7.24	94.16
25 year	Van Gaal Drain	Reach 2	1400	8.38	94.23
100 year	Van Gaal Drain	Reach 2	1400	10.81	94.36

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1364	5.00	93.99
5 Year	Van Gaal Drain	Reach 2	1364	6.32	94.06
10 Year	Van Gaal Drain	Reach 2	1364	7.24	94.11
25 year	Van Gaal Drain	Reach 2	1364	8.38	94.18
100 year	Van Gaal Drain	Reach 2	1364	10.81	94.31
2 Year	Van Gaal Drain	Reach 2	1340	5.79	93.96
5 Year	Van Gaal Drain	Reach 2	1340	7.32	94.01
10 Year	Van Gaal Drain	Reach 2	1340	8.34	94.05
25 year	Van Gaal Drain	Reach 2	1340	9.65	94.10
100 year	Van Gaal Drain	Reach 2	1340	11.62	94.21
2 Year	Van Gaal Drain	Reach 2	1312	6.08	93.94
5 Year	Van Gaal Drain	Reach 2	1312	7.69	93.98
10 Year	Van Gaal Drain	Reach 2	1312	8.76	94.01
25 year	Van Gaal Drain	Reach 2	1312	10.15	94.04
100 year	Van Gaal Drain	Reach 2	1312	3.44	94.13
2 Year	Van Gaal Drain	Reach 2	1302	6.08	93.91
5 Year	Van Gaal Drain	Reach 2	1302	7.69	93.97
10 Year	Van Gaal Drain	Reach 2	1302	8.76	94.00
25 year	Van Gaal Drain	Reach 2	1302	10.15	94.04
100 year	Van Gaal Drain	Reach 2	1302	12.20	94.15
2 Year	Van Gaal Drain	Reach 2	1268	6.08	93.87
5 Year	Van Gaal Drain	Reach 2	1268	7.69	93.93
10 Year	Van Gaal Drain	Reach 2	1268	8.76	93.96
25 year	Van Gaal Drain	Reach 2	1268	10.15	94.00
100 year	Van Gaal Drain	Reach 2	1268	12.20	94.14
2 Year	Van Gaal Drain	Reach 2	1212	6.08	93.78
5 Year	Van Gaal Drain	Reach 2	1212	7.69	93.85
10 Year	Van Gaal Drain	Reach 2	1212	8.76	93.89
25 year	Van Gaal Drain	Reach 2	1212	10.15	93.94
100 year	Van Gaal Drain	Reach 2	1212	3.44	94.12
2 Year	Van Gaal Drain	Reach 2	1169	6.08	93.70
5 Year	Van Gaal Drain	Reach 2	1169	7.69	93.76
10 Year	Van Gaal Drain	Reach 2	1169	8.76	93.80
25 year	Van Gaal Drain	Reach 2	1169	10.15	93.87
100 year	Van Gaal Drain	Reach 2	1169	3.44	94.12
2 Year	Van Gaal Drain	Reach 2	1091	6.08	93.57
5 Year	Van Gaal Drain	Reach 2	1091	7.69	93.64
10 Year	Van Gaal Drain	Reach 2	1091	8.76	93.69
25 year	Van Gaal Drain	Reach 2	1091	10.15	93.78
100 year	Van Gaal Drain	Reach 2	1091	3.44	94.12

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1002	6.08	93.38
5 Year	Van Gaal Drain	Reach 2	1002	7.69	93.49
10 Year	Van Gaal Drain	Reach 2	1002	8.76	93.59
25 year	Van Gaal Drain	Reach 2	1002	10.15	93.71
100 year	Van Gaal Drain	Reach 2	1002	3.44	94.12
2 Year	Van Gaal Drain	Reach 2	961	6.08	93.28
5 Year	Van Gaal Drain	Reach 2	961	7.69	93.41
10 Year	Van Gaal Drain	Reach 2	961	8.76	93.52
25 year	Van Gaal Drain	Reach 2	961	10.15	93.69
100 year	Van Gaal Drain	Reach 2	961	3.44	94.11
2 Year	Van Gaal Drain	Reach 2	910	6.08	93.22
5 Year	Van Gaal Drain	Reach 2	910	7.69	93.38
10 Year	Van Gaal Drain	Reach 2	910	8.76	93.49
25 year	Van Gaal Drain	Reach 2	910	10.15	93.68
100 year	Van Gaal Drain	Reach 2	910	3.44	94.11
2 Year	Van Gaal Drain	Reach 2	840	6.08	93.18
5 Year	Van Gaal Drain	Reach 2	840	7.69	93.35
10 Year	Van Gaal Drain	Reach 2	840	8.76	93.48
25 year	Van Gaal Drain	Reach 2	840	10.15	93.67
100 year	Van Gaal Drain	Reach 2	840	3.44	94.11
2 Year	Van Gaal Drain	Reach 1	746	7.86	93.17
5 Year	Van Gaal Drain	Reach 1	746	9.97	93.35
10 Year	Van Gaal Drain	Reach 1	746	11.34	93.48
25 year	Van Gaal Drain	Reach 1	746	13.11	93.67
100 year	Van Gaal Drain	Reach 1	746	4.06	94.12
2 Year	Van Gaal Drain	Reach 1	705	7.86	93.14
5 Year	Van Gaal Drain	Reach 1	705	9.97	93.34
10 Year	Van Gaal Drain	Reach 1	705	11.34	93.47
25 year	Van Gaal Drain	Reach 1	705	13.11	93.66
100 year	Van Gaal Drain	Reach 1	705	4.06	94.11
2 Year	Van Gaal Drain	Reach 1	668	7.86	93.05
5 Year	Van Gaal Drain	Reach 1	668	9.97	93.28
10 Year	Van Gaal Drain	Reach 1	668	11.34	93.42
25 year	Van Gaal Drain	Reach 1	668	13.11	93.63
100 year	Van Gaal Drain	Reach 1	668	4.06	94.11
2 Year	Van Gaal Drain	Reach 1	666	7.86	92.64
5 Year	Van Gaal Drain	Reach 1	666	9.97	92.83
10 Year	Van Gaal Drain	Reach 1	666	11.34	93.01
25 year	Van Gaal Drain	Reach 1	666	3.31	93.43
100 year	Van Gaal Drain	Reach 1	666	4.06	94.10

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Moore Drain	Reach 1	298	1.07	93.79
5 Year	Moore Drain	Reach 1	298	1.36	93.81
10 Year	Moore Drain	Reach 1	298	1.55	93.82
25 year	Moore Drain	Reach 1	298	1.78	93.83
100 year	Moore Drain	Reach 1	298	0.32	94.11
2 Year	Moore Drain	Reach 1	130	1.07	93.18
5 Year	Moore Drain	Reach 1	130	1.36	93.36
10 Year	Moore Drain	Reach 1	130	1.55	93.48
25 year	Moore Drain	Reach 1	130	1.78	93.67
100 year	Moore Drain	Reach 1	130	0.32	94.11
2 Year	Joys Road Trib	Reach 1	705	1.57	97.24
5 Year	Joys Road Trib	Reach 1	705	2.00	97.39
10 Year	Joys Road Trib	Reach 1	705	2.29	97.49
25 year	Joys Road Trib	Reach 1	705	2.64	97.60
100 year	Joys Road Trib	Reach 1	705	3.17	97.79
2 Year	Joys Road Trib	Reach 1	664	1.57	97.26
5 Year	Joys Road Trib	Reach 1	664	2.00	97.40
10 Year	Joys Road Trib	Reach 1	664	2.29	97.49
25 year	Joys Road Trib	Reach 1	664	2.64	97.61
100 year	Joys Road Trib	Reach 1	664	3.17	97.79
2 Year	Joys Road Trib	Reach 1	635	1.57	97.19
5 Year	Joys Road Trib	Reach 1	635	2.00	97.31
10 Year	Joys Road Trib	Reach 1	635	2.29	97.40
25 year	Joys Road Trib	Reach 1	635	2.64	97.50
100 year	Joys Road Trib	Reach 1	635	3.17	97.67
2 Year	Joys Road Trib	Reach 1	622	1.57	97.08
5 Year	Joys Road Trib	Reach 1	622	2.00	97.14
10 Year	Joys Road Trib	Reach 1	622	2.29	97.18
25 year	Joys Road Trib	Reach 1	622	2.64	97.21
100 year	Joys Road Trib	Reach 1	622	3.17	97.26
2 Year	Joys Road Trib	Reach 1	602	1.57	97.07
5 Year	Joys Road Trib	Reach 1	602	2.00	97.14
10 Year	Joys Road Trib	Reach 1	602	2.29	97.17
25 year	Joys Road Trib	Reach 1	602	2.64	97.22
100 year	Joys Road Trib	Reach 1	602	3.17	97.27
2 Year	Joys Road Trib	Reach 1	322	1.57	96.54
5 Year	Joys Road Trib	Reach 1	322	2.00	96.58
10 Year	Joys Road Trib	Reach 1	322	2.29	96.61
25 year	Joys Road Trib	Reach 1	322	2.64	96.65
100 year	Joys Road Trib	Reach 1	322	3.17	96.71

Maximum Spring Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Joys Road Trib	Reach 1	275	1.57	96.31
5 Year	Joys Road Trib	Reach 1	275	2.00	96.39
10 Year	Joys Road Trib	Reach 1	275	2.29	96.44
25 year	Joys Road Trib	Reach 1	275	2.64	96.49
100 year	Joys Road Trib	Reach 1	275	3.17	96.56
2 Year	Joys Road Trib	Reach 1	30	1.57	96.12
5 Year	Joys Road Trib	Reach 1	30	2.00	96.19
10 Year	Joys Road Trib	Reach 1	30	2.29	96.22
25 year	Joys Road Trib	Reach 1	30	2.64	96.26
100 year	Joys Road Trib	Reach 1	30	3.17	96.29

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 3	3165	1.33	96.50
5 Year	Van Gaal Drain	Reach 3	3165	2.15	96.61
10 Year	Van Gaal Drain	Reach 3	3165	2.74	96.67
25 year	Van Gaal Drain	Reach 3	3165	3.51	96.72
100 year	Van Gaal Drain	Reach 3	3165	4.81	96.75
2 Year	Van Gaal Drain	Reach 3	3149	1.33	96.46
5 Year	Van Gaal Drain	Reach 3	3149	2.15	96.57
10 Year	Van Gaal Drain	Reach 3	3149	2.74	96.62
25 year	Van Gaal Drain	Reach 3	3149	3.51	96.66
100 year	Van Gaal Drain	Reach 3	3149	4.81	96.72
2 Year	Van Gaal Drain	Reach 3	3086	1.33	96.35
5 Year	Van Gaal Drain	Reach 3	3086	2.15	96.47
10 Year	Van Gaal Drain	Reach 3	3086	2.74	96.53
25 year	Van Gaal Drain	Reach 3	3086	3.51	96.58
100 year	Van Gaal Drain	Reach 3	3086	4.81	96.65
2 Year	Van Gaal Drain	Reach 3	3016	1.33	96.26
5 Year	Van Gaal Drain	Reach 3	3016	2.15	96.41
10 Year	Van Gaal Drain	Reach 3	3016	2.74	96.48
25 year	Van Gaal Drain	Reach 3	3016	3.51	96.54
100 year	Van Gaal Drain	Reach 3	3016	4.81	96.61
2 Year	Van Gaal Drain	Reach 3	2980	1.33	96.21
5 Year	Van Gaal Drain	Reach 3	2980	2.15	96.36
10 Year	Van Gaal Drain	Reach 3	2980	2.74	96.44
25 year	Van Gaal Drain	Reach 3	2980	3.51	96.51
100 year	Van Gaal Drain	Reach 3	2980	4.81	96.57
2 Year	Van Gaal Drain	Reach 3	2851	1.33	95.90
5 Year	Van Gaal Drain	Reach 3	2851	2.15	96.10
10 Year	Van Gaal Drain	Reach 3	2851	2.74	96.21
25 year	Van Gaal Drain	Reach 3	2851	3.51	96.31
100 year	Van Gaal Drain	Reach 3	2851	4.81	96.41
2 Year	Van Gaal Drain	Reach 3	2808	1.33	95.86
5 Year	Van Gaal Drain	Reach 3	2808	2.15	96.07
10 Year	Van Gaal Drain	Reach 3	2808	2.74	96.18
25 year	Van Gaal Drain	Reach 3	2808	3.51	96.28
100 year	Van Gaal Drain	Reach 3	2808	4.81	96.38
2 Year	Van Gaal Drain	Reach 3	2658	1.33	95.78
5 Year	Van Gaal Drain	Reach 3	2658	2.15	95.99
10 Year	Van Gaal Drain	Reach 3	2658	2.74	96.10
25 year	Van Gaal Drain	Reach 3	2658	3.51	96.19
100 year	Van Gaal Drain	Reach 3	2658	4.81	96.28

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	2554	1.95	95.77
5 Year	Van Gaal Drain	Reach 2	2554	3.20	95.98
10 Year	Van Gaal Drain	Reach 2	2554	4.11	96.09
25 year	Van Gaal Drain	Reach 2	2554	5.28	96.18
100 year	Van Gaal Drain	Reach 2	2554	7.27	96.27
2 Year	Van Gaal Drain	Reach 2	2478	1.95	95.72
5 Year	Van Gaal Drain	Reach 2	2478	3.20	95.92
10 Year	Van Gaal Drain	Reach 2	2478	4.11	96.02
25 year	Van Gaal Drain	Reach 2	2478	5.28	96.09
100 year	Van Gaal Drain	Reach 2	2478	7.27	96.16
2 Year	Van Gaal Drain	Reach 2	2157	1.95	94.93
5 Year	Van Gaal Drain	Reach 2	2157	3.20	95.12
10 Year	Van Gaal Drain	Reach 2	2157	4.11	95.25
25 year	Van Gaal Drain	Reach 2	2157	5.28	95.37
100 year	Van Gaal Drain	Reach 2	2157	7.27	65.47
2 Year	Van Gaal Drain	Reach 2	2076	2.80	94.74
5 Year	Van Gaal Drain	Reach 2	2076	4.41	94.97
10 Year	Van Gaal Drain	Reach 2	2076	5.53	95.08
25 year	Van Gaal Drain	Reach 2	2076	6.96	95.17
100 year	Van Gaal Drain	Reach 2	2076	9.54	95.26
2 Year	Van Gaal Drain	Reach 2	1974	2.80	94.61
5 Year	Van Gaal Drain	Reach 2	1974	4.41	94.84
10 Year	Van Gaal Drain	Reach 2	1974	5.53	94.93
25 year	Van Gaal Drain	Reach 2	1974	6.96	95.01
100 year	Van Gaal Drain	Reach 2	1974	9.54	95.10
2 Year	Van Gaal Drain	Reach 2	1922	2.80	94.55
5 Year	Van Gaal Drain	Reach 2	1922	4.41	94.79
10 Year	Van Gaal Drain	Reach 2	1922	5.53	94.86
25 year	Van Gaal Drain	Reach 2	1922	6.96	94.92
100 year	Van Gaal Drain	Reach 2	1922	9.54	94.99
2 Year	Van Gaal Drain	Reach 2	1833	2.80	94.47
5 Year	Van Gaal Drain	Reach 2	1833	4.41	94.69
10 Year	Van Gaal Drain	Reach 2	1833	5.53	94.74
25 year	Van Gaal Drain	Reach 2	1833	6.96	94.78
100 year	Van Gaal Drain	Reach 2	1833	9.54	94.85
2 Year	Van Gaal Drain	Reach 2	1796	2.80	94.44
5 Year	Van Gaal Drain	Reach 2	1796	4.41	94.66
10 Year	Van Gaal Drain	Reach 2	1796	5.53	94.71
25 year	Van Gaal Drain	Reach 2	1796	6.96	94.74
100 year	Van Gaal Drain	Reach 2	1796	9.54	94.80

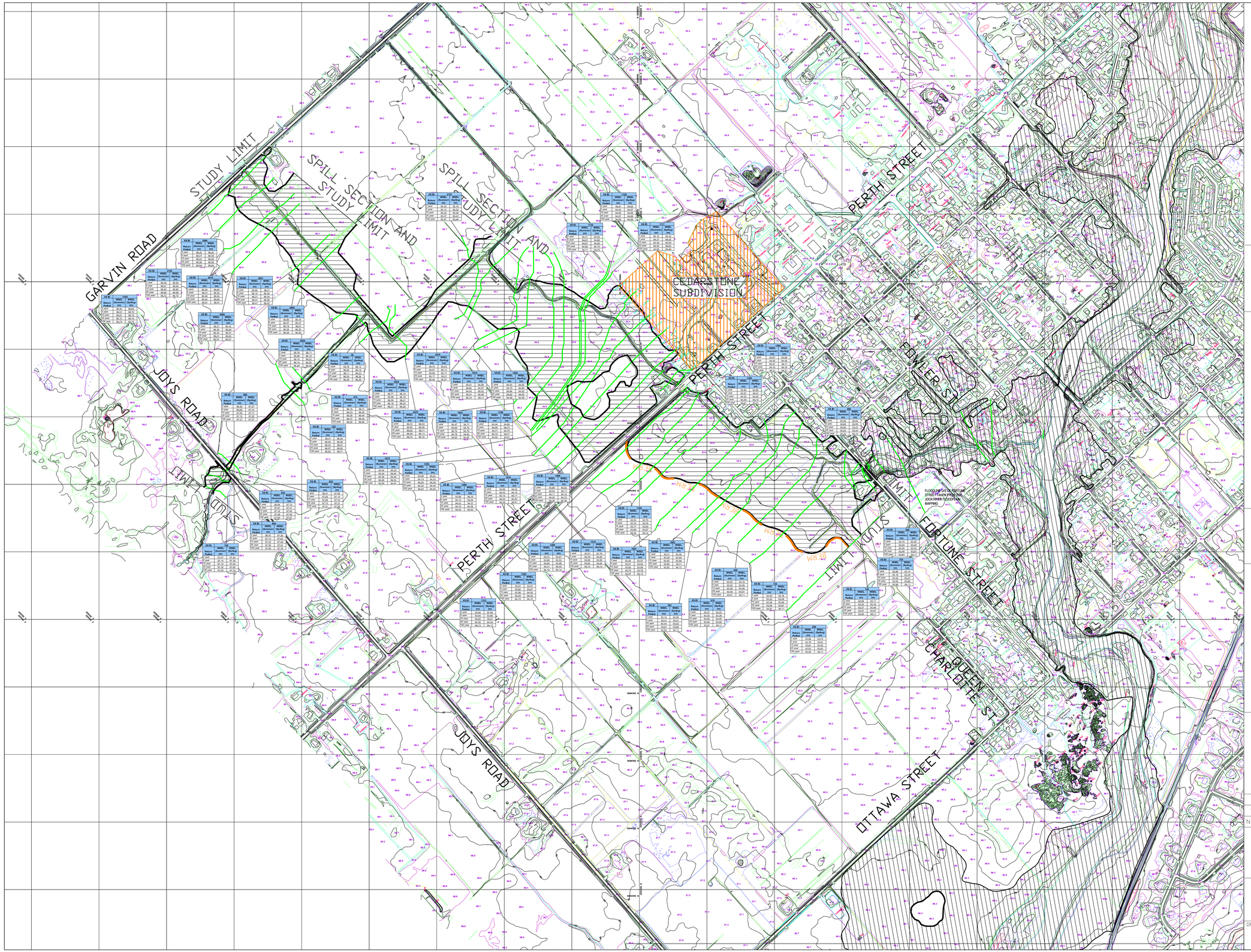
Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1735	2.80	94.41
5 Year	Van Gaal Drain	Reach 2	1735	4.41	94.63
10 Year	Van Gaal Drain	Reach 2	1735	5.53	94.67
25 year	Van Gaal Drain	Reach 2	1735	6.96	94.68
100 year	Van Gaal Drain	Reach 2	1735	9.54	94.71
2 Year	Van Gaal Drain	Reach 2	1728	2.80	94.41
5 Year	Van Gaal Drain	Reach 2	1728	4.41	94.62
10 Year	Van Gaal Drain	Reach 2	1728	5.53	94.66
25 year	Van Gaal Drain	Reach 2	1728	6.96	94.67
100 year	Van Gaal Drain	Reach 2	1728	9.54	94.69
2 Year	Van Gaal Drain	Reach 2	1717	2.80	94.15
5 Year	Van Gaal Drain	Reach 2	1717	4.41	94.37
10 Year	Van Gaal Drain	Reach 2	1717	5.53	94.49
25 year	Van Gaal Drain	Reach 2	1717	6.96	94.59
100 year	Van Gaal Drain	Reach 2	1717	9.54	94.69
2 Year	Van Gaal Drain	Reach 2	1615	2.80	94.04
5 Year	Van Gaal Drain	Reach 2	1615	4.41	94.24
10 Year	Van Gaal Drain	Reach 2	1615	5.53	94.36
25 year	Van Gaal Drain	Reach 2	1615	6.96	94.46
100 year	Van Gaal Drain	Reach 2	1615	9.54	94.60
2 Year	Van Gaal Drain	Reach 2	1555	2.80	93.99
5 Year	Van Gaal Drain	Reach 2	1555	4.41	94.19
10 Year	Van Gaal Drain	Reach 2	1555	5.53	94.29
25 year	Van Gaal Drain	Reach 2	1555	6.96	94.40
100 year	Van Gaal Drain	Reach 2	1555	9.54	94.53
2 Year	Van Gaal Drain	Reach 2	1488	2.80	93.96
5 Year	Van Gaal Drain	Reach 2	1488	4.41	94.13
10 Year	Van Gaal Drain	Reach 2	1488	5.53	94.23
25 year	Van Gaal Drain	Reach 2	1488	6.96	94.33
100 year	Van Gaal Drain	Reach 2	1488	9.54	94.45
2 Year	Van Gaal Drain	Reach 2	1416	2.80	93.89
5 Year	Van Gaal Drain	Reach 2	1416	4.41	94.03
10 Year	Van Gaal Drain	Reach 2	1416	5.53	94.10
25 year	Van Gaal Drain	Reach 2	1416	6.96	94.20
100 year	Van Gaal Drain	Reach 2	1416	9.54	94.39
2 Year	Van Gaal Drain	Reach 2	1400	2.80	93.89
5 Year	Van Gaal Drain	Reach 2	1400	4.41	94.03
10 Year	Van Gaal Drain	Reach 2	1400	5.53	94.11
25 year	Van Gaal Drain	Reach 2	1400	6.96	94.20
100 year	Van Gaal Drain	Reach 2	1400	9.54	94.36

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1364	2.80	93.87
5 Year	Van Gaal Drain	Reach 2	1364	4.41	94.00
10 Year	Van Gaal Drain	Reach 2	1364	5.53	94.07
25 year	Van Gaal Drain	Reach 2	1364	6.96	94.16
100 year	Van Gaal Drain	Reach 2	1364	9.54	94.31
2 Year	Van Gaal Drain	Reach 2	1340	3.64	93.85
5 Year	Van Gaal Drain	Reach 2	1340	5.57	93.97
10 Year	Van Gaal Drain	Reach 2	1340	6.92	94.03
25 year	Van Gaal Drain	Reach 2	1340	8.58	94.09
100 year	Van Gaal Drain	Reach 2	1340	11.43	94.21
2 Year	Van Gaal Drain	Reach 2	1312	3.87	93.84
5 Year	Van Gaal Drain	Reach 2	1312	5.93	93.95
10 Year	Van Gaal Drain	Reach 2	1312	7.38	94.00
25 year	Van Gaal Drain	Reach 2	1312	9.17	94.05
100 year	Van Gaal Drain	Reach 2	1312	12.20	94.14
2 Year	Van Gaal Drain	Reach 2	1302	3.87	93.81
5 Year	Van Gaal Drain	Reach 2	1302	5.93	93.92
10 Year	Van Gaal Drain	Reach 2	1302	7.38	93.98
25 year	Van Gaal Drain	Reach 2	1302	9.17	94.04
100 year	Van Gaal Drain	Reach 2	1302	12.20	94.15
2 Year	Van Gaal Drain	Reach 2	1268	3.87	93.75
5 Year	Van Gaal Drain	Reach 2	1268	5.93	93.88
10 Year	Van Gaal Drain	Reach 2	1268	7.38	93.94
25 year	Van Gaal Drain	Reach 2	1268	9.17	94.01
100 year	Van Gaal Drain	Reach 2	1268	12.20	94.14
2 Year	Van Gaal Drain	Reach 2	1212	3.87	93.61
5 Year	Van Gaal Drain	Reach 2	1212	5.93	93.78
10 Year	Van Gaal Drain	Reach 2	1212	7.38	93.85
25 year	Van Gaal Drain	Reach 2	1212	9.17	93.93
100 year	Van Gaal Drain	Reach 2	1212	12.20	94.10
2 Year	Van Gaal Drain	Reach 2	1169	3.87	93.53
5 Year	Van Gaal Drain	Reach 2	1169	5.93	93.70
10 Year	Van Gaal Drain	Reach 2	1169	7.38	93.77
25 year	Van Gaal Drain	Reach 2	1169	9.17	93.85
100 year	Van Gaal Drain	Reach 2	1169	12.20	94.04
2 Year	Van Gaal Drain	Reach 2	1091	3.87	93.40
5 Year	Van Gaal Drain	Reach 2	1091	5.93	93.57
10 Year	Van Gaal Drain	Reach 2	1091	7.38	93.65
25 year	Van Gaal Drain	Reach 2	1091	9.17	93.75
100 year	Van Gaal Drain	Reach 2	1091	12.20	93.97

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Van Gaal Drain	Reach 2	1002	3.87	93.21
5 Year	Van Gaal Drain	Reach 2	1002	5.93	93.39
10 Year	Van Gaal Drain	Reach 2	1002	7.38	93.50
25 year	Van Gaal Drain	Reach 2	1002	9.17	93.65
100 year	Van Gaal Drain	Reach 2	1002	12.20	93.92
2 Year	Van Gaal Drain	Reach 2	961	3.87	93.14
5 Year	Van Gaal Drain	Reach 2	961	5.93	93.31
10 Year	Van Gaal Drain	Reach 2	961	7.38	93.44
25 year	Van Gaal Drain	Reach 2	961	9.17	93.61
100 year	Van Gaal Drain	Reach 2	961	12.20	93.92
2 Year	Van Gaal Drain	Reach 2	910	3.87	93.07
5 Year	Van Gaal Drain	Reach 2	910	5.93	93.25
10 Year	Van Gaal Drain	Reach 2	910	7.38	93.40
25 year	Van Gaal Drain	Reach 2	910	9.17	93.59
100 year	Van Gaal Drain	Reach 2	910	12.20	93.91
2 Year	Van Gaal Drain	Reach 2	840	3.87	93.00
5 Year	Van Gaal Drain	Reach 2	840	5.93	93.22
10 Year	Van Gaal Drain	Reach 2	840	7.38	93.38
25 year	Van Gaal Drain	Reach 2	840	9.17	93.58
100 year	Van Gaal Drain	Reach 2	840	12.20	93.91
2 Year	Van Gaal Drain	Reach 1	746	5.36	92.96
5 Year	Van Gaal Drain	Reach 1	746	8.09	93.20
10 Year	Van Gaal Drain	Reach 1	746	10.02	93.37
25 year	Van Gaal Drain	Reach 1	746	12.40	93.57
100 year	Van Gaal Drain	Reach 1	746	16.38	93.90
2 Year	Van Gaal Drain	Reach 1	705	5.36	92.88
5 Year	Van Gaal Drain	Reach 1	705	8.09	93.16
10 Year	Van Gaal Drain	Reach 1	705	10.02	93.34
25 year	Van Gaal Drain	Reach 1	705	12.40	93.55
100 year	Van Gaal Drain	Reach 1	705	16.38	93.89
2 Year	Van Gaal Drain	Reach 1	668	5.36	92.72
5 Year	Van Gaal Drain	Reach 1	668	8.09	93.04
10 Year	Van Gaal Drain	Reach 1	668	10.02	93.25
25 year	Van Gaal Drain	Reach 1	668	12.40	93.48
100 year	Van Gaal Drain	Reach 1	668	16.38	93.84
2 Year	Van Gaal Drain	Reach 1	666	5.36	92.48
5 Year	Van Gaal Drain	Reach 1	666	8.09	92.66
10 Year	Van Gaal Drain	Reach 1	666	10.02	92.80
25 year	Van Gaal Drain	Reach 1	666	12.40	93.03
100 year	Van Gaal Drain	Reach 1	666	16.38	93.32

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Moore Drain	Reach 1	298	0.67	93.68
5 Year	Moore Drain	Reach 1	298	1.06	93.78
10 Year	Moore Drain	Reach 1	298	1.32	93.81
25 year	Moore Drain	Reach 1	298	1.64	93.83
100 year	Moore Drain	Reach 1	298	2.17	93.90
2 Year	Moore Drain	Reach 1	130	0.67	93.00
5 Year	Moore Drain	Reach 1	130	1.06	93.22
10 Year	Moore Drain	Reach 1	130	1.32	93.38
25 year	Moore Drain	Reach 1	130	1.64	93.58
100 year	Moore Drain	Reach 1	130	2.17	93.91
2 Year	Joys Road Trib	Reach 1	705	0.66	97.07
5 Year	Joys Road Trib	Reach 1	705	1.11	97.14
10 Year	Joys Road Trib	Reach 1	705	1.44	97.19
25 year	Joys Road Trib	Reach 1	705	1.87	97.35
100 year	Joys Road Trib	Reach 1	705	2.62	97.59
2 Year	Joys Road Trib	Reach 1	664	0.66	96.97
5 Year	Joys Road Trib	Reach 1	664	1.11	97.12
10 Year	Joys Road Trib	Reach 1	664	1.44	97.22
25 year	Joys Road Trib	Reach 1	664	1.87	97.36
100 year	Joys Road Trib	Reach 1	664	2.62	97.60
2 Year	Joys Road Trib	Reach 1	635	0.66	96.94
5 Year	Joys Road Trib	Reach 1	635	1.11	97.07
10 Year	Joys Road Trib	Reach 1	635	1.44	97.16
25 year	Joys Road Trib	Reach 1	635	1.87	97.28
100 year	Joys Road Trib	Reach 1	635	2.62	97.50
2 Year	Joys Road Trib	Reach 1	622	0.66	96.91
5 Year	Joys Road Trib	Reach 1	622	1.11	97.00
10 Year	Joys Road Trib	Reach 1	622	1.44	97.06
25 year	Joys Road Trib	Reach 1	622	1.87	97.13
100 year	Joys Road Trib	Reach 1	622	2.62	97.21
2 Year	Joys Road Trib	Reach 1	602	0.66	96.90
5 Year	Joys Road Trib	Reach 1	602	1.11	96.99
10 Year	Joys Road Trib	Reach 1	602	1.44	97.05
25 year	Joys Road Trib	Reach 1	602	1.87	97.12
100 year	Joys Road Trib	Reach 1	602	2.62	97.21
2 Year	Joys Road Trib	Reach 1	322	0.66	96.41
5 Year	Joys Road Trib	Reach 1	322	1.11	96.49
10 Year	Joys Road Trib	Reach 1	322	1.44	96.53
25 year	Joys Road Trib	Reach 1	322	1.87	96.57
100 year	Joys Road Trib	Reach 1	322	2.62	96.65

Maximum Summer Scenario Results					
Return Period	*River*	*Reach*	*River Station*	*Q Total (m^3/s)*	*W.S. Elev (m)*
2 Year	Joys Road Trib	Reach 1	275	0.66	96.18
5 Year	Joys Road Trib	Reach 1	275	1.11	96.23
10 Year	Joys Road Trib	Reach 1	275	1.44	96.28
25 year	Joys Road Trib	Reach 1	275	1.87	96.37
100 year	Joys Road Trib	Reach 1	275	2.62	96.50
2 Year	Joys Road Trib	Reach 1	30	0.66	95.78
5 Year	Joys Road Trib	Reach 1	30	1.11	96.00
10 Year	Joys Road Trib	Reach 1	30	1.44	96.11
25 year	Joys Road Trib	Reach 1	30	1.87	96.20
100 year	Joys Road Trib	Reach 1	30	2.62	96.29



LEGEND :

- 100 Yr Floodlines
- Cross Section Locations
- Cedarstone Subdivision
- Water Surface Elevation Tables

XS ID	xxx	
Return Period	WSEL (Summer) (m)	WSEL (Spring) (m)
2 year	XXX	XXX
5 year	XXX	XXX
10 year	XXX	XXX
25 year	XXX	XXX
100 year	XXX	XXX

SCALE : 1: 5000

0 100 200 300 400 500 m

N

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836-3884
GATINEAU (819) 243-6858

CLIENT :

MATTAMY homes

PROJECT :

Van Gaal and Arbuckle Drain 2, 5, 10, 25, and 100 Yr WSEL

No.	BY	DATE	DESCRIPTION	BY
1	CB	03/25/2010	ISSUED FOR REVIEW	CB

WSEL for the 2, 5, 10, 25, and 100 Year Design Storms

DESIGNED:
DRAWN: CB
VERIFIED: BW
APPROVED: JFS

DRAWING REF.

DATE	PROJECT No.
Mar/10	709(02)

APPENDIX F

Hydrogeology

TECHNICAL MEMORANDUM

DATE August 11, 2011 **PROJECT No.** 08-1122-0078 (9600)

TO Ms. Susan Murphy
Mattamy Homes

FROM Dale Holtze
Brian Byerley

EMAIL Dale_Holtze@Golder.com
Brian_Byerley@Golder.com

GROUNDWATER MONITORING PROGRAM
PROPOSED MATTAMY HOMES DEVELOPMENT
RICHMOND (OTTAWA), ONTARIO

This memo presents the results of a one year groundwater monitoring program conducted by Golder Associates Ltd. (Golder) at the site of the proposed Mattamy Homes (Mattamy) development in the Village of Richmond (in the City of Ottawa), Ontario (see Key Plan: Figure 1). The results of previous hydrogeological investigation conducted at the site by Golder are discussed in the Technical Memorandum entitled: Hydrogeological Investigation Proposed Mattamy Homes Development Richmond (Ottawa), Ontario, dated July 16, 2010, which includes a summary of the drilling of eight boreholes equipped with monitoring and/or multi-level monitoring wells, description of subsurface conditions and hydraulic conductivity testing performed in all groundwater monitors.

Monitoring Program

The groundwater monitoring program included monthly groundwater level measurements from April 2010 to April 2011 at monitoring wells MW10-1, MW10-2, MW10-3, MW10-4, MW10-5, MW10-6, MW10-7 and MW10-8, located as shown on Figure 2. Groundwater monitor MW10-5 was observed to be damaged in June 2010 (MW10-5A) and July 2010 (MW10-5B); therefore groundwater levels are not available for the remainder of the monitoring program at this location.

Groundwater levels at monitor MW10-6A (bedrock) was measured continuously (two hour interval) using a transducer from March 19 to April 21, 2011 in order to assess the hydrogeological response of the shallow overburden and bedrock aquifers related to the spring melt and precipitation recharge events. Average daily climatic data was obtained from Environment Canada database at the Ottawa-Macdonald Cartier International Airport. Local rain gauge data for the period between August 1 to October 3, 2010, was also provided by the City of Ottawa. Monitor MW10-6B (overburden) was frozen during that time period and thus could not provide useful data.

Results

Monthly groundwater levels and description of the subsurface conditions at each monitoring well are presented in Table 1. Groundwater levels are subject to seasonal fluctuations ranging from 0.5 metres (MW10-4A) to 1.8 metres (MW10-6B) in overburden monitoring wells (see Figures 2 and 3) and 0.8 metres (MW10-3A) to

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1.3 metres (MW10-8) in bedrock monitoring wells (see Figure 4). The groundwater levels generally vary from less than 0.1 to 2 metres below ground surface, with the exception of bedrock monitor MW10-3A where water levels were up to 0.2 metres above ground surface, indicating artesian conditions in the upper bedrock. Continuous groundwater level measurements at monitors MW10-6A (bedrock) and MW10-6B (overburden) in Spring 2011 are presented in Figure 5.

Discussion

Groundwater levels are subject to seasonal variability: minimum groundwater levels are encountered in the summer and winter months and maximum levels occur in spring and fall.

The greatest fluctuations in groundwater levels occurred at MW10-7 and MW10-6B (overburden monitors) and at MW10-6A and MW10-8 (bedrock monitors). Shallow groundwater levels are influenced significantly by infiltration, which vary according to precipitation, snowmelt and evapotranspiration.

The horizontal groundwater flow direction within the overburden is interpreted to be controlled by local surface water drainage features (i.e. Jock River, drains and ditches).

Multi-level monitors installed within the overburden and bedrock were used to assess vertical hydraulic gradients. In general, the hydraulic gradients indicated groundwater was observed to consistent upward flow from the bedrock to the overburden at MW10-3 and downward at MW10-6.

If you have any questions regarding the content of this memo, please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Dale Holtze

Dale Holtze, B.Sc., GIT.
Environmental Consultant

for Brian Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Associate

DH/BTB/sg
n:\active\2008\1122 - environmental\08-1122-0078 mattamy richmond\phase 9600\mem 11aug11 groundwater levels.docx

Attachments: Table 1 – Groundwater Monitoring Data
Figure 1: Key Plan
Figure 2: Spring 2011 Groundwater Levels
Figure 3: Groundwater Levels in Overburden Monitoring Wells April 2010 to April 2011
Figure 4: Groundwater Levels in Bedrock Monitoring Wells April 2010 to April 2011
Figure 5: Continuous Measurements of Groundwater Levels at MW10-6 March and April 2011

Table 1: Groundwater Monitoring Data

Well ID	Ground Surface Elevation (geodetic)	Screen depth (middle of screen) (mbgs)	Soil/rock at depth of well screen	Groundwater Level (mbgs)						
				Apr.29 & 30, 2010	May 14, 2010	Jun.16, 2010	Jul. 15, 2010	Aug. 20, 2011	Sept. 16, 2010	Oct. 1, 2010
MW10-1A	94.55	1.11	Grey silty Clay	0.73	0.78	0.80	0.81	0.78	0.81	0.61
MW10-1B	94.55	1.21	Grey brown silty Clay (weathered crust)	0.74	0.77	0.80	0.79	0.79	0.81	0.62
MW10-2	94.90	2.12	Grey brown silty find Sand	0.73	0.67	0.86	0.66	0.96	0.94	0.17
MW10-3A	94.0	4.55	Fresh grey Dolomite	0.22	0.26	0.58	0.28	0.23	0.25	-0.09[1]
MW10-3B	94.0	2.12	Grey brown silty Clay (weathered crust)/grey brown fine sandy Silt	0.82	0.81	0.87	0.79	0.87	0.85	0.44
MW10-4A	94.34	3.03	Grey brown fine sandy Silt	0.48	0.47	0.56	0.49	0.64	0.62	0.11
MW10-4B	94.34	1.21	Grey brown silty Clay (weathered crust)	0.47	0.49	0.56	0.49	0.64	0.62	0.08
MW10-5A	95.65	3.03	Glacial Till	0.82	0.79	--[2]	--[2]	--[2]	--[2]	--[2]
MW10-5B	95.65	1.21	Grey brown silty find Sand	0.89	0.88	1.33	--[2]	--[2]	--[2]	--[2]
MW10-6A	95.67	4.24	Fresh grey Dolomite	1.38	1.38	1.98	1.34	1.31	1.52	0.66
MW10-6B	95.67	1.52	Grey brown silty Sand trace Clay	1.29	1.28	1.84	1.59	1.12	1.55	0.31
MW10-7	95.36	2.42	Grey brown silty fine Sand	0.51	0.49	1.09	0.98	0.38	0.47	0.03
MW10-8	93.32	2.42	Weathered to fresh grey Dolomite	1.02	1.15	1.52	1.39	1.24	1.29	0.23

Golder Associates

Well ID	Ground Surface Elevation (geodetic)	Screen depth (middle of screen) (mbgs)	Soil/rock at depth of well screen	Groundwater Level (mbgs)						
				Oct 18, 2010	Nov. 19, 2010	Dec. 15, 2010	Jan. 18, 2011	Feb. 14, 2011	Mar. 15, 2011	Apr. 15, 2011
MW10-1A	94.55	1.11	Grey silty Clay	0.77	0.72	0.78	1.00	1.21	0.89	0.64
MW10-1B	94.55	1.21	Grey brown silty Clay (weathered crust)	0.75	0.72	0.78	0.97	1.17	0.90	0.66
MW10-2	94.90	2.12	Grey brown silty find Sand	0.59	0.34	0.55	0.78	0.89	0.56	0.13
MW10-3A	94.0	4.55	Fresh grey Dolomite	0.08	-0.06[1]	--[3]	--[3]	--[3]	--[3]	-0.21[1]
MW10-3B	94.0	2.12	Grey brown silty Clay (weathered crust)/grey brown fine sandy Silt	0.72	0.56	0.73	0.90	0.77	0.69	0.29
MW10-4A	94.34	3.03	Grey brown fine sandy Silt	0.47	0.27	0.44	0.53	0.64	0.41	0.21
MW10-4B	94.34	1.21	Grey brown silty Clay (weathered crust)	0.46	0.25	0.44	0.56	0.65	--[3]	0.26
MW10-5A	95.65	3.03	Glacial Till	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
MW10-5B	95.65	1.21	Grey brown silty find Sand	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
MW10-6A	95.67	4.24	Fresh grey Dolomite	0.84	0.67	0.68	1.22	1.44	0.56	0.46
MW10-6B	95.67	1.52	Grey brown silty Sand trace Clay	0.62	0.26	0.50	1.16	1.42	--[3]	0.05
MW10-7	95.36	2.42	Grey brown silty fine Sand	0.06	0.04	0.03	--[3]	--[3]	--[3]	0.02
MW10-8	93.32	2.42	Weathered to fresh grey Dolomite	0.31	0.26	0.27	0.80	0.81	--[3]	0.19

Notes: [1] Artesian conditions exist. Groundwater level above ground surface.
[2] Monitoring well MW 10-5 A and B vandalized and groundwater levels not available after May 14, 2010.
[3] Groundwater in monitoring well frozen. Depth to groundwater level could not be measured.

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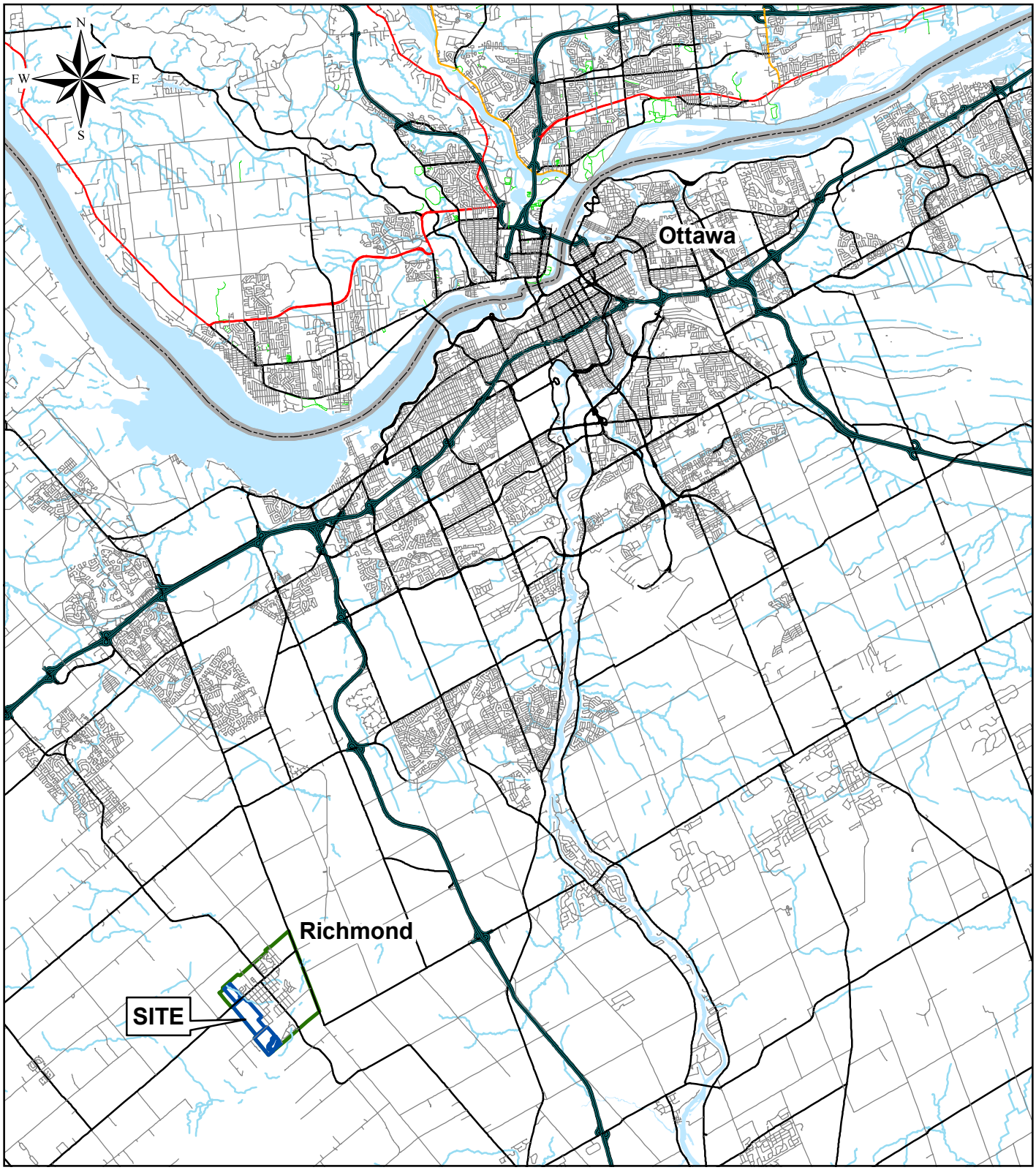


REFERENCE

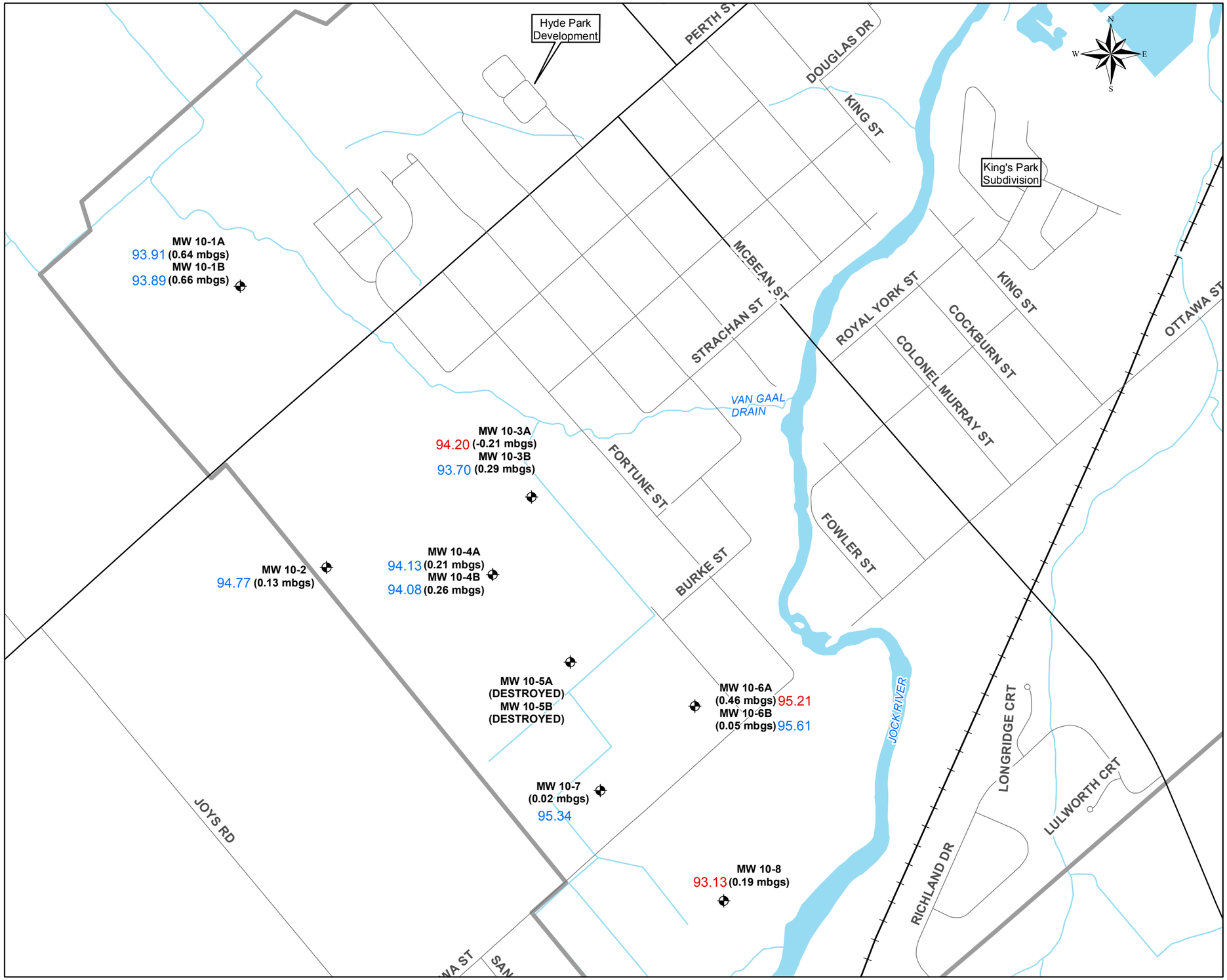
Digital base map data supplied by DMTI Spatial Inc. CANMAP, 2005

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 18

5,000 0 5,000

SCALE 1:200,000

Golder Associates, Ottawa, Ontario	DATE 10 Aug 2011	TITLE	**KEY PLAN**
	DESIGN JPAO		
	GIS ABD		
PROJECT No. 08-1122-0078	CHECK DH	PROJECT MATTAMY HOMES VILLAGE OF RICHMOND	**FIGURE: 1**
SCALE AS SHOWN / REV. 0	REVIEW BTB		



LEGEND

- MONITORING WELL (CURRENT INVESTIGATION) (0.64 mbgs) - SPRING 2011 GROUNDWATER LEVEL, metres below ground surface
- MAJOR ROAD
- LOCAL ROAD
- RAILWAY
- RICHMOND VILLAGE BOUNDARY
- WATERCOURSE
- SURFACE WATER
- 95.34 SPRING 2011 GROUNDWATER ELEVATION IN OVERBURDEN
- 95.34 SPRING 2011 GROUNDWATER ELEVATION IN BEDROCK

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. TECHNICAL MEMO NO. 08-1122-0078 PHASE 9600

REFERENCE

DIGITAL DATA PROVIDED BY ONTARIO MINISTRY OF NATURAL RESOURCES, USED UNDER LICENSE © QUEEN'S PRINTER OF ONTARIO, 2008.
WATER WELLS PROVIDED BY ONTARIO MINISTRY OF ENVIRONMENT, 2006.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

250 0 250
SCALE 1:10,000 METRES

PROJECT
MATTAMY HOMES
VILLAGE OF RICHMOND

TITLE
SPRING 2011 GROUNDWATER LEVELS

Golder Associates
Ottawa, Ontario

PROJECT No. 08-1122-0078			SCALE AS SHOWN	REV. 0
DESIGN	DH	10 Aug. 2011	FIGURE 2	
GIS	BR	10 Aug. 2011		
CHECK	DH	10 Aug. 2011		
REVIEW	JPAO	11 Aug. 2011		

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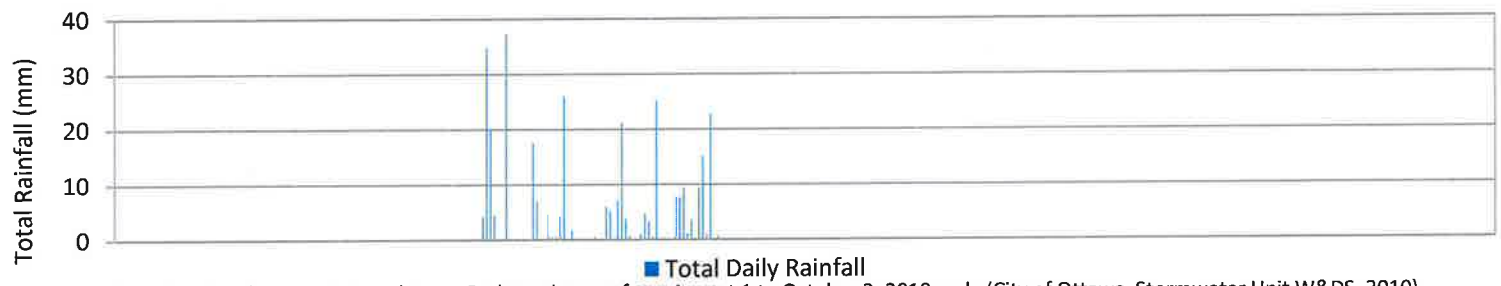
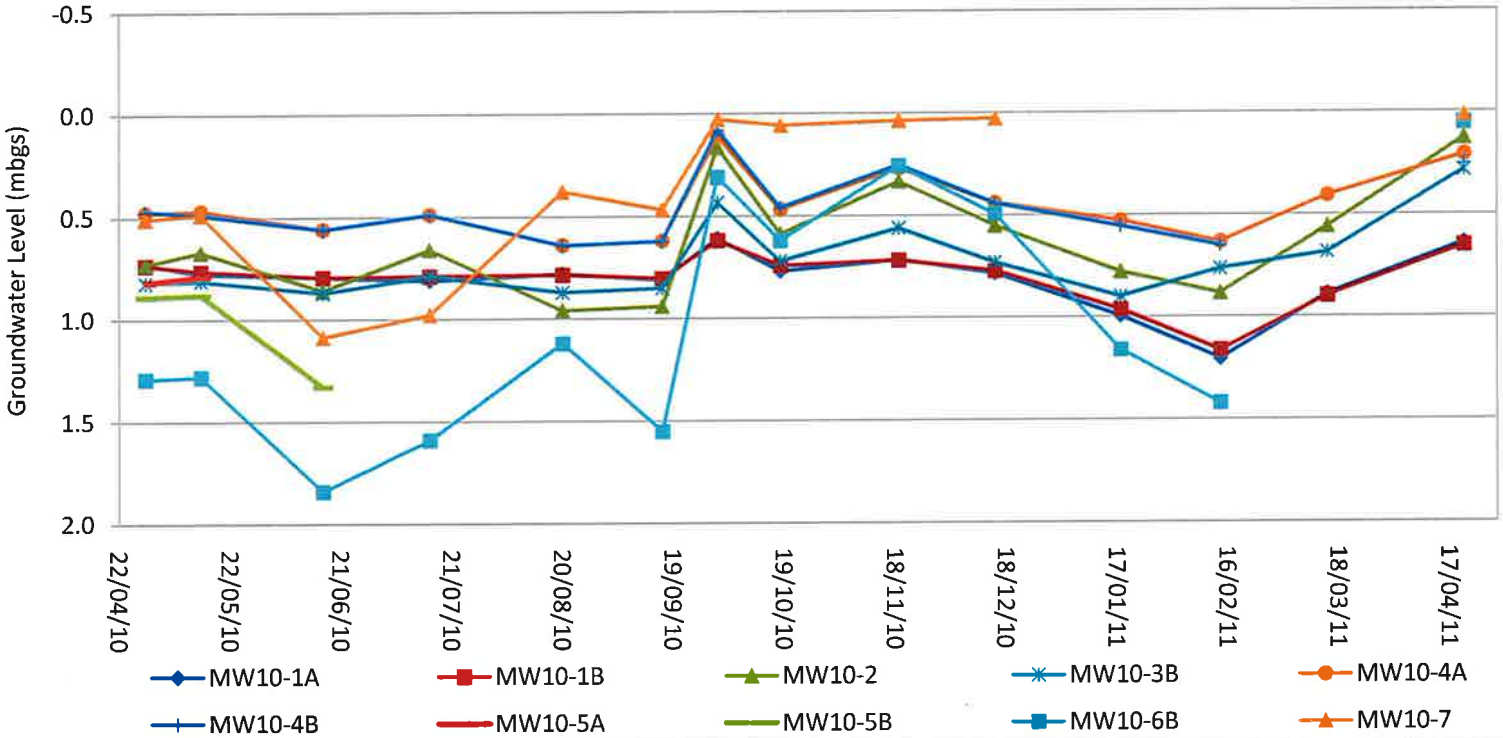
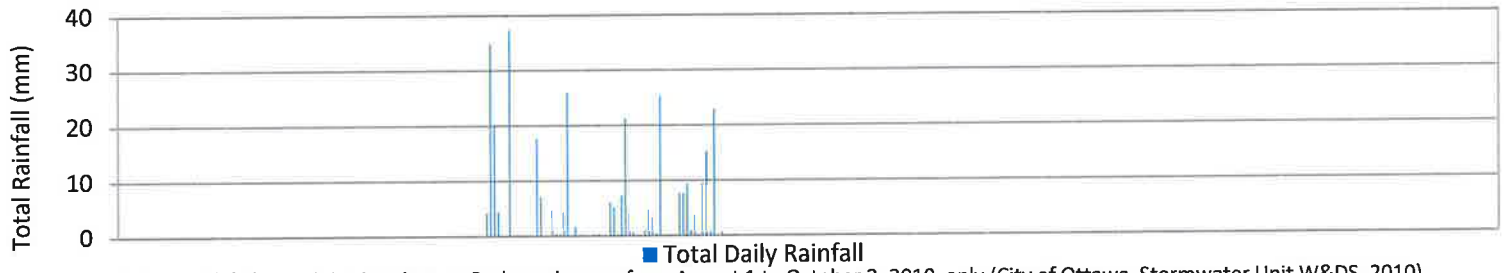


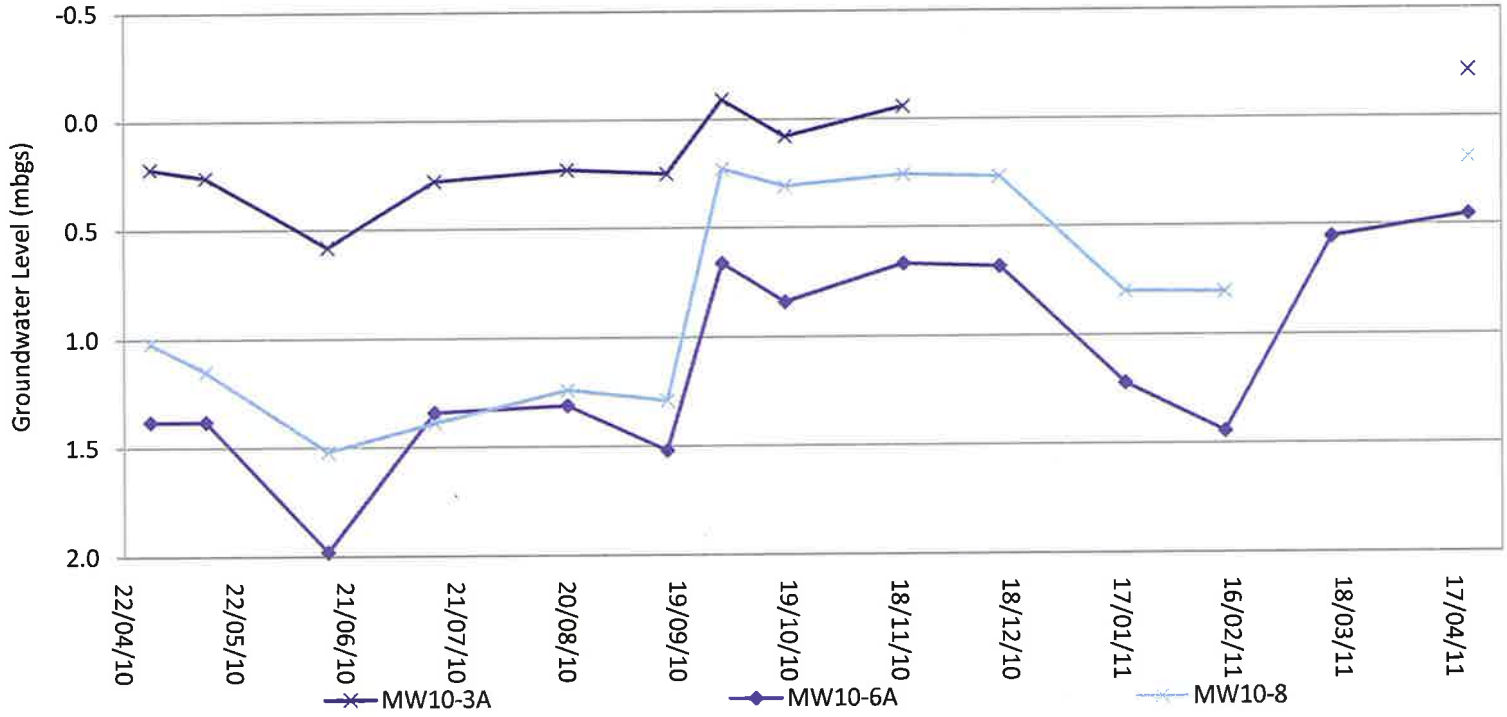
Note: Total daily precipitation data at Redmond gauge from August 1 to October 3, 2010 only (City of Ottawa, Stormwater Unit W&DS, 2010).



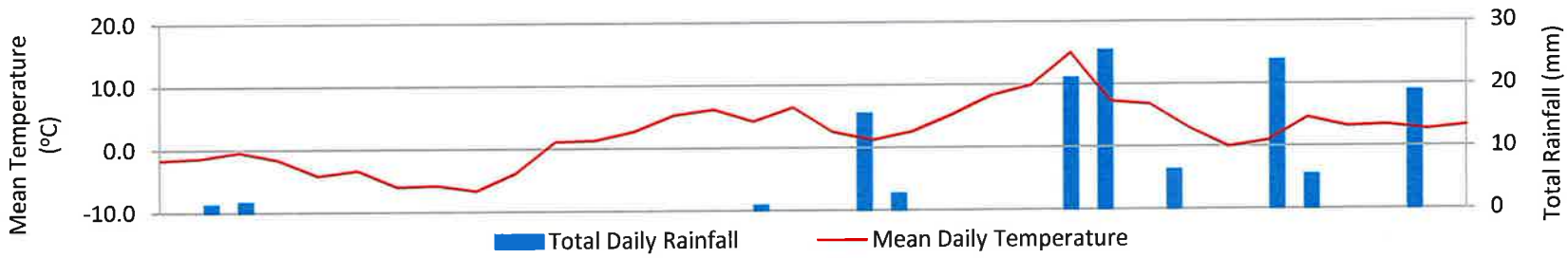
Golder Associates	Date: August 2011 Project: 08-1122-0078 (9600)	Drawn: DH Checked: BTB	Groundwater Levels in Overburden Monitoring Wells April 2010 to April 2011	Figure 3



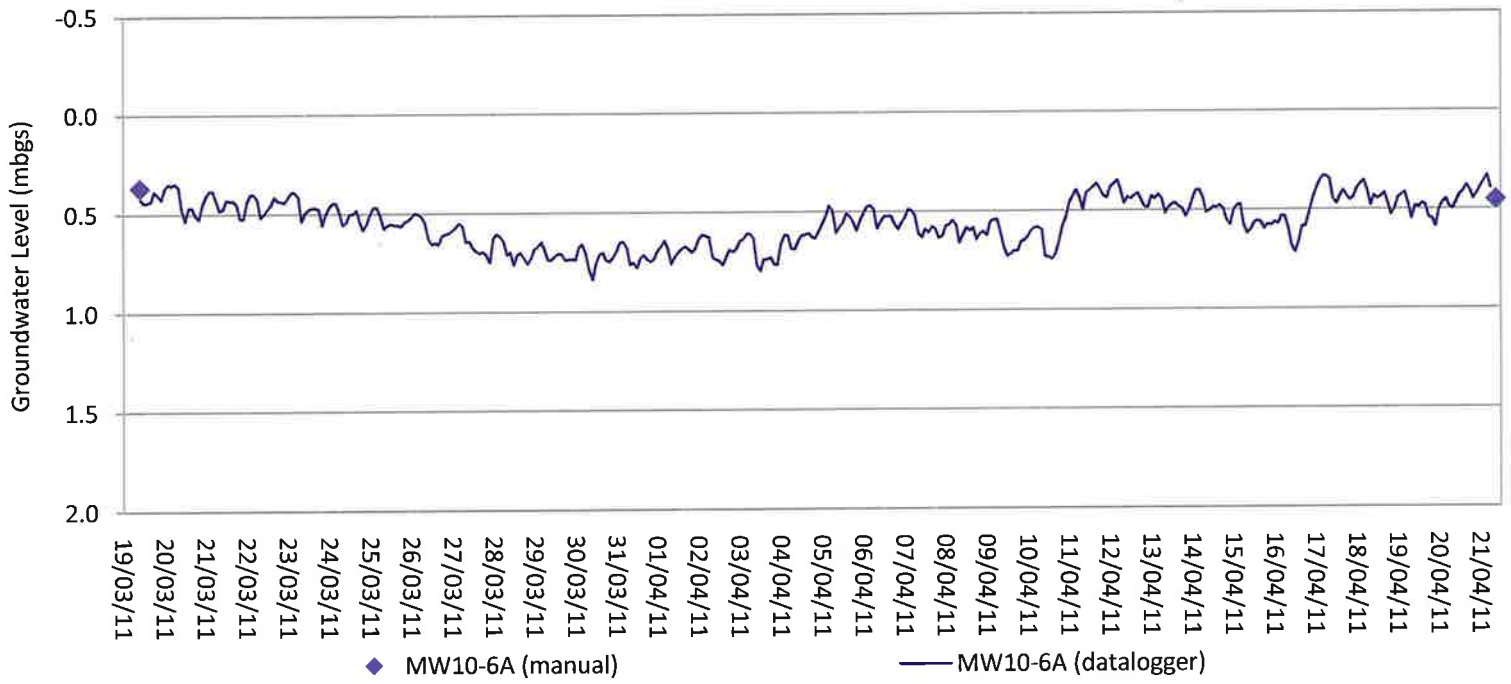
Note: Total daily precipitation data at Redmond gauge from August 1 to October 3, 2010 only (City of Ottawa, Stormwater Unit W&DS, 2010).



Golder Associates	Date: August 2011 Project: 08-1122-0078 (9600)	Drawn: DH Checked: BTB	Groundwater Levels in Bedrock Monitoring Wells April 2010 to April 2011	Figure 4



Note: Total daily precipitation and temperature data at Ottawa Macdonald -Cartier nternational Airport (Environment Canada, 2010).



Notes: MW10-6A is situated in the upper bedrock .

Golder Associates	Date: August 2011 Project: 08-1122-0078 (9600)	Drawn: DH Checked: BTB	Continuous Measurements of Groundwater Levels at MW10-6 During March and April 2011	Figure 5

APPENDIX G

Evaluation of Alternatives

Richmond Village (South) Limited
Option 1

Stage 1 Estimate
Cost Summary

			Unit	Approx. Qty.		Unit Rate		Estimated Value
A	**Site Preparation**							
	A.1	Strip and Stockpile Top Soil	m^3	335,554	$	6.00	$	2,013,000.00
	A.2	Site Grading - Cut to Fill	m^3	180,543	$	3.00	$	542,000.00
	A.3	Import Fill	m^3	1,302,158	$	18.00	$	23,439,000.00
	A.4	Re-use top soil as fill	m^3	201,332	$	6.00	$	1,208,000.00
						Sub-Total Subsection A	$	27,202,000.00
B	**Stormwater Conveyance**							
	B.1	Local Storm Sewer	m	9,953.5	$	445.00	$	4,429,000.00
	B.2	Trunk Storm Sewers	m	7,894.5	$	900.00	$	7,105,000.00
						Sub-Total Subsection B	$	11,534,000.00
						Estimated Capital Cost	**$**	**38,736,000.00**
C	**Estimated Annual Maintenance Cost**							
	C.1	Local Storm Sewer - Flushing	m	9,953.5	$	5.00	$	50,000.00
	C.2	Trunk Storm Sewer - Flushing	m	7,894.5	$	6.00	$	47,000.00
						Estimated Life Cycle Cost	**$**	**97,000.00**

Notes:
1) Import Fill required is net fill required less re-use top soil as fill.
2) Re-use top soil as fill assumes 60% of stripped and stock piled top soil is available for fill material.

Richmond Village (South) Limited
Option 2

Stage 1 Estimate
Cost Summary

			Unit	Approx. Qty.		Unit Rate		Estimated Value
A	**Site Preparation**							
	A.1	Strip and Stockpile Top Soil	m^3	335,554	$	6.00	$	2,013,000.00
	A.2	Site Grading - Cut to Fill	m^3	222,732	$	3.00	$	668,000.00
	A.3	Import Fill	m^3	351,953	$	18.00	$	6,335,000.00
	A.4	Re-use top soil as fill	m^3	201,332	$	6.00	$	1,208,000.00
						Sub-Total Subsection A	$	10,224,000.00
B	**Stormwater Conveyance**							
	B.1	Local Storm Sewer	m	9,953.5	$	445.00	$	4,429,000.00
	B.2	Trunk Storm Sewers	m	7,894.5	$	900.00	$	7,105,000.00
	B.3	Foundation Collector	m	17,850.0	$	300.00	$	5,355,000.00
	B.4	Lift Station	ea	1.0	$	5,000,000.00	$	5,000,000.00
						Sub-Total Subsection B	$	21,889,000.00
						Estimated Capital Cost	**$**	**32,113,000.00**
C	**Estimated Annual Maintenance Cost**							
	C.1	Local Storm Sewer - Flushing	m	9,953.5	$	5.00	$	50,000.00
	C.2	Trunk Storm Sewer - Flushing	m	7,894.5	$	6.00	$	47,000.00
	C.3	Foundation Collector - Flushing	m	17,850.0	$	5.00	$	89,000.00
	C.4	Lift Station Operation and Maintenance	m	1.0	$	100,000.00	$	100,000.00
						Estimated Life Cycle Cost	**$**	**286,000.00**

Notes:
1) Import Fill required is net fill required less re-use top soil as fill.
2) Re-use top soil as fill assumes 60% of stripped and stock piled top soil is available for fill material.

Richmond Village (South) Limited
Option 3

Stage 1 Estimate
Cost Summary

			Unit	Approx. Qty.		Unit Rate		Estimated Value
A	**Site Preparation**							
	A.1	Strip and Stockpile Top Soil	m^3	335,554	$	6.00	$	2,013,000.00
	A.2	Site Grading - Cut to Fill	m^3	203,011	$	3.00	$	609,000.00
	A.3	Import Fill	m^3	592,580	$	18.00	$	10,666,000.00
	A.4	Re-use top soil as fill	m^3	201,332	$	6.00	$	1,208,000.00
						Sub-Total Subsection A	$	14,496,000.00
B	**Stormwater Conveyance**							
	B.1	Local Storm Sewer	m	9,953.5	$	445.00	$	4,429,000.00
	B.2	Trunk Storm Sewers	m	7,894.5	$	900.00	$	7,105,000.00
						Sub-Total Subsection B	$	11,534,000.00
						Estimated Capital Cost	**$**	**26,030,000.00**
C	**Estimated Annual Maintenance Cost**							
	C.1	Local Storm Sewer - Flushing	m	9,953.5	$	5.00	$	50,000.00
	C.2	Trunk Storm Sewer - Flushing	m	7,894.5	$	6.00	$	47,000.00
						Estimated Life Cycle Cost	**$**	**97,000.00**

Notes:
1) Import Fill required is net fill required less re-use top soil as fill.
2) Re-use top soil as fill assumes 60% of stripped and stock piled top soil is available for fill material.

Richmond Village (South) Limited
Option 4

Stage 1 Estimate
Cost Summary

			Unit	Approx. Qty.		Unit Rate		Estimated Value
A	**Site Preparation**							
	A.1	Strip and Stockpile Top Soil	m^3	335,554	$	6.00	$	2,013,000.00
	A.2	Site Grading - Cut to Fill	m^3	219,640	$	3.00	$	659,000.00
	A.3	Import Fill	m^3	395,941	$	18.00	$	7,127,000.00
	A.4	Re-use top soil as fill	m^3	201,332	$	6.00	$	1,208,000.00
						Sub-Total Subsection A	$	11,007,000.00
B	**Stormwater Conveyance**							
	B.1	Local Storm Sewer	m	9,953.5	$	445.00	$	4,429,000.00
	B.2	Trunk Storm Sewers	m	7,894.5	$	900.00	$	7,105,000.00
						Sub-Total Subsection B	$	11,534,000.00
						Estimated Capital Cost	**$**	**22,541,000.00**
C	**Estimated Annual Maintenance Cost**							
	C.1	Local Storm Sewer - Flushing	m	9,953.5	$	5.00	$	50,000.00
	C.2	Trunk Storm Sewer - Flushing	m	7,894.5	$	6.00	$	47,000.00
						Estimated Life Cycle Cost	**$**	**97,000.00**

Notes:
1) Import Fill required is net fill required less re-use top soil as fill.
2) Re-use top soil as fill assumes 60% of stripped and stock piled top soil is available for fill material.

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APPENDIX H

Rational Method Calculation Sheet

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013 Return Frequency = 5 years

Location	LOCATION From Node	LOCATION To Node	AREA (Ha) R= 0.25	R= 0.60	R= 0.62	R= 0.70	R= 0.75	R= 0.80	R= 0.90	FLOW Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc.	Rainfall Intensity	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min.)	RATIO Q/Q full
TRUNK 1																							
	101	102			0.36					0.62	0.62	10.00	104.19	65	450	450	CONC	0.20	57.5	127	0.80	1.20	0.51
	102	103			0.26					0.45	1.07	11.20	98.28	105	525	525	CONC	0.16	62.5	172	0.79	1.31	0.61
	103	104			0.16					0.28	1.34	12.51	92.59	124	600	600	CONC	0.14	12.5	230	0.81	0.26	0.54
	104	105			0.50					0.86	2.21	12.76	91.56	202	750	750	CONC	0.10	79.0	352	0.80	1.65	0.57
	105	106			2.37					4.08	6.29	14.41	85.50	538	975	975	CONC	0.15	68.5	868	1.16	0.98	0.62
	106	MH TEE			1.84					3.17	9.46	15.40	82.30	779	1200	1200	CONC	0.10	68.0	1232	1.09	1.04	0.63
	MH TEE	HW								0.00	9.46	16.44	79.19	749	1200	1200	CONC	0.10	18.0	1232	1.09	0.28	0.61
To SWMP											9.46	16.71											
TRUNK 2																							
	201	202			0.28					0.48	0.48	10.00	104.19	50	375	375	CONC	0.25	60.0	88	0.79	1.26	0.57
	202	203			0.80					1.38	1.86	11.26	97.98	182	675	675	CONC	0.12	97.0	291	0.81	1.99	0.63
	203	204			1.00					1.72	3.59	13.25	89.69	322	900	900	CONC	0.10	66.5	572	0.90	1.23	0.56
	204	205			1.54					2.65	6.24	14.48	85.28	532	1050	1050	CONC	0.10	100.5	863	1.00	1.68	0.62
	205	206			1.69					2.91	9.15	16.16	79.99	732	1200	1200	CONC	0.10	72.5	1232	1.09	1.11	0.59
	206	207			2.60					4.48	13.63	17.27	76.88	1048	1200	1200	CONC	0.10	120.0	1232	1.09	1.83	0.85
	207	208			0.78					1.34	14.98	19.10	72.29	1083	1200	1200	CONC	0.10	120.0	1232	1.09	1.83	0.88
	208	209			0.19					0.33	15.31	20.94	68.26	1045	1200	1200	CONC	0.10	32.5	1232	1.09	0.50	0.85
External from South														3300									
	209	MH TEE			0.11					0.19	15.50	21.43	67.26	4342	1200x2400	1200x2400	CONC	0.14	57.0	4491	1.60	0.59	0.97
	MH TEE	HW								0.00	15.50	22.02	66.10	4324	1200x2400	1200x2400	CONC	0.14	10.0	4491	1.60	0.10	0.96
To SWMP											15.50	22.02											
TRUNK 3																							
	301	302			0.33					0.57	0.57	10.00	104.19	59	450	450	CONC	0.20	67.5	127	0.80	1.40	0.47
	302	303			0.23					0.40	0.97	11.40	97.32	94	525	525	CONC	0.16	56.5	172	0.79	1.18	0.55
	303	304			0.20					0.34	1.31	12.59	92.26	121	600	600	CONC	0.14	15.5	230	0.81	0.32	0.53
	304	305			0.67					1.15	2.46	12.91	90.99	224	750	750	CONC	0.11	101.5	369	0.84	2.02	0.61
	305	306			2.45					4.22	6.69	14.93	83.78	560	1050	1050	CONC	0.10	90.0	863	1.00	1.50	0.65
	306	307			1.51					2.60	9.29	16.43	79.19	736	1200	1200	CONC	0.10	56.0	1232	1.09	0.86	0.60
	307	308								0.00	9.29	17.29	76.82	714	1200	1200	CONC	0.10	90.0	1232	1.09	1.38	0.58
	308	309								0.00	9.29	18.67	73.32	681	1200	1200	CONC	0.10	30.0	1232	1.09	0.46	0.55
	309	HW								0.00	9.29	19.13	72.23	671	1200	1200	CONC	0.10	38.5	1232	1.09	0.59	0.54
To SWMP											9.29	19.71											
TRUNK 4																							
	401	402			0.31					0.53	0.53	10.00	104.19	56	450	450	CONC	0.20	49.0	127	0.80	1.02	0.44
	402	403			0.19					0.33	0.86	11.02	99.10	85	525	525	CONC	0.16	14.0	172	0.79	0.29	0.50
	403	404			0.76					1.31	2.17	11.31	97.74	212	750	750	CONC	0.12	120.0	385	0.87	2.29	0.55
	404	405			0.26					0.45	2.62	13.60	88.36	231	750	750	CONC	0.12	72.0	385	0.87	1.37	0.60
	405	406			1.90					3.27	5.89	14.98	83.63	493	975	975	CONC	0.10	66.0	708	0.95	1.16	0.70
	406	407			0.46					0.79	6.69	16.14	80.06	535	1050	1050	CONC	0.10	78.0	863	1.00	1.30	0.62
	407	HW			0.87					1.50	8.19	17.44	76.42	626	1200	1200	CONC	0.10	49.5	1232	1.09	0.76	0.51
To SWMP											8.19	18.20											

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.76 m/sec

Designed: K.M.	PROJECT:	VILLAGE OF RICHMOND SWM - SUBMISSION 2	
Checked: Z.L.	LOCATION:	City of Ottawa	
Dwg. Reference: Storm Drainage Plan	File Ref: 11-468	Date: April, 2012	Sheet No. 1 of 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013 Return Frequency = 5 years

Location	LOCATION From Node	LOCATION To Node	AREA (Ha) R= 0.25	R= 0.6	R= 0.62	R= 0.70	R= 0.75	R= 0.80	R= 0.9	FLOW Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc.	Rainfall Intensity	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min.)	RATIO Q/Q full
TRUNK 5																							
	501	502			0.31					0.53	0.53	10.00	104.19	56	450	450	CONC	0.20	49.0	127	0.80	1.02	0.44
	502	503			0.19					0.33	0.86	11.02	99.10	85	525	525	CONC	0.16	13.5	172	0.79	0.28	0.50
	503	504			0.63					1.09	1.95	11.30	97.79	190	675	675	CONC	0.12	96.0	291	0.81	1.97	0.65
	504	505			1.21					2.09	4.03	13.27	89.60	361	900	900	CONC	0.10	96.0	572	0.90	1.78	0.63
	505	506			2.21					3.81	7.84	15.05	83.41	654	1050	1050	CONC	0.10	123.5	863	1.00	2.06	0.76
	506	507			0.33					0.57	8.41	17.11	77.31	650	1200	1200	CONC	0.10	59.0	1232	1.09	0.90	0.53
	507	508			1.13					1.95	10.36	18.01	74.94	776	1200	1200	CONC	0.10	82.0	1232	1.09	1.25	0.63
Contribution From Trunk 6, Pipe 608 - 508										10.81	21.17	19.66											
	508	HW								0.00	21.17	19.66	71.01	1503	1200x2400	1200x2400	CONC	0.10	28.5	3795	1.36	0.35	0.40
To SWMP											10.36	19.27											
TRUNK 6																							
	601	602			0.31					0.53	0.53	10.00	104.19	56	450	450	CONC	0.20	52.0	127	0.80	1.08	0.44
	602	603			0.21					0.36	0.90	11.08	98.81	89	525	525	CONC	0.16	16.5	172	0.79	0.35	0.52
	603	604			0.80					1.38	2.28	11.43	97.21	221	750	750	CONC	0.10	120.0	352	0.80	2.51	0.63
	604	605			1.57					2.71	4.98	13.94	87.16	434	975	975	CONC	0.10	74.0	708	0.95	1.30	0.61
	605	606			1.03					1.78	6.76	15.24	82.80	559	1050	1050	CONC	0.10	68.0	863	1.00	1.14	0.65
	606	607			1.11					1.91	8.67	16.37	79.37	688	1200	1200	CONC	0.10	112.5	1232	1.09	1.72	0.56
	607	608			0.40					0.69	9.36	18.09	74.74	699	1200	1200	CONC	0.10	65.5	1232	1.09	1.00	0.57
	608	508			0.84					1.45	10.81	19.09	72.30	781	1200	1200	CONC	0.10	37.0	1232	1.09	0.57	0.63
To Trunk 5, Pipe 508 - HW											10.81	19.66											
TRUNK 8																							
	801	802			0.18					0.31	0.31	10.00	104.19	32	300	300	CONC	0.34	35.0	56	0.80	0.73	0.57
	802	803			0.45					0.78	1.09	10.73	100.48	109	525	525	CONC	0.16	71.5	172	0.79	1.50	0.63
	803	804			1.01					1.74	2.83	12.23	93.72	265	825	825	CONC	0.10	71.5	454	0.85	1.40	0.58
	804	805			1.00					1.72	4.55	13.63	88.25	402	975	975	CONC	0.10	71.5	708	0.95	1.26	0.57
					4.67					8.05	12.60												
	805	806			4.09					7.05	19.65	14.89	83.92	1649	1500	1500	CONC	0.10	88.0	2234	1.26	1.16	0.74
	806	711			2.44					4.21	23.85	16.05	80.31	1916	1500x3000	1500x3000	CONC	0.10	15.0	6936	1.57	0.16	0.28
	711	712								0.00	23.85	16.21	79.85	1905	1500x3000	1500x3000	CONC	0.10	23.0	6936	1.57	0.24	0.27
To Trunk 7, Pipe 712 - MH TEE											23.85	16.45											

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.76 m/sec

Designed: K.M.
Checked: Z.L.
Dwg. Reference: Storm Drainage Plan

PROJECT: **VILLAGE OF RICHMOND SWM - SUBMISSION 2**
LOCATION: **City of Ottawa**
File Ref: 11-468
Date: April, 2012
Sheet No. 2 of 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013 Return Frequency = 5 years

Location	LOCATION From Node	LOCATION To Node	AREA (Ha) R= 0.25	R= 0.60	R= 0.62	R= 0.70	R= 0.75	R= 0.80	R= 0.9	FLOW Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc.	Rainfall Intensity	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min.)	RATIO Q/Q full
TRUNK 7																							
	701	702			0.60					1.03	1.03	10.00	104.19	108	525	525	CONC	0.16	90.0	172	0.79	1.89	0.63
	702	703			0.58					1.00	2.03	11.89	95.18	194	675	675	CONC	0.13	90.5	303	0.85	1.78	0.64
														3700									
	703	704			0.50					0.86	2.90	13.67	88.12	3955	1500x3000	1500x3000	CONC	0.10	105.5	6936	1.57	1.12	0.57
	704	705			0.31					0.53	3.43	14.79	84.24	3989	1500x3000	1500x3000	CONC	0.10	12.0	6936	1.57	0.13	0.58
	705	706			1.28					2.21	5.64	14.92	83.83	4172	1500x3000	1500x3000	CONC	0.10	110.5	6936	1.57	1.17	0.60
	706	707			0.90					1.55	7.19	16.09	80.19	4276	1500x3000	1500x3000	CONC	0.10	88.5	6936	1.57	0.94	0.62
	707	708			1.53					2.64	9.82	17.03	77.52	4462	1500x3000	1500x3000	CONC	0.10	120.0	6936	1.57	1.27	0.64
	708	709			0.68					1.17	11.00	18.30	74.21	4516	1500x3000	1500x3000	CONC	0.10	59.5	6936	1.57	0.63	0.65
	709	710			0.27					0.47	11.46	18.94	72.67	4533	1500x3000	1500x3000	CONC	0.10	25.0	6936	1.57	0.27	0.65
	710	712			0.25					0.43	11.89	19.20	72.05	4557	1500x3000	1500x3000	CONC	0.10	23.5	6936	1.57	0.25	0.66
Contribution From Trunk 8, Pipe 711 - 712										23.85	35.75	16.45											
	712	MH TEE								0.00	35.75	19.45	71.48	6255	1500x3000	1500x3000	CONC	0.10	70.0	6936	1.57	0.74	0.90
	MH TEE	713								0.00	35.75	20.20	69.82	6196	1500x3000	1500x3000	CONC	0.10	69.5	6936	1.57	0.74	0.89
	713	HW								0.00	35.75	20.93	68.27	6140	1500x3000	1500x3000	CONC	0.10	31.0	6936	1.57	0.33	0.89
To SWMP											35.75	21.26											
TRUNK 9																							
	901	902			1.14					1.96	1.96	10.00	104.19	205	750	750	CONC	0.10	90.0	352	0.80	1.88	0.58
	902	903								0.00	1.96	11.88	95.20	187	750	750	CONC	0.10	70.0	352	0.80	1.46	0.53
	903	904			1.53					2.64	4.60	13.35	89.31	411	975	975	CONC	0.10	71.5	708	0.95	1.26	0.58
	904	905			4.36					7.51	12.12	14.60	84.87	1028	1200x2400	1200x2400	CONC	0.10	43.0	3795	1.36	0.53	0.27
	905	906			1.96					3.38	15.50	15.13	83.14	1288	1200x2400	1200x2400	CONC	0.10	74.5	3795	1.36	0.92	0.34
	906	907			2.94					5.07	20.56	16.05	80.32	1652	1200x2400	1200x2400	CONC	0.10	37.5	3795	1.36	0.46	0.44
	907	HW								0.00	20.56	16.51	78.98	1624	1200x2400	1200x2400	CONC	0.10	20.5	3795	1.36	0.25	0.43
To SWMP											20.56	16.76											
TRUNK 10																							
	1001	1002			2.35					4.05	4.05	10.00	104.19	422	900	900	CONC	0.15	88.5	701	1.10	1.34	0.60
	1002	1003								0.00	4.05	11.34	97.62	395	900	900	CONC	0.13	82.5	652	1.03	1.34	0.61
	1003	1004								0.00	4.05	12.68	91.89	372	900	900	CONC	0.10	70.0	572	0.90	1.30	0.65
	1004	1005								0.00	4.05	13.97	87.02	352	900	900	CONC	0.10	71.5	572	0.90	1.32	0.62
	1005	1006			1.52					2.62	6.67	15.30	82.60	551	1050	1050	CONC	0.10	74.5	863	1.00	1.25	0.64
	1006	1007			2.54					4.38	11.05	16.54	78.88	871	1200	1200	CONC	0.10	75.0	1232	1.09	1.15	0.71
	1007	1008			1.85					3.19	14.24	17.69	75.76	1079	1200	1200	CONC	0.10	72.0	1232	1.09	1.10	0.88
	1008	1009								0.00	14.24	18.79	73.02	1040	1200	1200	CONC	0.10	38.5	1232	1.09	0.59	0.84
														3300									
	1009	HW								0.00	14.24	19.38	71.64	4320	1200x2400	1200x2400	CONC	0.14	36.0	4491	1.60	0.37	0.96
To SWMP											14.24	19.75											
TRUNK 12																							
	1201	1202			1.76					3.03	3.03	10.00	104.19	316	825	825	CONC	0.15	55.0	556	1.04	0.88	0.57
	1202	1203								0.00	3.03	10.88	99.76	303	825	825	CONC	0.10	13.5	454	0.85	0.26	0.67
	1203	1204								0.00	3.03	11.15	98.50	299	825	825	CONC	0.10	98.0	454	0.85	1.92	0.66
	1204	1205			2.29					3.95	6.98	13.07	90.36	631	1200	1200	CONC	0.10	68.5	1232	1.09	1.05	0.51
	1205	1206								0.00	6.98	14.12	86.52	604	1200	1200	CONC	0.10	64.5	1232	1.09	0.99	0.49
	1206	1207								0.00	6.98	15.10	83.22	581	1200	1200	CONC	0.10	14.0	1232	1.09	0.21	0.47
	1207	1116								0.00	6.98	15.32	82.55	576	1200	1200	CONC	0.10	81.0	1232	1.09	1.24	0.47
To Trunk 11, Pipe 1116 - 1117											6.98	16.56											

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.76 m/sec

Designed: K.M.	PROJECT:	VILLAGE OF RICHMOND SWM - SUBMISSION 2	
Checked: Z.L.	LOCATION:	City of Ottawa	
Dwg. Reference: Storm Drainage Plan	File Ref: 11-468	Date: April, 2012	Sheet No. 3 of 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013 Return Frequency = 5 years

Location	LOCATION From Node	LOCATION To Node	AREA (Ha) R= 0.25	R= 0.60	R= 0.62	R= 0.70	R= 0.75	R= 0.80	R= 0.9	FLOW Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc.	Rainfall Intensity	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min.)	RATIO Q/Q full
TRUNK 11																							
	1100	1101			1.47					2.53	2.53	10.00	104.19	264	750	750	CONC	0.15	52.0	431	0.98	0.89	0.61
	1101	1102								0.00	2.53	10.89	99.73	253	825	825	CONC	0.10	14.0	454	0.85	0.27	0.56
	1102	1103								0.00	2.53	11.16	98.43	249	825	825	CONC	0.10	61.5	454	0.85	1.21	0.55
	1103	1104			0.88					1.52	4.05	12.37	93.15	377	900	900	CONC	0.10	107.5	572	0.90	1.99	0.66
	1104	1105			0.88					1.52	5.57	14.36	85.68	477	975	975	CONC	0.10	64.0	708	0.95	1.12	0.67
	1105	1106								0.00	5.57	15.48	82.02	457	975	975	CONC	0.10	13.5	708	0.95	0.24	0.64
	1106	1107								0.00	5.57	15.72	81.30	453	975	975	CONC	0.10	33.0	708	0.95	0.58	0.64
	1107	1108								0.00	5.57	16.30	79.58	443	975	975	CONC	0.10	7.5	708	0.95	0.13	0.63
	1108	1109								0.00	5.57	16.43	79.20	441	975	975	CONC	0.10	24.5	708	0.95	0.43	0.62
	1109	1110								0.00	5.57	16.86	77.98	434	975	975	CONC	0.10	13.5	708	0.95	0.24	0.61
	1110	1111								0.00	5.57	17.10	77.33	431	975	975	CONC	0.10	34.0	708	0.95	0.60	0.61
	1111	1112			2.80					4.83	10.39	17.70	75.75	787	1200	1200	CONC	0.10	68.5	1232	1.09	1.05	0.64
	1112	1113			0.58					1.00	11.39	18.74	73.13	833	1200	1200	CONC	0.10	13.5	1232	1.09	0.21	0.68
	1113	1114			0.69					1.19	12.58	18.95	72.64	914	1200x2400	1200x2400	CONC	0.10	55.0	3795	1.36	0.68	0.24
	1114	1115								0.00	12.58	19.63	71.08	894	1200x2400	1200x2400	CONC	0.10	14.0	3795	1.36	0.17	0.24
	1115	1116								0.00	12.58	19.80	70.69	890	1200x2400	1200x2400	CONC	0.10	86.5	3795	1.36	1.06	0.23
Contribution From Trunk 12, Pipe 1207 - 1116										6.98	19.56	16.56											
	1116	1117			1.35					2.33	21.89	20.86	68.41	1498	1200x2400	1200x2400	CONC	0.10	68.0	3795	1.36	0.84	0.39
	1117	1119								0.00	21.89	21.70	66.73	1461	1200x2400	1200x2400	CONC	0.10	71.0	3795	1.36	0.87	0.38
	1119	1120			5.43					9.36	31.25	22.57	65.07	2033	1200x2400	1200x2400	CONC	0.10	82.0	3795	1.36	1.01	0.54
	1120	1121			0.74					1.28	32.52	23.58	63.26	2058	1200x2400	1200x2400	CONC	0.10	13.5	3795	1.36	0.17	0.54
	1121	1122								0.00	32.52	23.75	62.97	2048	1200x2400	1200x2400	CONC	0.10	64.5	3795	1.36	0.79	0.54
	1122	1123			3.07					5.29	37.82	24.54	61.64	2331	1200x2400	1200x2400	CONC	0.10	71.5	3795	1.36	0.88	0.61
	1123	1124								0.00	37.82	25.42	60.24	2278	1200x2400	1200x2400	CONC	0.10	68.0	3795	1.36	0.84	0.60
	1124	HW								0.00	37.82	26.25	58.96	2230	1200x2400	1200x2400	CONC	0.10	32.0	3795	1.36	0.39	0.59
To SWMP											37.82	26.65											
TRUNK 13																							
	1304	1305			3.36					5.79	5.79	10.00	104.19	603	900	900	CONC	0.25	70.0	905	1.42	0.82	0.67
	1305	HW								0.00	5.79	10.82	100.05	579	900	900	CONC	0.25	31.0	905	1.42	0.36	0.64
To SWMP											5.79	11.18											

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.76 m/sec

Designed: K.M.	PROJECT:	VILLAGE OF RICHMOND SWM - SUBMISSION 2	
Checked: Z.L.	LOCATION:	City of Ottawa	
Dwg. Reference: Storm Drainage Plan	File Ref: 11-468	Date: April, 2012	Sheet No. 4 of 4

APPENDIX I

JFSA Hydrologic / Hydraulic Modeling

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

52 Springbrook Drive
Ottawa (Stittsville), ON K2S 1B9
TEL: (613) 836-3884
FAX: (613) 836-0332
WEB: www.jfsa.com

May 3, 2012

David Schaeffer Engineering Ltd.
120 Iber Road, Unit 203
Ottawa, Ontario K2S 1E9

Attention: **Adam Fobert, P.Eng.**

Subject: **Richmond Village (South) Limited Subdivision / Preliminary Stormwater Management Plan** *our file: 709(03)-10*

As requested by your office, we have evaluated, based on the provided information as described below; (i) the adequacy of the proposed minor system to convey the 5- and 100-year storm flows from within the development to the stormwater management (SWM) facilities; (ii) the capacity of the proposed major system to safely convey the excess 100-year flows to the SWM facilities; (iii) the operation of the proposed SWM facilities based on quality, erosion and quantity control requirements; and (iv) the hydraulic impact of the proposed subdivision and SWM facilities on the Van Gaal Drain.

The proposed subdivision consists of approximately 118.20 ha serviced by three SWM facilities; 69.46 ha at 48% imperviousness are serviced by SWM Pond 1 along with major system flows from 1.67 ha at 60% imperviousness; 43.21 ha at 51% imperviousness are serviced by SWM Pond 2 along with minor system flows from 1.67 ha at 60% imperviousness, and 3.86 ha at 60% imperviousness are serviced by SWM Pond 3. Additionally, 208.2 ha of undeveloped lands to the southwest of the proposed subdivision will drain to SWM Pond 1, and 71.8 ha of undeveloped lands to the southwest of the proposed subdivision will drain to SWM Pond 2. Note that 16.5 ha of the 208.2 ha of undeveloped lands draining to SWM Pond 1 will ultimately be developed as a commercial site with flows controlled on-site. Refer to Figures 1A and 1B of Attachment 1 for the existing and proposed subject site drainage areas, respectively.

SWM Ponds 1 and 3 discharge to the Van Gaal Drain and require quality, erosion and quantity control, and SWM Pond 2 discharges to the Jock River and requires quality control only. Quality control will be provided for SWM Ponds 1 and 2 by permanent pools and 40 m^3/ha of active storage volume (released over 24 hours) in accordance with Ministry of the Environment enhanced protection requirements. Quality control for SWM Pond 3 (a dry pond) will be provided by an oil-and-grit separator. Erosion control for SWM Ponds 1 and 3 will be provided by controlling the 2-year release rate from each pond to 330 L/s or less, where 330 L/s is the erosion threshold for the Van Gaal Drain identifed by Parish Geomorphic in the *Natural Environment & Impact Assessment Study for the Mattamy Richmond Lands* (March 2009). Quantity control will be provided for SWM Ponds 1 and 3 to restrict the 2- to 100-year release rates to pre-development levels.

The SWMHYMO program was used to simulate the major system flows and minor system inflows for the drainage area to the SWM facilities, to estimate the quantity control target release rates for SWM Ponds 1 and 3 based on existing conditions, and to simulate proposed conditions flows to the Van Gaal Drain and Jock River. The XPSWMM program was used to model the conveyance of the minor system flows and the operation of the SWM facilities. The HEC-RAS program was used to simulate water levels on the Van Gaal Drain and Jock River. Refer to Attachment 2 for schematics of the XPSWMM models; digital SWMHYMO, XPSWMM and HEC-RAS models are attached.

PROPOSED MINOR AND MAJOR SYSTEM DRAINAGE

The proposed minor and major system drainage routes are shown in plan view in Figure 1B of Attachment 1. The catchments shown in Figure 1B were divided into front yard / non-residential areas and rear yard areas for the SWMHYMO model, where rear yard areas are equal to approximately 37.5% of residential catchments based on a typical subdivision layout.

In accordance with City of Ottawa standards, the minor system has been designed to accommodate the 5-year post-development flows from within the site. For modelling purposes, minor system captures rates on front yard / non-residential areas were limited to 112% of the 5-year flows simulated in SWMHYMO, in order to account for additional flows captured by standard inlet control devices and catchbasins during the 100-year storm. In accordance with the potential design approach suggested in the January 2012 *City of Ottawa Technical Bulletin ISTB-2012-1*, 100% of the 100-year flows simulated in the rear yard areas are to be captured to the minor system.

The street segments within the proposed development are to be designed using a 'saw tooth' or 'sagged' road profile. The runoff from within front yard / non-residential areas will be conveyed to catchbasins located at low points on the street. Flows in excess of the minor system capture rate are temporarily stored within approximately 30 m^3/ha of surface storage and released slowly to the storm sewers and then, when that storage is surpassed, conveyed overland to the next downstream catchment. A 0.5% longitudinal slope, 3% road cross-slope and 3.5% shoulder cross-slope were assumed for the purposes of modelling the routing of major system flows along the main streets in the development. Road widths are as provided by DSEL. Refer to Table 1A of Attachment 2 for a summary of the subdivision drainage areas as modelled in SWMHYMO.

The proposed storm sewers will convey 100% of the 100-year flows generated on 280.0 ha of undeveloped lands to SWM Ponds 1 and 2. Total drainage areas through the subject site under existing and proposed conditions, including undeveloped lands and the proposed subdivision drainage areas, are summarized in Tables 1B and 1C of Attachment 2.

We understand that homes in the proposed subdivision are to be serviced by sump pumps. It is estimated that sump pumps will contribute approximately 3.19 L/s/ha of flow to the proposed storm sewer based on a average development density of approximately 27.8 lots/ha and a flow contribution of 0.23 L/s/lot, where 50% of sump pumps are on at any given time. Sump pump flows have been accounted for in evaluating the operations of the proposed minor system.

In addition to the typical summer design storms, the performances of the SWM facilities were also assessed for the 100-year 10-day spring snowmelt plus rainfall event. This is in keeping with the previous floodplain mapping studies for the Van Gaal Drain and the Jock River, where the spring snowmelt plus rainfall events resulted in the highest flows and water levels on the watercourses, both at the SWM facility outlets and downstream.

Several modifications were made to the drainage area characteristics in the spring SWMHYMO models in order to best represent spring conditions. A curve number (CN) value of 95 was selected for undeveloped lands to model the limited infiltration capacity of the frozen soils. Similarly, the Horton's minimum and maximum infiltration parameters for the sudivision drainage areas were set to 2.4 mm/hour; the lowest infiltration rate in the *SWMHYMO User's Manual* (May 2000, JFSA). Furthermore, it was assumed, according to generally accepted practice, that half of the volume in the snowmelt plus rainfall event may be attributed to snowmelt, and half to rainfall. As it is expected that most of the snow on impervious areas like roads, driveways and roofs would have melted prior to such an event, half of the impervious area was removed from each developed drainage area such that only the runoff resulting from rainfall, not snowmelt, is simulated for impervious areas.

The SWMHYMO and XPSWMM analyses, discussed in the next sections, demonstrate that it is possible for the proposed drainage systems for the development to control the excess flow during a 100-year storm and safely capture and convey the minor system flows to the SWM facility.

ASSUMPTIONS AND SOURCES OF DATA USED

The following parameters and assumptions used in the analysis are based on City of Ottawa standards and generally accepted stormwater management design guidelines.

- Stormwater Management Model:	*SWMHYMO (version 5.02), XPSWMM (version 10), HEC-RAS (version 4.1.0)*
- Minor System Design:	*1:5 year*
- Major System Design:	*1:100 year*
- Max. Allowable Flow Depth:	*30 cm above gutter.*
- Extent of Major System:	*Must be contained within the municipal right-of-way.*
- SWMHYMO Model Parameters:	*Fo = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm (as per 2004 City of Ottawa Guidelines).*
- Undeveloped Area Characteristics:	*As per "Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond" (November 2009, JFSA).*
- Imperviousness:	*SWM Facilities: based on SWM block layout.* *Front Yard / Non-Residential: based on runoff coefficient (C) where Percent Imperviousness = (C - 0.2) / 0.7 x 100%.* *Rear Yard: equal to half of the front yard percent imperviousness. Half of that rear yard impervious area is assumed to be indirectly connected.*
- Design Storms:	*Chicago 3-hour and SCS Type II 24-hour design storms based on 2004 City of Ottawa Sewer Design Guidelines; maximum intensity averaged over 10 minutes. 10-day snowmelt plus rainfall events based on AES Ottawa CDA snowmelt plus rainfall IDF curves; maximum intensity averaged over 1 hour.*
- Historical Events:	*July 1st, 1979 event per 2004 City of Ottawa Sewer Design Guidelines.*
- Climate Change Street Test:	*20% increase in the 100-year, 3-hour Chicago and 100-year, 24-hour SCS storms, as per January 2012 City of Ottawa Technical Bulletin ISTB-2012-1.*
- Manning's Roughness Coeff.:	*0.013 for concrete pipes (free flow).*
- Minor System Losses:	*Refer to Attachment 2 for manhole loss coefficients.*
- Sump Pump Flows:	*3.19 L/s/ha based on 27.8 lot/ha, 0.23 L/s/lot, and 50% of sump pumps on.*
- Downstream HGL:	*Jock River water levels at Pond 2 outlet as per "Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report" (November 2004, PSR Group Ltd. and JFSA).* *Van Gaal Drain water levels at Pond 1 and 3 outlets as per HEC-RAS models from "Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond" (November 2009, JFSA) with proposed Fortune Street culvert improvements in place.*

MAJOR SYSTEM CONVEYANCE

As per City standards, the total 100-year depth of water (static and dynamic) on the street must be retained within the right-of-way and should not exceed 30 cm. Although static ponding depths are unknown at this stage of the design, the dynamic flow depths at a typical low point were estimated in SWMHYMO based on the excess major system flows in a front yard / non-residential catchment and an assumed longitudinal street slope of 0.15% from high point to high point. The results of this analysis are presented in Table 2A of Attachment 3 for the 100-year 3-hour Chicago storm. As may be seen in Attachment 3, the dynamic flow depths on all catchments are below 30 cm, allowing for some static ponding depth to be incorporated into the detailed design without exceeding City standards for total depth of water. In general, it may be concluded that it is possible to provide a total 100-year depth of water that is less than 30 cm and retained within the right-of-way, in accordance with City standards.

Table 2B of Attachment 3 presents the simulated dynamic flow depths for the development based on a 20% increase in the 100-year 3-hour Chicago storm, in accordance with the climate change stress test prescribed in the January

2012 *City of Ottawa Technical Bulletin ISTB-2012-1*. As shown in Table 2B, the maximum dynamic flow depth at a typical low point was estimated as approximately 18.6 cm under these conditions.

STORMWATER MANAGEMENT FACILITIES

As previously noted, 69.46 ha of the subdivision at 48% imperviousness are serviced by SWM Pond 1 along with major system flows from 1.67 ha at 60% imperviousness; 43.21 ha at 51% imperviousness are serviced by SWM Pond 2 along with minor system flows from 1.67 ha at 60% imperviousness, and 3.86 ha at 60% imperviousness are serviced by SWM Pond 3. Additionally, 208.2 ha of undeveloped lands to the southwest of the proposed subdivision will drain to SWM Pond 1, and 71.8 ha of undeveloped lands to the southwest of the proposed subdivision will drain to SWM Pond 2. Refer to Tables 3A, 3B and 3C of Attachment 4 for a summary of the proposed operating conditions for SWM Ponds 1, 2 and 3, respectively.

The permanent pool volumes of SWM Ponds 1 and 2 are sufficient to provide an enhanced protection level (80% long-term suspended solids removal) according to Ministry of the Environment standards. Active storage volumes of 40 m^3/ha minimum were also provided for quality control in SWM Ponds 1 and 2 and detained for approximately 24 hours. Drawdown time calculations for SWM Ponds 1 and 2 are presented in Tables 4A and 4B of Attachment 4. Quality control for SWM Pond 3 will be provided by an oil-and-grit separator.

Erosion control for SWM Ponds 1 and 3 will be provided by controlling the 2-year release rate from each pond to 330 L/s or less, where 330 L/s is the erosion threshold for the Van Gaal Drain identifed by Parish Geomorphic in the *Natural Environment & Impact Assessment Study for the Mattamy Richmond Lands* (March 2009). We understand that erosion control is not required for SWM Pond 2, which discharges to the Jock River.

Quantity control for SWM Ponds 1 and 3 is to be provided by controlling post-development outflows to pre-development levels for the 2- to 100-year 24-hour SCS design storms. Pre-development flows from the site were estimated in SWMHYMO based on the undeveloped drainage area characteristics presented in Figure 1A of Attachment 1 and Table 1B of Attachment 2. We understand that quantity control is not required for SWM Pond 2, which discharges to the Jock River; however, the 100-year release rate from Pond 2 has been limited to a maximum of 2.235 m^3/s based on the capacity of the 1500 mm diameter (at 0.1% slope) outlet pipe to the Jock River. Refer to Tables 5A, 5B and 5C of Attachment 4 for the outlet control design and stage-storage-discharge relationships for SWM Ponds 1, 2 and 3, respectively.

The performances of the SWM facilities were analyzed in XPSWMM based on both free outfall and restrictive downstream conditions. Restrictive downstream conditions for the outlet of SWM Pond 2 to the Jock River are based on the *Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report* (November 2004, PSR Group Ltd. and JFSA). During the 100-year 10-day spring snowmelt plus rainfall event, the water level on the Jock River at the outlet of SWM Pond 2 (Jock River Lower Reach 2 cross-section 19353) is 94.18 m. During the 100-year 24-hour SCS design storm, the water level on the Jock River at this location is below the permanent pool elevation of SWM Pond 2 and therefore does not affect the operation of the pond.

Restrictive downstream conditions for the outlets of SWM Ponds 1 and 3 to the Van Gaal Drain are based on the existing conditions HEC-RAS models from *Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond* (November 2009, JFSA) with proposed Fortune Street culvert improvements in place. It is proposed that the width of the Fortune Street culvert on the Van Gaal Drain be increased from 4.2 m to 6.3 m. Under these conditions, the water level on the Van Gaal Drain at the outlet of SWM Pond 1 (Van Gaal Drain Reach 2 cross-section 961) is 93.68 m for the 100-year 24-hour SCS design storm and 94.11 m for the 100-year 10-day spring snowmelt plus rainfall event. Similarly, the water level on the Van Gaal Drain at the outlet of SWM Pond 3 (Van Gaal Drain Reach 2 cross-section 1796) is 94.81 m for the 100-year 24-hour SCS design storm and 94.81 m for the 100-year 10-day spring snowmelt plus rainfall event.

HYDRAULIC GRADELINE ANALYSIS

The minor system and hydraulic gradeline analysis was completed for the proposed systems discharging to SWM Ponds 1 and 2 using the XPSWMM program based on the 100-year 3-hour Chicago and 100-year 24-hour SCS design storms, the 100-year 10-day spring snowmelt plus rainfall event and for the July 1st 1979 historical event. Note that a minor system analysis was not completed for the proposed system discharging to SWM Pond 3; however, given the relatively small size of the drainage area to SWM Pond 3, it may be reasonably assumed that it is possible to convey the 5- and 100-year storm flows from within the development to SWM Pond 3 via storm sewer system (to be sized at the detailed design stage).

Attachment 5 summarizes the hydraulic simulation results for the proposed systems under restrictive downstream conditions. Note that the flowing full pipe velocities are not less than 0.8 m/s and no greater than 6.0 m/s for all proposed pipes.

Attachment 5 also presents the hydraulic simulation results for the climate change stress test based on a 20% increase in the 100-year 3-hour Chicago and 100-year 24-hour SCS design storms, as per the January 2012 *City of Ottawa Technical Bulletin ISTB-2012-1*.

DOWNSTREAM HYDRAULIC IMPACTS

The impact of the proposed subdivision and SWM facility designs on the flows and flood levels on the downstream Van Gaal Drain was evaluated using the existing conditions SWMHYMO and HEC-RAS models from *Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond* (November 2009, JFSA).

The SWMHYMO models from the November 2009 report were modified to include the proposed subdivision and SWM pond storage-discharge curves, and the resultant proposed conditions flows entered into the HEC-RAS models. The HEC-RAS models were also modified to include the proposed Fortune Street culvert improvements in place; as noted above, it is proposed that the width of the Fortune Street culvert on the Van Gaal Drain be increased from 4.2 m to 6.3 m. Additionally, the Moore Drain (and Moore Drain tributary) was eliminated from the HEC-RAS models; the existing drain passes through the subject site and will be eliminated upon development of the proposed subdivision.

Attachment 6 presents the existing and proposed conditions 100-year flows and water levels on the Van Gaal Drain. Three different scenarios are considered, as per the November 2009 report; (1) When the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River; (2) When the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River; and (4) When the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

Note that flows and water levels on the Van Gaal Drain generally decrease between existing and proposed conditions. This result is expected, as the provided release rates from SWM Pond 1 to the Van Gaal Drain are well below pre-development levels owing to the real-world limitations of the outlet controls. That is, the 45 m long quantity control weir for SWM Pond 1 is set 1.33 m above the permanent pool elevation at an invert of 93.68 m to match the 100-year 24-hour SCS water level on the Van Gaal Drain (as per existing conditions with the Fortune Street culvert improvements in place). This results in minimal head over the quantity control weir and consequently lower release rates; for example, the 100-year 24-hour SCS release rate from SWM Pond 1 is 5.866 m^3/s at a pond level of 93.86 m, while the allowable release rate is 11.337 m^3/s based on existing conditions.

As may be seen from Attachment 6, proposed conditions flows on the Van Gaal Drain are equal to or less than existing flows, and proposed conditions water levels are a maximum of 1 cm greater than existing water levels.

Yours truly,
J.F. Sabourin and Associates Inc.

Laura Pipkins, P.Eng.

cc: J.F. Sabourin, M.Eng, P.Eng.
Director of Water Resources Projects

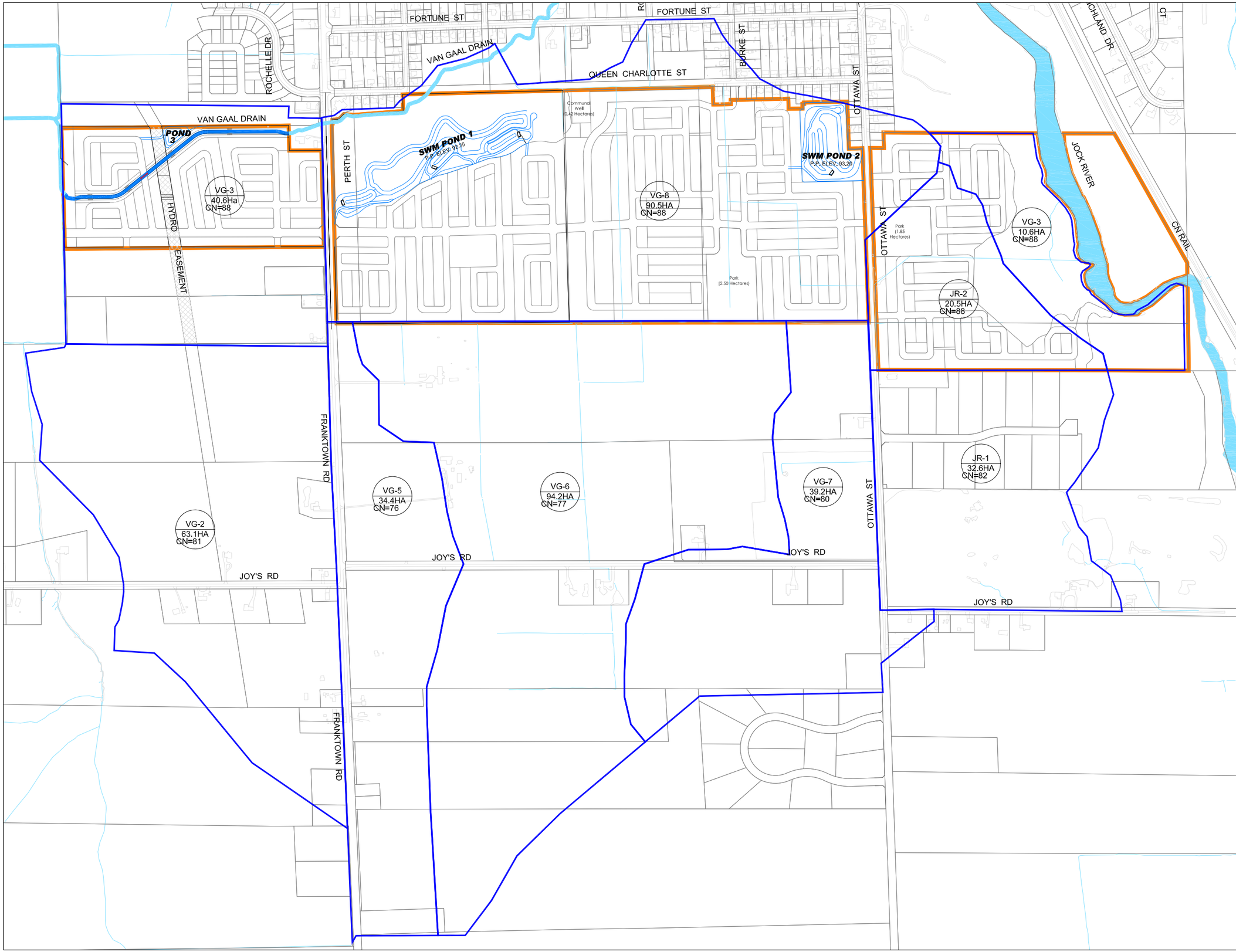
Attachment 1:	Drainage Area to SWM Facilities
Attachment 2:	Summary of Drainage Area to SWM Facilities; XPSWMM Model Schematic; and Minor System Loss Coefficients
Attachment 3:	Major System Results
Attachment 4:	SWM Facility Operating Conditions
Attachment 5:	Pipe Data and Hydraulic Simulation Results
Attachment 6:	Flows and Water Levels on the Van Gaal Drain Under Existing and Proposed Conditions

ATTACHMENT

1

DRAINAGE AREA TO SWM FACILITIES

JFSA Water Resources and Environmental Consultants



LEGEND :

SUBCATCHMENT BOUNDARY PER DEC 2009 RICHMOND FLOODPLAIN STUDY)

5.43Ha — SUBCATCHMENT ID
0.82 — SUBCATCHMENT AREA
Ref. 1119 — CURVE NUMBER (CN)

SCALE :

0 100 200 300 400 500m

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836-3884
GATINEAU (819) 243-6858

CLIENT :

DSEL
david schaeffer engineering ltd
600 ALDEN ROAD., SUITE 500
MARKHAM, ONTARIO., L3R 0E7
(905) 475-3080

PROJECT :
RICHMOND VILLAGE (SOUTH) LIMITED SUBDIVISION

BY	DATE	DESCRIPTION	BY

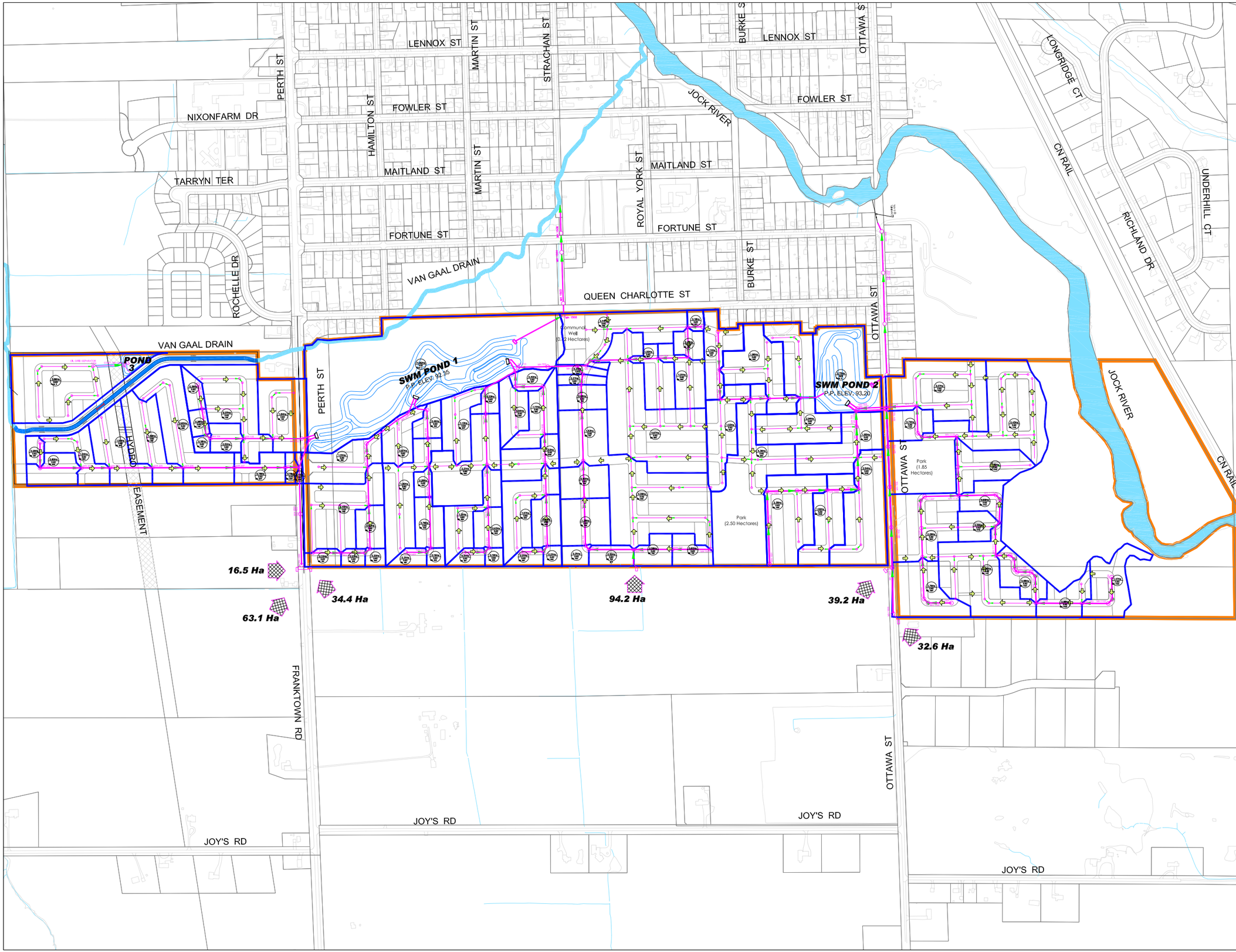
EXISTING DRAINAGE AREAS THROUGH SUBJECT SITE

FIGURE 1A

DESIGNED:
DRAWN: LP
VERIFIED: JFS
APPROVED: JFS

DRAWING REF.
709(03)-10\Design\CAD\JFSA Figures.dwg

DATE	PROJECT No.
May/12	709(03)



LEGEND :

SUBCATCHMENT BOUNDARY (PER DSEL)

5.43Ha — SUB–CATCHMENT AREA
0.82 — RUNOFF COEFFICIENT
Ref. 1119 — UPSTREAM MANHOLE

MAJOR SYSTEM FLOW DIRECTION

16.5 Ha — UNDEVELOPED DRAINAGE AREA

SCALE :

0 100 200 300 400 500m

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
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PROJECT :
RICHMOND VILLAGE (SOUTH) LIMITED SUBDIVISION

BY	DATE	DESCRIPTION	BY

PROPOSED DRAINAGE AREA TO SWM FACILITIES

FIGURE 1B

DESIGNED:
DRAWN: LP
VERIFIED: JFS
APPROVED: JFS

DRAWING REF.
709(03)–10\Design\CAD\JFSA Figures.dwg

DATE	PROJECT No.
May/12	709(03)

ATTACHMENT

2

SUMMARY OF DRAINAGE AREA TO SWM FACILITIES

XPSWMM MODEL SCHEMATIC

MINOR SYSTEM LOSS COEFFICIENTS

JFSA Water Resources and Environmental Consultants

Table 1A: Proposed Subdivision Drainage Area to SWM Ponds 1, 2 and 3

MH	SWMHYMO ID	Total Area (ha)	Front Yard / Non-Resid. (ha)	Rear Yard [1] (ha)	Runoff Coefficient	Front Yard / Non-Residential Area Parameters							Sump Pump Flow [2] (m^3/s)
						Imperviousness (%)	Storage (m^3)	5-Year Flow (m^3/s)	Minor Capture (m^3/s)	Road Width (m)	Length (m)	Downstream Segment	
101	101a	0.36	0.292	0.068	0.62	60	8.76	0.052	0.058	8.5	67	102a	0.00115
102	102a	0.26	0.211	0.049	0.62	60	6.33	0.038	0.043	8.5	63	103a	0.00083
103	103a	0.16	0.130	0.030	0.62	60	3.90	0.023	0.026	8.5	13	104a	0.00051
104	104a	0.5	0.406	0.094	0.62	60	12.18	0.072	0.081	8.5	79	105a	0.00160
105	105a	2.37	1.481	0.889	0.62	60	44.43	0.252	0.282	8.5	301	106a	0.00756
106	106a	1.84	1.150	0.690	0.62	60	34.50	0.198	0.222	8.5	220	209a	0.00587
201	201a	0.28	0.227	0.053	0.62	60	6.81	0.040	0.045	8.5	66	202a	0.00089
202	202a	0.8	0.650	0.150	0.62	60	19.50	0.114	0.128	8.5	97	203a	0.00255
203	203a	1	0.625	0.375	0.62	60	18.75	0.110	0.123	8.5	217	204a	0.00319
204	204a	1.54	0.962	0.578	0.62	60	28.86	0.166	0.186	8.5	228	205a	0.00491
205	205a	1.69	1.056	0.634	0.62	60	31.68	0.182	0.204	8.5	230	206a	0.00539
206	206a	2.6	1.625	0.975	0.62	60	48.75	0.275	0.308	8.5	400	207a	0.00829
207	207a	0.78	0.634	0.146	0.62	60	19.02	0.111	0.124	8.5	120	208a	0.00249
208	208a	0.19	0.119	0.071	0.62	60	3.57	0.021	0.024	8.5	33	209a	0.00061
209	209a	0.11	0.069	0.041	0.62	60	2.07	0.012	0.013	8.5	8	306a	0.00035
301	301a	0.33	0.268	0.062	0.62	60	8.04	0.048	0.054	8.5	67	302a	0.00105
302	302a	0.23	0.187	0.043	0.62	60	5.61	0.033	0.037	8.5	56	303a	0.00073
303	303a	0.2	0.162	0.038	0.62	60	4.86	0.029	0.032	8.5	16	304a	0.00064
304	304a	0.67	0.419	0.251	0.62	60	12.57	0.074	0.083	8.5	102	305a	0.00214
305	305a	2.45	1.531	0.919	0.62	60	45.93	0.260	0.291	8.5	305	306a	0.00782
306	306a	1.51	0.944	0.566	0.62	60	28.32	0.163	0.183	8.5	233	Pond1	0.00482
401	401a	0.31	0.252	0.058	0.62	60	7.56	0.045	0.050	8.5	55	402a	0.00099
402	402a	0.19	0.154	0.036	0.62	60	4.62	0.028	0.031	8.5	12	403a	0.00061
403	403a	0.76	0.475	0.285	0.62	60	14.25	0.084	0.094	8.5	119	404a	0.00242
404	404a	0.26	0.211	0.049	0.62	60	6.33	0.038	0.043	8.5	71	405a	0.00083
405	405a	1.9	1.187	0.713	0.62	60	35.61	0.204	0.228	8.5	332	406a	0.00606
406	406a	0.46	0.287	0.173	0.62	60	8.61	0.051	0.057	8.5	75	Pond1	0.00147
407	407a	0.87	0.544	0.326	0.62	60	16.32	0.096	0.108	8.5	184	Pond1	0.00278
501	501a	0.31	0.252	0.058	0.62	60	7.56	0.045	0.050	8.5	55	502a	0.00099
502	502a	0.19	0.154	0.036	0.62	60	4.62	0.028	0.031	8.5	12	503a	0.00061
503	503a	0.63	0.512	0.118	0.62	60	15.36	0.090	0.101	8.5	94	504a	0.00201
504	504a	1.21	0.756	0.454	0.62	60	22.68	0.132	0.148	8.5	268	505a	0.00386
505	505a	2.21	1.381	0.829	0.62	60	41.43	0.236	0.264	8.5	256	506a	0.00705
506	506a	0.33	0.206	0.124	0.62	60	6.18	0.037	0.041	8.5	57	Pond1	0.00105
507	507a	1.13	0.706	0.424	0.62	60	21.18	0.124	0.139	8.5	227	Pond1	0.00360
601	601a	0.31	0.252	0.058	0.62	60	7.56	0.045	0.050	8.5	55	602a	0.00099
602	602a	0.21	0.171	0.039	0.62	60	5.13	0.031	0.035	8.5	15	603a	0.00067
603	603a	0.8	0.500	0.300	0.62	60	15.00	0.088	0.099	8.5	118	604a	0.00255
604	604a	1.57	0.981	0.589	0.62	60	29.43	0.170	0.190	8.5	267	605a	0.00501
605	605a	1.03	0.644	0.386	0.62	60	19.32	0.113	0.127	8.5	170	606a	0.00329

Table 1A: Proposed Subdivision Drainage Area to SWM Ponds 1, 2 and 3

MH	SWMHYMO ID	Total Area (ha)	Front Yard / Non-Resid. (ha)	Rear Yard [1] (ha)	Runoff Coefficient	Front Yard / Non-Residential Area Parameters							Sump Pump Flow [2] (m^3/s)
						Imperviousness (%)	Storage (m^3)	5-Year Flow (m^3/s)	Minor Capture (m^3/s)	Road Width (m)	Length (m)	Downstream Segment	
606	606a	1.11	0.694	0.416	0.62	60	20.82	0.122	0.137	8.5	173	607a	0.00354
607	607a	0.4	0.325	0.075	0.62	60	9.75	0.058	0.065	8.5	64	Pond1	0.00128
608	608a	0.84	0.525	0.315	0.62	60	15.75	0.093	0.104	8.5	110	Pond1	0.00268
701	701a	0.6	0.375	0.225	0.62	60	11.25	0.067	0.075	8.5	85	702a	0.00191
702	702a	0.58	0.362	0.218	0.62	60	10.86	0.064	0.072	8.5	89	703a	0.00185
703	703a	0.5	0.406	0.094	0.62	60	12.18	0.072	0.081	8.5	104	704a	0.00160
704	704a	0.31	0.252	0.058	0.62	60	7.56	0.045	0.050	8.5	11	705a	0.00099
705	705a	1.28	0.800	0.480	0.62	60	24.00	0.139	0.156	8.5	110	706a	0.00408
706	706a	0.9	0.562	0.338	0.62	60	16.86	0.099	0.111	8.5	87	707a	0.00287
707	707a	1.53	0.956	0.574	0.62	60	28.68	0.165	0.185	8.5	179	708a	0.00488
708	708a	0.68	0.425	0.255	0.62	60	12.75	0.075	0.084	8.5	59	709a	0.00217
709	709a	0.27	0.169	0.101	0.62	60	5.07	0.030	0.034	8.5	25	710a	0.00086
710	710a	0.25	0.156	0.094	0.62	60	4.68	0.028	0.031	8.5	22	Pond1	0.00080
901	901a	1.14	0.712	0.428	0.62	60	21.36	0.125	0.140	8.5	190	801a	0.00364
801	801a	0.18	0.146	0.034	0.62	60	4.38	0.026	0.029	8.5	37	806a	0.00057
802	802a	0.45	0.281	0.169	0.62	60	8.43	0.050	0.056	8.5	71	803a	0.00144
803	803a	1.01	0.631	0.379	0.62	60	18.93	0.111	0.124	8.5	188	804a	0.00322
804	804a	1	0.625	0.375	0.62	60	18.75	0.110	0.123	8.5	188	805a	0.00319
903	903a	1.53	0.956	0.574	0.62	60	28.68	0.165	0.185	8.5	173	805b	0.00488
805	805b	4.67	2.919	1.751	0.62	60	87.57	0.472	0.529	8.5	379	805a	0.01490
805	805a	4.09	2.556	1.534	0.62	60	76.68	0.418	0.468	8.5	479	806a	0.01305
806	806a	2.44	1.525	0.915	0.62	60	45.75	0.259	0.290	8.5	240	Pond1	0.00778
904	904b	2.5	2.500	0.000	0.62	60	75.00	0.409	0.458	8.5	240	904a	0.00798
904	904a	1.86	1.162	0.698	0.62	60	34.86	0.200	0.224	8.5	196	1007a	0.00593
905	905b	0.86	0.860	0.000	0.62	60	25.80	0.149	0.167	8.5	101	905a	0.00274
905	905a	1.10	0.687	0.413	0.62	60	20.61	0.120	0.134	8.5	209	906a	0.00351
906	906a	2.94	1.837	1.103	0.62	60	55.11	0.310	0.347	8.5	206	Pond2	0.00938
1001	1001a	2.35	1.469	0.881	0.62	60	44.07	0.250	0.280	8.5	312	1005a	0.00750
1005	1005a	1.52	0.950	0.570	0.62	60	28.50	0.164	0.184	8.5	200	1006a	0.00485
1006	1006a	2.54	1.587	0.953	0.62	60	47.61	0.269	0.301	8.5	298	1007a	0.00810
1007	1007a	1.85	1.503	0.347	0.62	60	45.09	0.255	0.286	8.5	215	Pond2	0.00590
1100	1100a	1.47	0.919	0.551	0.62	60	27.57	0.159	0.178	8.5	128	1103a	0.00469
1103	1103a	0.88	0.550	0.330	0.62	60	16.50	0.097	0.109	8.5	184	1104a	0.00281
1104	1104a	0.88	0.550	0.330	0.62	60	16.50	0.097	0.109	8.5	182	1111a	0.00281
1111	1111a	2.80	1.750	1.050	0.62	60	52.50	0.296	0.332	8.5	282	1113a	0.00893
1112	1112a	0.58	0.362	0.218	0.62	60	10.86	0.064	0.072	8.5	100	1113a	0.00185
1113	1113a	0.69	0.431	0.259	0.62	60	12.93	0.076	0.085	8.5	146	1116a	0.00220
1201	1201a	1.76	1.100	0.660	0.62	60	33.00	0.189	0.212	8.5	161	1204a	0.00561
1204	1204a	2.29	1.431	0.859	0.62	60	42.93	0.244	0.273	8.5	298	1116a	0.00731
1116	1116a	1.35	0.844	0.506	0.62	60	25.32	0.146	0.164	8.5	241	1119a	0.00431

Table 1A: Proposed Subdivision Drainage Area to SWM Ponds 1, 2 and 3

MH	SWMHYMO ID	Total Area (ha)	Front Yard / Non-Resid. (ha)	Rear Yard [1] (ha)	Runoff Coefficient	Front Yard / Non-Residential Area Parameters							Sump Pump Flow [2] (m^3/s)
						Imperviousness (%)	Storage (m^3)	5-Year Flow (m^3/s)	Minor Capture (m^3/s)	Road Width (m)	Length (m)	Downstream Segment	
1119	1119b	1.85	1.850	0.000	0.62	60	55.50	0.312	0.349	8.5	125	1119a	0.00590
1119	1119a	3.58	2.237	1.343	0.62	60	67.11	0.373	0.418	8.5	395	1120a	0.01142
1120	1120a	0.74	0.462	0.278	0.62	60	13.86	0.082	0.092	8.5	75	1122a	0.00236
1122	1122a	3.07	1.919	1.151	0.62	60	57.57	0.323	0.362	8.5	250	Pond2	0.00979
Pond1	Pnd1a	11.82	11.816	0.000	N/A	41	N/A	1.185	N/A	N/A	N/A	N/A	0.00000
Pond2	Pnd2a	2.75	2.750	0.000	N/A	50	N/A	0.377	N/A	N/A	N/A	N/A	0.00000
Pond3	Pond3	3.86	2.750	0.000	0.62	60	N/A	0.542	N/A	N/A	N/A	N/A	0.01231
		114.336	**80.657**	**33.679**									

[1] Rear yard imperviousness is equal to half of the front yard imperviousness, and half of that rear yard impervious area is assumed to be indirectly connected.
100% of the 100-year flows generated on the rear yards are captured to the minor system.

[1] 3.19 L/s/ha based on approximately 27.8 lots/ha, 0.23 L/s/lot and 50% of sump pumps on at any given time.

Table 1B: Summary of Study Area under Existing Conditions (Drains to SWM Ponds 1, 2 and 3 in Future)

Area ID	VG-2	VG-3 [1]	VG-3 [2]	VG-3 [2]	VG-5	VG-6	VG-7	VG-8 [2]	JR-1	JR-2 [2]	JR-3 [2]
In future drains to:	Pond 1	Pond 1	Pond 1	Pond 3	Pond 1	Pond 1	Pond 2	Pond 1 / Pond 2	Pond 2	Pond 2	Pond 2
A (ha)	63.1	16.5	13.935	3.86	34.4	94.2	39.2	81.556	32.6	15.112	3.733
CN (-)	81	88	88	88	76	77	80	88	82	88	88
Ia	2.8	2.5	2.5	2.5	3.0	2.9	3.5	2.6	3.5	2.5	2.5
L (m)	1220	660	630	160	1540	1990	1520	590	790	540	150
S (%)	0.4	0.2	0.2	0.2	0.4	0.3	0.2	0.2	0.2	0.1	0.6
Tc (min)	147.6	100.2	96.5	32.2	207.1	285.1	256.9	91.6	142.8	120.6	17.7
Tp (hrs)	1.6	1.1	1.1	0.4	2.3	3.2	2.9	1.0	1.6	1.3	0.2

[1] To be developed as a commercial site - flows to be controlled on-site

[2] Proposed subdivision drainage area

[3] Characteristics of undeveloped lands as per *Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond* dated November 2009 by JFSA.

Table 1C: Summary of Study Area under Proposed Conditions (Drains to SWM Ponds 1, 2 and 3)

Area ID	VG-2	VG-3 [1]	VG-5	VG-6	VG-7	JR-1	Split Major / Minor [b]	Pond 1 [2]	Pond 2 [2]	Pond 3 [2]
Drains to:	Pond 1	Pond 1	Pond 1	Pond 1	Pond 2	Pond 2	Pond 1 / Pond 2	Pond 1	Pond 2	Pond 3
A (ha)	63.1	16.5	34.4	94.2	39.2	32.6	1.668	69.46	43.21	3.86
CN (-)	81	88	76	77	80	82	N/A	N/A	N/A	N/A
Ia	2.8	2.5	3.0	2.9	3.5	3.5	N/A	N/A	N/A	N/A
L (m)	1220	660	1540	1990	1520	790	N/A	N/A	N/A	N/A
S (%)	0.4	0.2	0.4	0.3	0.2	0.2	0.5	0.5	0.5	0.5
Tc (min)	147.6	100.2	207.1	285.1	256.9	142.8	N/A	N/A	N/A	N/A
Tp (hrs)	1.6	1.1	2.3	3.2	2.9	1.6	N/A	N/A	N/A	N/A
TIMP	N/A	N/A	N/A	N/A	N/A	N/A	60.0	48.1	50.5	60.0
XIMP	N/A	N/A	N/A	N/A	N/A	N/A	60.0	43.7	46.0	50.0

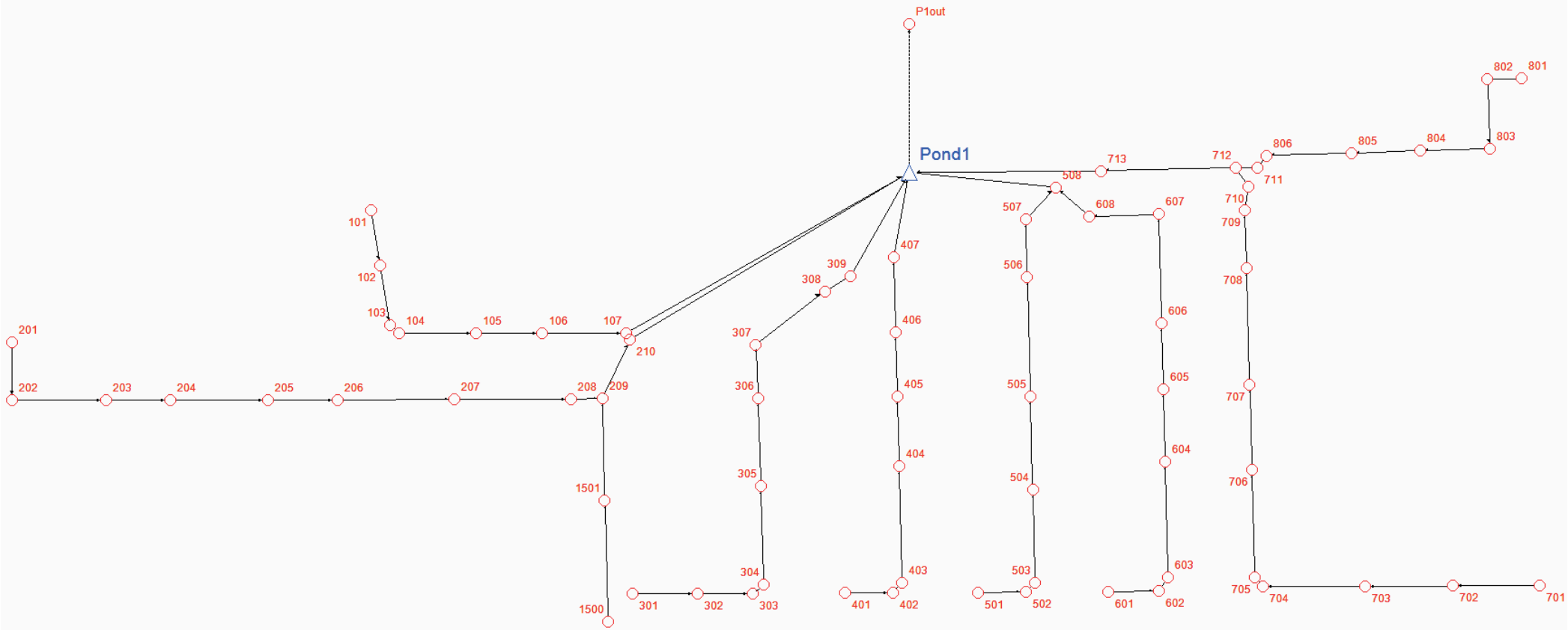
[1] To be developed as a commercial site - flows to be controlled on-site

[2] Proposed subdivision drainage area

[3] Characteristics of undeveloped lands as per *Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond* dated November 2009 by JFSA.

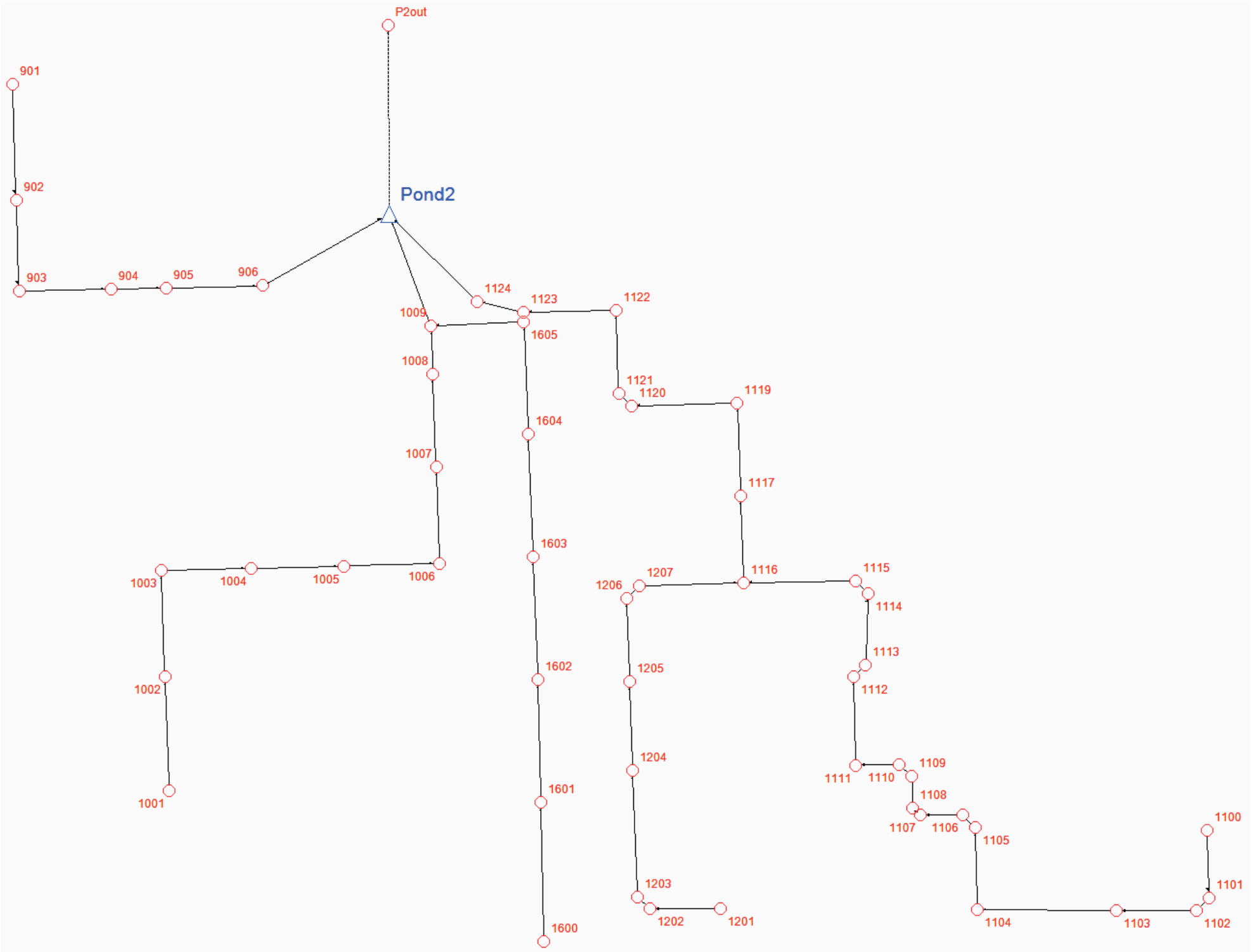
XPSWMM MODEL SCHEMATIC - POND 1

JFSA Water Resources and Environmental Consultants



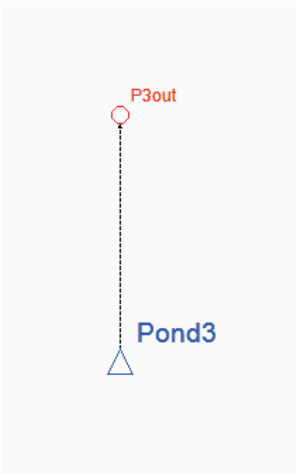
XPSWMM MODEL SCHEMATIC - POND 2

JFSA Water Resources and Environmental Consultants



XPSWMM MODEL SCHEMATIC - POND 3

JFSA Water Resources and Environmental Consultants



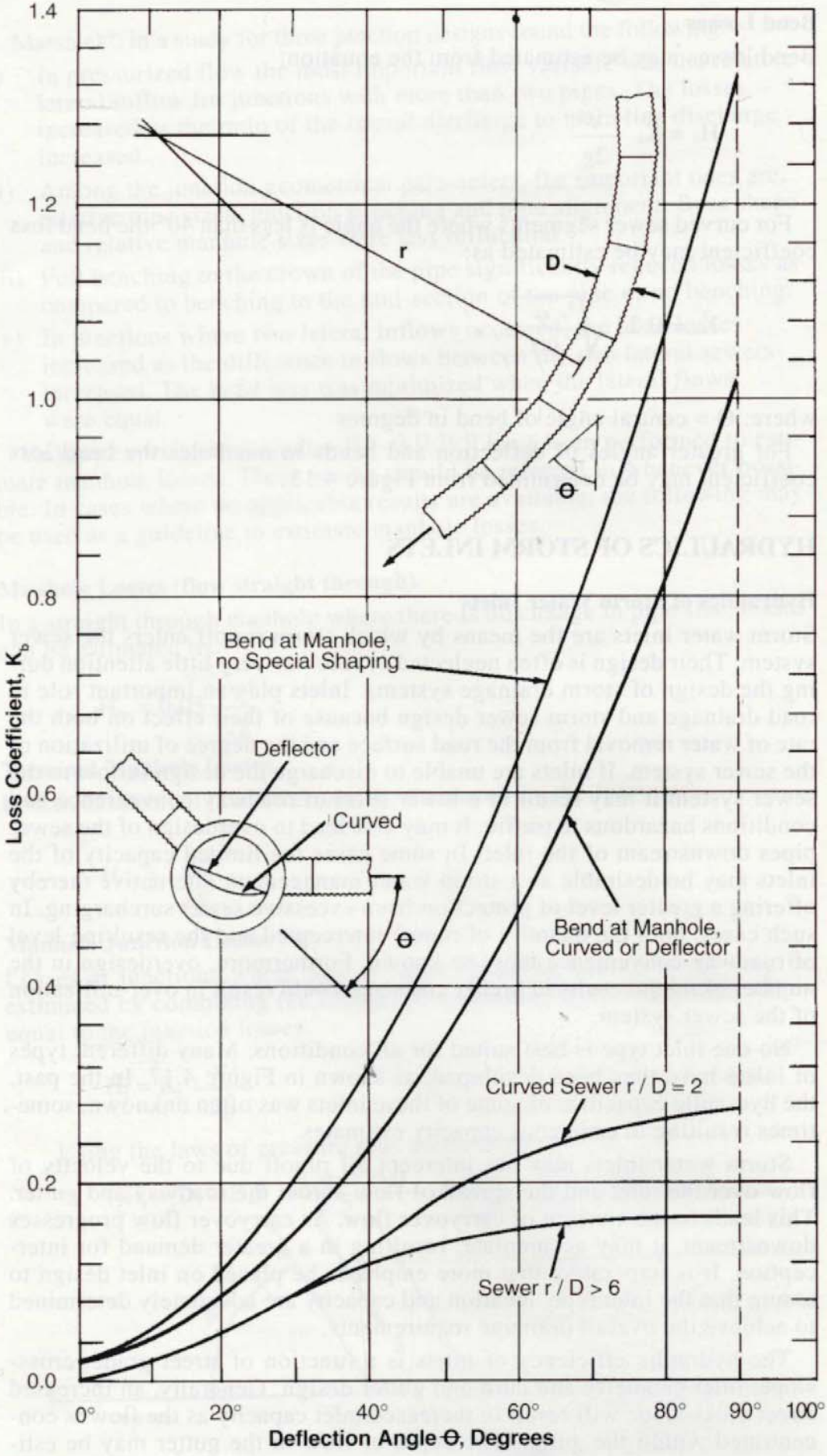


Figure 4.13 Sewer bend loss coefficient[16]

Manhole Loss Coefficient as per Nomograph

Angle (^{o})	MH Loss Coef
0	0.02
5	0.035
10	0.055
15	0.08
20	0.11
25	0.16
30	0.21
35	0.26
40	0.32
45	0.39
50	0.47
55	0.54
60	0.635
65	0.73
70	0.84
75	0.95
80	1.07
85	1.19
90	1.33

ATTACHMENT

3

MAJOR SYSTEM RESULTS

JFSA Water Resources and Environmental Consultants

Table 2A: Major System Results for the 100-Year, 3-Hour Chicago Storm

MH	SWMHYMO ID	Area (ha)	Flow (m^3/s)	Flow Depth (m)	Velocity (m/s)	V*D (m^2/s)
101	101a	0.36	0.038	0.060	0.282	0.017
102	102a	0.26	0.044	0.063	0.292	0.018
103	103a	0.16	0.048	0.066	0.298	0.020
104	104a	0.50	0.082	0.082	0.352	0.029
105	105a	2.37	0.090	0.085	0.358	0.030
106	106a	1.84	0.055	0.070	0.311	0.022
201	201a	0.28	0.028	0.055	0.269	0.015
202	202a	0.80	0.096	0.087	0.363	0.032
203	203a	1.00	0.076	0.080	0.348	0.028
204	204a	1.54	0.064	0.075	0.328	0.025
205	205a	1.69	0.054	0.069	0.309	0.021
206	206a	2.60	0.000	0.000	0.000	0.000
207	207a	0.78	0.067	0.077	0.335	0.026
208	208a	0.19	0.049	0.067	0.301	0.020
209	209a	0.11	0.045	0.064	0.294	0.019
301	301a	0.33	0.033	0.057	0.275	0.016
302	302a	0.23	0.039	0.061	0.284	0.017
303	303a	0.20	0.049	0.066	0.301	0.020
304	304a	0.67	0.082	0.082	0.352	0.029
305	305a	2.45	0.097	0.087	0.364	0.032
306	306a	1.51	0.051	0.067	0.304	0.020
401	401a	0.31	0.032	0.057	0.275	0.016
402	402a	0.19	0.050	0.067	0.301	0.020
403	403a	0.76	0.083	0.082	0.353	0.029
404	404a	0.26	0.067	0.076	0.334	0.025
405	405a	1.90	0.047	0.065	0.297	0.019
406	406a	0.46	0.036	0.059	0.280	0.017
407	407a	0.87	0.056	0.070	0.312	0.022
501	501a	0.31	0.032	0.057	0.275	0.016
502	502a	0.19	0.050	0.067	0.301	0.020
503	503a	0.63	0.093	0.086	0.360	0.031
504	504a	1.21	0.078	0.081	0.349	0.028
505	505a	2.21	0.070	0.078	0.341	0.027
506	506a	0.33	0.044	0.064	0.292	0.019
507	507a	1.13	0.037	0.060	0.281	0.017
601	601a	0.31	0.032	0.057	0.275	0.016
602	602a	0.21	0.051	0.067	0.304	0.020
603	603a	0.80	0.087	0.084	0.356	0.030
604	604a	1.57	0.081	0.082	0.352	0.029
605	605a	1.03	0.043	0.063	0.291	0.018
606	606a	1.11	0.044	0.064	0.292	0.019
607	607a	0.40	0.042	0.062	0.289	0.018
608	608a	0.84	0.080	0.082	0.351	0.029
701	701a	0.60	0.047	0.065	0.297	0.019
702	702a	0.58	0.061	0.073	0.321	0.023
703	703a	0.50	0.070	0.078	0.340	0.027
704	704a	0.31	0.068	0.077	0.337	0.026
705	705a	1.28	0.128	0.097	0.391	0.038
706	706a	0.90	0.136	0.099	0.399	0.040
707	707a	1.53	0.140	0.101	0.403	0.041
708	708a	0.68	0.123	0.095	0.386	0.037
709	709a	0.27	0.116	0.093	0.380	0.035
710	710a	0.25	0.109	0.091	0.374	0.034

Table 2A: Major System Results for the 100-Year, 3-Hour Chicago Storm

MH	SWMHYMO ID	Area (ha)	Flow (m^3/s)	Flow Depth (m)	Velocity (m/s)	V*D (m^2/s)
901	901a	1.14	0.031	0.056	0.273	0.015
801	801a	0.18	0.019	0.046	0.231	0.011
802	802a	0.45	0.052	0.068	0.305	0.021
803	803a	1.01	0.074	0.080	0.346	0.028
804	804a	1.00	0.056	0.070	0.314	0.022
903	903a	1.53	0.080	0.081	0.351	0.028
805	805b	4.67	0.113	0.092	0.377	0.035
805	805a	4.09	0.000	0.000	0.000	0.000
806	806a	2.44	0.071	0.078	0.342	0.027
904	904b	2.50	0.209	0.116	0.447	0.052
904	904a	1.86	0.119	0.094	0.383	0.036
905	905b	0.86	0.105	0.090	0.371	0.033
905	905a	1.10	0.093	0.086	0.361	0.031
906	906a	2.94	0.180	0.110	0.431	0.047
1001	1001a	2.35	0.000	0.000	0.000	0.000
1005	1005a	1.52	0.058	0.071	0.316	0.022
1006	1006a	2.54	0.054	0.069	0.309	0.021
1007	1007a	1.85	0.108	0.091	0.374	0.034
1100	1100a	1.47	0.100	0.088	0.367	0.032
1103	1103a	0.88	0.069	0.078	0.340	0.027
1104	1104a	0.88	0.053	0.068	0.307	0.021
1111	1111a	2.80	0.085	0.083	0.355	0.029
1112	1112a	0.58	0.044	0.063	0.291	0.018
1113	1113a	0.69	0.057	0.071	0.315	0.022
1201	1201a	1.76	0.097	0.087	0.364	0.032
1204	1204a	2.29	0.071	0.079	0.344	0.027
1116	1116a	1.35	0.059	0.072	0.317	0.023
1119	1119b	1.85	0.217	0.118	0.451	0.053
1119	1119a	3.58	0.145	0.102	0.408	0.042
1120	1120a	0.74	0.068	0.077	0.337	0.026
1122	1122a	3.07	0.134	0.099	0.397	0.039

Table 2B: Major System Results for the 100-Year, 3-Hour Chicago Storm +20%

MH	SWMHYMO ID	Area (ha)	Flow (m^3/s)	Flow Depth (m)	Velocity (m/s)	V*D (m^2/s)
101	101a	0.36	0.061	0.073	0.323	0.024
102	102a	0.26	0.097	0.087	0.364	0.032
103	103a	0.16	0.118	0.094	0.382	0.036
104	104a	0.50	0.182	0.111	0.432	0.048
105	105a	2.37	0.316	0.135	0.509	0.069
106	106a	1.84	0.350	0.140	0.526	0.074
201	201a	0.28	0.047	0.065	0.297	0.019
202	202a	0.80	0.175	0.109	0.428	0.047
203	203a	1.00	0.209	0.116	0.446	0.052
204	204a	1.54	0.255	0.125	0.474	0.059
205	205a	1.69	0.287	0.132	0.495	0.065
206	206a	2.60	0.314	0.135	0.508	0.069
207	207a	0.78	0.319	0.136	0.510	0.069
208	208a	0.19	0.318	0.136	0.510	0.069
209	209a	0.11	0.318	0.136	0.510	0.069
301	301a	0.33	0.055	0.070	0.311	0.022
302	302a	0.23	0.089	0.084	0.358	0.030
303	303a	0.20	0.117	0.093	0.381	0.035
304	304a	0.67	0.178	0.110	0.430	0.047
305	305a	2.45	0.320	0.136	0.511	0.069
306	306a	1.51	0.315	0.135	0.509	0.069
401	401a	0.31	0.053	0.069	0.308	0.021
402	402a	0.19	0.085	0.083	0.354	0.029
403	403a	0.76	0.161	0.107	0.421	0.045
404	404a	0.26	0.171	0.108	0.426	0.046
405	405a	1.90	0.234	0.121	0.461	0.056
406	406a	0.46	0.227	0.120	0.457	0.055
407	407a	0.87	0.211	0.117	0.448	0.052
501	501a	0.31	0.053	0.069	0.308	0.021
502	502a	0.19	0.085	0.083	0.354	0.029
503	503a	0.63	0.180	0.110	0.430	0.047
504	504a	1.21	0.210	0.116	0.447	0.052
505	505a	2.21	0.300	0.133	0.501	0.067
506	506a	0.33	0.296	0.133	0.500	0.067
507	507a	1.13	0.276	0.130	0.488	0.063
601	601a	0.31	0.053	0.069	0.308	0.021
602	602a	0.21	0.088	0.084	0.357	0.030
603	603a	0.80	0.169	0.108	0.425	0.046
604	604a	1.57	0.238	0.122	0.464	0.057
605	605a	1.03	0.242	0.123	0.466	0.057
606	606a	1.11	0.250	0.124	0.471	0.058
607	607a	0.40	0.253	0.125	0.473	0.059
608	608a	0.84	0.257	0.126	0.475	0.060
701	701a	0.60	0.077	0.081	0.348	0.028
702	702a	0.58	0.134	0.099	0.397	0.039
703	703a	0.50	0.179	0.110	0.430	0.047
704	704a	0.31	0.193	0.113	0.437	0.049
705	705a	1.28	0.303	0.134	0.503	0.067
706	706a	0.90	0.355	0.140	0.529	0.074
707	707a	1.53	0.406	0.147	0.557	0.082
708	708a	0.68	0.422	0.149	0.567	0.084
709	709a	0.27	0.423	0.149	0.568	0.085
710	710a	0.25	0.426	0.149	0.569	0.085

Table 2B: Major System Results for the 100-Year, 3-Hour Chicago Storm +20%

MH	SWMHYMO ID	Area (ha)	Flow (m^3/s)	Flow Depth (m)	Velocity (m/s)	V*D (m^2/s)
901	901a	1.14	0.120	0.094	0.383	0.036
801	801a	0.18	0.127	0.097	0.390	0.038
802	802a	0.45	0.128	0.097	0.391	0.038
803	803a	1.01	0.180	0.110	0.430	0.047
804	804a	1.00	0.204	0.115	0.444	0.051
903	903a	1.53	0.166	0.108	0.423	0.046
805	805b	4.67	0.520	0.161	0.622	0.100
805	805a	4.09	0.691	0.178	0.683	0.122
806	806a	2.44	0.667	0.176	0.674	0.119
904	904b	2.50	0.449	0.152	0.584	0.089
904	904a	1.86	0.459	0.154	0.591	0.091
905	905b	0.86	0.172	0.109	0.426	0.046
905	905a	1.10	0.214	0.117	0.449	0.053
906	906a	2.94	0.442	0.151	0.579	0.087
1001	1001a	2.35	0.199	0.114	0.441	0.050
1005	1005a	1.52	0.221	0.119	0.453	0.054
1006	1006a	2.54	0.307	0.134	0.505	0.068
1007	1007a	1.85	0.771	0.186	0.710	0.132
1100	1100a	1.47	0.176	0.110	0.428	0.047
1103	1103a	0.88	0.203	0.115	0.443	0.051
1104	1104a	0.88	0.206	0.116	0.445	0.052
1111	1111a	2.80	0.343	0.139	0.523	0.073
1112	1112a	0.58	0.073	0.079	0.345	0.027
1113	1113a	0.69	0.367	0.142	0.535	0.076
1201	1201a	1.76	0.199	0.114	0.441	0.050
1204	1204a	2.29	0.303	0.134	0.503	0.067
1116	1116a	1.35	0.569	0.166	0.639	0.106
1119	1119b	1.85	0.376	0.143	0.540	0.077
1119	1119a	3.58	0.744	0.184	0.704	0.130
1120	1120a	0.74	0.753	0.185	0.706	0.131
1122	1122a	3.07	0.768	0.186	0.710	0.132

ATTACHMENT

4

SWM FACILITY OPERATING CONDITIONS

JFSA Water Resources and Environmental Consultants

Table 3A: Summary of SWM Pond 1 Operating Characteristics [1]

Pond Component	Pre-Development Outflow (m^3/s)	Pond Level (m)	Pond Outflow (m^3/s)	Volume Used [2] (m^3)
Permanent Pool	N/A	92.35	N/A	42008
Quality Control	N/A	92.45	0.025	3043
2-Year, 24-Hour SCS	3.518	93.66	0.319	48640
5-Year, 24-Hour SCS	5.458	93.75	1.720	52121
10-Year, 24-Hour SCS	6.806	93.78	2.792	53460
25-Year, 24-Hour SCS	8.524	93.81	4.019	54805
50-Year, 24-Hour SCS	9.872	93.83	4.903	55711
100-Year, 24-Hour SCS	11.337	93.85	5.805	56576
100-Year, 24-Hour SCS [3]	11.337	93.86	5.866	56885
100-Year, 10-Year Spring [3]	N/A	94.26	4.612	75690

[1] Based on 24 hour detention of 40 m^3/ha quality control volume, erosion control of 2-year release rate to 330 L/s (as per Parish Geomorphic threshold) and quantity control of 5- to 100-year release rates to pre-development levels.

[2] Volumes used are active storage only for all pond components except the permanent pool.

[3] Restrictive downstream conditions; Summer = 93.68 m, Spring = 94.11 m. All other results based on free outfall conditions.

Table 3B: Summary of SWM Pond 2 Operating Characteristics [1]

Pond Component	Pre-Development Outflow (m^3/s)	Pond Level (m)	Pond Outflow (m^3/s)	Volume Used [2] (m^3)
Permanent Pool	N/A	93.20	N/A	17136
Quality Control	N/A	93.35	0.047	1983
2-Year, 24-Hour SCS	0.646	93.82	0.784	9606
5-Year, 24-Hour SCS	1.007	93.99	1.143	12606
10-Year, 24-Hour SCS	1.257	94.10	1.386	14582
25-Year, 24-Hour SCS	1.576	94.23	1.696	17106
50-Year, 24-Hour SCS	1.826	94.34	1.939	19089
100-Year, 24-Hour SCS	2.096	94.45	2.204	21253
100-Year, 10-Year Spring [3]	N/A	95.06	1.673	33724

[1] Based on 24 hour detention of 40 m^3/ha quality control volume and quantity control of 100-year release rate to capacity of 1500 mm outlet pipe at 0.1% slope (2.235 m^3/s). No erosion control is provided.

[2] Volumes used are active storage only for all pond components except the permanent pool.

[3] Restrictive downstream conditions; Spring = 94.18 m. All other results based on free outfall conditions.

Table 3C: Summary of SWM Pond 3 Operating Characteristics [1]

Pond Component	Pre-Development Outflow [2] (m^3/s)	Pond Level (m)	Pond Outflow (m^3/s)	Volume Used [2] (m^3)
2-Year, 24-Hour SCS	0.161	94.47	0.142	323
5-Year, 24-Hour SCS	0.244	94.62	0.196	483
10-Year, 24-Hour SCS	0.300	94.72	0.223	593
25-Year, 24-Hour SCS	0.370	94.83	0.256	733
50-Year, 24-Hour SCS	0.425	94.91	0.298	833
100-Year, 24-Hour SCS	0.483	94.99	0.348	937
100-Year, 24-Hour SCS [3]	0.483	95.34	0.473	1489
100-Year, 10-Year Spring [3]	N/A	94.90	0.057	817

[1] Based on quantity control of 2- to 100-year release rates to pre-development levels. Quality control to be provided by an oil-and-gril separator. 2-year release rate is below erosion threshold of 330 L/s.

[2] Volumes required are active storage only for all pond components (dry pond).

[3] Restrictive downstream conditions; Summer = 94.81 m, Spring = 94.81 m. All other results based on free outfall conditions.

Table 4A: Extended Detention Parameters for SWM Pond 1

Permanent Pool Parameters			Quality Orifice Parameters		
Area (C3)	29585.10	m^2	Diameter	0.300	m
Volume	42007.50	m^3			
PP Elev	92.35	m	Area	0.07069	m^2
QC Elev	92.45	m	Invert	92.35	m
h (m)	0.10	m	C_o	0.620	

Notes: C3 is the intercept from the area-depth linear regression
PP Elev indicates the elevation of the permanent pool
QC Elev indicates the elevation of the storage volume required by MOE for quality control
h is the maximum water elevation above the orifice (m)

Table 4B: Extended Detention Drawdown Time for SWM Pond 1

Elev.	Active Storage			C2	Drawdown Time	Drawdown Time	Flow	Demarkation
(m)	V (m^3)	A (m^2)	depth (m)	(m^2/m)	(h)	(days)	(m^3/s)	Point
92.35	**0.00**	**29585.10**	**0.00**				**0.000**	**PP Elev**
92.40	1488.90	30125.90	0.05	10816	19.02	0.79	0.013	
92.45	**3042.90**	**31249.20**	**0.10**	**16641**	**27.23**	**1.13**	**0.025**	**QC Elev**
92.50	4619.40	31670.90	0.15	13905	33.51	1.40	0.038	
92.55	6231.20	32422.40	0.20	14186	39.01	1.63	0.050	

Notes: C2 is the slope coefficient from the area-depth linear regression
QC Elev indicates the elevation of the quality control volume required by MOE

Table 4C: Extended Detention Parameters for SWM Pond 2

Permanent Pool Parameters			Quality Orifice Parameters		
Area (C3)	12146.70	m^2	Diameter	0.350	m
Volume	17135.70	m^3			
PP Elev	93.20	m	Area	0.09621	m^2
QC Elev	93.35	m	Invert	93.20	m
h (m)	0.15	m	C_o	0.620	

Notes: C3 is the intercept from the area-depth linear regression
PP Elev indicates the elevation of the permanent pool
QC Elev indicates the elevation of the storage volume required by MOE for quality control
h is the maximum water elevation above the orifice (m)

Table 4D: Extended Detention Drawdown Time for SWM Pond 2

Elev.	Active Storage			C2	Drawdown Time	Drawdown Time	Flow	Demarkation
(m)	V (m^3)	A (m^2)	depth (m)	(m^2/m)	(h)	(days)	(m^3/s)	Point
93.20	**0.00**	**12146.70**	**0.00**				**0.000**	**PP Elev**
93.25	630.10	12828.30	0.90	757	24.64	1.03	0.016	
93.30	1298.00	13497.00	0.95	1421	25.77	1.07	0.032	
93.35	**1983.40**	**13935.60**	**1.00**	**1789**	**26.74**	**1.11**	**0.047**	**QC Elev**
93.40	2702.40	14502.40	1.05	2244	27.81	1.16	0.063	

Notes: C2 is the slope coefficient from the area-depth linear regression
QC Elev indicates the elevation of the quality control volume required by MOE

Table 5A: Stage-Storage-Outflow Curve for SWM Pond 1

			Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.300	Dia (m)	0.220	L (m)	45.000		
			Area (m^2)	0.071	Area (m^2)	0.038				
			Invert (m)	92.35	Invert (m)	92.45	C_w	1.700		
			C_o	0.62	C_o	0.62	Invert (m)	93.68		
			Q @ D	0.075	Q @ D	0.035	n contr.	2		
Elevation	Active Sto.	Demarkation	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)	Points	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.40	1489		0.050	0.013	0.000	0.000	0.000	0.000	0.013	0.149
92.45	**3043**	**QC Elev**	**0.100**	**0.025**	**0.000**	**0.000**	**0.000**	**0.000**	**0.025**	**0.304**
92.50	4619		0.150	0.038	0.050	0.008	0.000	0.000	0.045	0.462
92.55	6231		0.200	0.050	0.100	0.016	0.000	0.000	0.066	0.623
92.60	7860		0.250	0.063	0.150	0.024	0.000	0.000	0.086	0.786
92.65	9517		0.300	0.075	0.200	0.031	0.000	0.000	0.107	0.952
92.70	11256		0.350	0.087	0.250	0.039	0.000	0.000	0.126	1.126
92.75	12987		0.400	0.097	0.300	0.046	0.000	0.000	0.143	1.299
92.80	14772		0.450	0.106	0.350	0.051	0.000	0.000	0.157	1.477
92.85	16572		0.500	0.115	0.400	0.056	0.000	0.000	0.171	1.657
92.90	18383		0.550	0.123	0.450	0.061	0.000	0.000	0.184	1.838
92.95	20220		0.600	0.130	0.500	0.065	0.000	0.000	0.195	2.022
93.00	22075		0.650	0.137	0.550	0.069	0.000	0.000	0.207	2.207
93.05	23947		0.700	0.144	0.600	0.073	0.000	0.000	0.217	2.395
93.10	25833		0.750	0.150	0.650	0.077	0.000	0.000	0.227	2.583
93.15	27752		0.800	0.157	0.700	0.080	0.000	0.000	0.237	2.775
93.20	29683		0.850	0.162	0.750	0.084	0.000	0.000	0.246	2.968
93.25	31637		0.900	0.168	0.800	0.087	0.000	0.000	0.255	3.164
93.30	33598		0.950	0.174	0.850	0.090	0.000	0.000	0.263	3.360
93.35	35588		1.000	0.179	0.900	0.093	0.000	0.000	0.272	3.559
93.40	37590		1.050	0.184	0.950	0.096	0.000	0.000	0.280	3.759
93.45	39616		1.100	0.189	1.000	0.098	0.000	0.000	0.288	3.962
93.50	41659		1.150	0.194	1.050	0.101	0.000	0.000	0.295	4.166
93.55	43702		1.200	0.199	1.100	0.104	0.000	0.000	0.303	4.370
93.60	45799		1.250	0.204	1.150	0.106	0.000	0.000	0.310	4.580
93.65	47924		1.300	0.208	1.200	0.109	0.000	0.000	0.317	4.792
93.68	**49322**	**Ext. Det.**	**1.330**	**0.211**	**1.230**	**0.110**	**0.000**	**0.000**	**0.321**	**4.932**
93.70	50479		1.350	0.213	1.250	0.111	0.020	0.216	0.540	5.048
93.75	52155		1.400	0.217	1.300	0.114	0.070	1.416	1.747	5.215
93.80	54330		1.450	0.221	1.350	0.116	0.120	3.178	3.516	5.433
93.85	56488		1.500	0.226	1.400	0.119	0.170	5.358	5.702	5.649
93.90	58693		1.550	0.230	1.450	0.121	0.220	7.886	8.237	5.869
93.95	60961		1.600	0.234	1.500	0.123	0.270	10.720	11.077	6.096
94.00	63312		1.650	0.238	1.550	0.125	0.320	13.828	14.191	6.331
94.05	65663		1.700	0.242	1.600	0.127	0.370	17.189	17.558	6.566
94.10	67999		1.750	0.246	1.650	0.130	0.420	20.784	21.159	6.800
94.15	70316		1.800	0.249	1.700	0.132	0.470	24.598	24.979	7.032
94.20	72686		1.850	0.253	1.750	0.134	0.520	28.619	29.006	7.269
94.25	75117		1.900	0.257	1.800	0.136	0.570	32.838	33.230	7.512
94.30	77507		1.950	0.260	1.850	0.138	0.620	37.244	37.642	7.751
94.35	79906		2.000	0.264	1.900	0.140	0.670	41.829	42.233	7.991
94.40	82293		2.050	0.268	1.950	0.142	0.720	46.587	46.997	8.229
94.45	84689		2.100	0.271	2.000	0.144	0.770	51.512	51.927	8.469
94.50	87132		2.150	0.275	2.050	0.145	0.820	56.597	57.017	8.713
94.55	89570		2.200	0.278	2.100	0.147	0.870	61.838	62.264	8.957
94.60	92017		2.250	0.281	2.150	0.149	0.920	67.230	67.661	9.202
94.65	94442		2.300	0.285	2.200	0.151	0.970	72.768	73.204	9.444

Table 5A: Stage-Storage-Outflow Curve for SWM Pond 1

			Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.300	Dia (m)	0.220	L (m)	45.000		
			Area (m^2)	0.071	Area (m^2)	0.038				
			Invert (m)	92.35	Invert (m)	92.45	C_w	1.700		
			C_o	0.62	C_o	0.62	Invert (m)	93.68		
			Q @ D	0.075	Q @ D	0.035	n contr.	2		
Elevation	Active Sto.	Demarkation Points	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
94.70	96838		2.350	0.288	2.250	0.153	1.020	78.449	78.890	9.684
94.75	99276		2.400	0.291	2.300	0.154	1.070	84.269	84.714	9.928
94.80	101720		2.450	0.294	2.350	0.156	1.120	90.224	90.674	10.172
94.85	104579		2.500	0.298	2.400	0.158	1.170	96.311	96.767	10.458
94.90	107417		2.550	0.301	2.450	0.160	1.220	102.527	102.988	10.742
94.95	109567		2.600	0.304	2.500	0.161	1.270	108.870	109.335	10.957
95.00	**112089**	**Top of Berm**	**2.650**	**0.307**	**2.550**	**0.163**	**1.320**	**115.337**	**115.807**	**11.209**

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume provided for quality control according to MOE requirements.
- Ext. Det. indicates the elevation of extended detention provided.
- Top of Berm indicates the elevation at the top of the berm.

Table 5B: Stage-Storage-Outflow Curve for SWM Pond 2

			Quality Control 1		Quantity Control 1			
			Vertical Orifice		Rectangular Weir			
			Dia (m)	0.350	L (m)	1.150		
			Area (m^2)	0.096				
			Invert (m)	93.20	C_w	1.800		
			C_o	0.62	Invert (m)	93.35		
			Q @ D	0.111	n contr.	2		
Elevation	Active Sto.	Demarkation	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)	Points	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
93.20	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
93.25	630		0.050	0.016	0.000	0.000	0.016	0.063
93.30	1298		0.100	0.032	0.000	0.000	0.032	0.130
93.35	**1983**	**QC Elev**	**0.150**	**0.047**	**0.000**	**0.000**	**0.047**	**0.198**
93.40	2702		0.200	0.063	0.050	0.023	0.086	0.270
93.45	3438		0.250	0.079	0.100	0.064	0.143	0.344
93.50	4207		0.300	0.095	0.150	0.117	0.212	0.421
93.55	5026		0.350	0.111	0.200	0.179	0.289	0.503
93.60	5857		0.400	0.125	0.250	0.248	0.373	0.586
93.65	6701		0.450	0.139	0.300	0.322	0.461	0.670
93.70	7555		0.500	0.151	0.350	0.403	0.553	0.755
93.75	8417		0.550	0.162	0.400	0.487	0.649	0.842
93.80	9290		0.600	0.172	0.450	0.576	0.748	0.929
93.85	10168		0.650	0.182	0.500	0.668	0.850	1.017
93.90	11054		0.700	0.191	0.550	0.764	0.955	1.105
93.95	11941		0.750	0.200	0.600	0.862	1.062	1.194
94.00	12840		0.800	0.209	0.650	0.962	1.171	1.284
94.05	13747		0.850	0.217	0.700	1.065	1.282	1.375
94.10	14654		0.900	0.225	0.750	1.169	1.394	1.465
94.15	15575		0.950	0.233	0.800	1.275	1.508	1.557
94.20	16503		1.000	0.240	0.850	1.382	1.622	1.650
94.25	17446		1.050	0.247	0.900	1.491	1.738	1.745
94.30	18402		1.100	0.254	0.950	1.600	1.854	1.840
94.35	19356		1.150	0.261	1.000	1.710	1.971	1.936
94.40	20310		1.200	0.268	1.050	1.820	2.088	2.031
94.45	21272		1.250	0.274	1.100	1.931	2.205	2.127
94.50	22254		1.300	0.280	1.150	2.042	2.322	2.225
94.55	23238		1.350	0.286	1.200	2.153	2.440	2.324
94.60	24230		1.400	0.292	1.250	2.264	2.556	2.423
94.65	25235		1.450	0.298	1.300	2.375	2.673	2.523
94.70	26242		1.500	0.304	1.350	2.485	2.789	2.624
94.75	27258		1.550	0.310	1.400	2.594	2.904	2.726
94.80	28240		1.600	0.315	1.450	2.703	3.018	2.824
94.85	29270		1.650	0.321	1.500	2.811	3.132	2.927
94.90	30303		1.700	0.326	1.550	2.918	3.244	3.030
94.95	31347		1.750	0.332	1.600	3.024	3.355	3.135
95.00	32403		1.800	0.337	1.650	3.128	3.465	3.240
95.05	33469		1.850	0.342	1.700	3.232	3.574	3.347
95.10	34532		1.900	0.347	1.750	3.334	3.681	3.453
95.15	35614		1.950	0.352	1.800	3.434	3.786	3.561
95.20	36693		2.000	0.357	1.850	3.533	3.890	3.669
95.25	37801		2.050	0.362	1.900	3.630	3.992	3.780
95.30	38904		2.100	0.367	1.950	3.725	4.092	3.890
95.35	39997		2.150	0.371	2.000	3.818	4.190	4.000
95.40	41109		2.200	0.376	2.050	3.910	4.286	4.111
95.45	42227		2.250	0.381	2.100	3.999	4.379	4.223
95.50	43375		2.300	0.385	2.150	4.086	4.471	4.338
95.55	44523		2.350	0.390	2.200	4.170	4.560	4.452

Table 5B: Stage-Storage-Outflow Curve for SWM Pond 2

			Quality Control 1		Quantity Control 1			
			Vertical Orifice		Rectangular Weir			
			Dia (m)	0.350	L (m)	1.150		
			Area (m^2)	0.096				
			Invert (m)	93.20	C_w	1.800		
			C_o	0.62	Invert (m)	93.35		
			Q @ D	0.111	n contr.	2		
Elevation	Active Sto.	Demarkation Points	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
95.60	45673		2.400	0.394	2.250	4.253	4.647	4.567
95.65	46751		2.450	0.399	2.300	4.332	4.731	4.675
95.70	47875		2.500	0.403	2.350	4.409	4.812	4.788
95.75	49039		2.550	0.407	2.400	4.484	4.891	4.904
95.80	50236		2.600	0.411	2.450	4.556	4.967	5.024
95.85	51668		2.650	0.416	2.500	4.625	5.041	5.167
95.90	53716		2.700	0.420	2.550	4.691	5.111	5.372
95.95	53724		2.750	0.424	2.600	4.754	5.178	5.372
96.00	**54933**	**Top of Berm**	**2.800**	**0.428**	**2.650**	**4.814**	**5.242**	**5.493**

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume provided for quality control according to MOE requirements.
- Top of Berm indicates the elevation at the top of the berm.

Table 5C: Stage-Storage-Outflow Curve for SWM Pond 3

			Quantity Control 1		Quantity Control 2			
			Vertical Orifice		Rectangular Weir			
			Dia (m)	0.400	L (m)	0.500		
			Area (m^2)	0.126				
			Invert (m)	94.10	C_w	1.800		
			C_o	0.62	Invert (m)	94.81		
			Q @ D	0.154	n contr.	2		
Elevation (m)	Active Sto. (m^3)	Demarkation Points	Head (m)	Outflow (m^3/s)	Head (m)	Outflow (m^3/s)	Outflow (m^3/s)	Storage (ha·m)
94.10	**0**	**Bottom Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
94.15	38		0.050	0.019	0.000	0.000	0.019	0.004
94.20	79		0.100	0.039	0.000	0.000	0.039	0.008
94.25	120		0.150	0.058	0.000	0.000	0.058	0.012
94.30	164		0.200	0.077	0.000	0.000	0.077	0.016
94.35	209		0.250	0.096	0.000	0.000	0.096	0.021
94.40	256		0.300	0.116	0.000	0.000	0.116	0.026
94.45	304		0.350	0.135	0.000	0.000	0.135	0.030
94.50	354		0.400	0.154	0.000	0.000	0.154	0.035
94.55	406		0.450	0.173	0.000	0.000	0.173	0.041
94.60	459		0.500	0.189	0.000	0.000	0.189	0.046
94.65	514		0.550	0.204	0.000	0.000	0.204	0.051
94.70	572		0.600	0.218	0.000	0.000	0.218	0.057
94.75	631		0.650	0.232	0.000	0.000	0.232	0.063
94.80	692		0.700	0.244	0.000	0.000	0.244	0.069
94.81	**704**		**0.710**	**0.246**	**0.000**	**0.000**	**0.246**	**0.070**
94.85	755		0.750	0.256	0.040	0.007	0.263	0.075
94.90	820		0.800	0.267	0.090	0.023	0.291	0.082
94.95	887		0.850	0.278	0.140	0.045	0.323	0.089
95.00	956		0.900	0.289	0.190	0.069	0.358	0.096
95.05	1027		0.950	0.299	0.240	0.096	0.395	0.103
95.10	1101		1.000	0.309	0.290	0.124	0.433	0.110
95.15	1176		1.050	0.318	0.340	0.154	0.472	0.118
95.20	1254		1.100	0.327	0.390	0.185	0.512	0.125
95.25	1334		1.150	0.336	0.440	0.216	0.553	0.133
95.30	1416		1.200	0.345	0.490	0.248	0.593	0.142
95.35	1501		1.250	0.354	0.540	0.280	0.634	0.150
95.40	1588		1.300	0.362	0.590	0.312	0.674	0.159
95.45	1678		1.350	0.370	0.640	0.343	0.713	0.168
95.50	1826		1.400	0.378	0.690	0.373	0.752	0.183
95.55	1960		1.450	0.386	0.740	0.403	0.789	0.196
95.60	1906		1.500	0.393	0.790	0.432	0.826	0.191
95.65	2001		1.550	0.401	0.840	0.460	0.861	0.200
95.70	2104		1.600	0.408	0.890	0.487	0.895	0.210
95.75	**2231**	**Top of Berm**	**1.650**	**0.416**	**0.940**	**0.512**	**0.927**	**0.223**

Notes : - Bottom Elev indicates the elevation of the pond bottom.
- Top of Berm indicates the elevation at the top of the berm.

ATTACHMENT

5

PIPE DATA AND HYDRAULIC SIMULATION RESULTS

JFSA Water Resources and Environmental Consultants

Table 6A: Pipe Data and Hydraulic Simulation Results for Pond 1 [(1)]

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm							100-year, 12-hour SCS Type II Storm							100-year, 10-day Spring Snowmelt + Rainfall Event						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
101	102	93.601	93.486	0.450	N/A	57.5	0.2	0.013	95.744	95.659	0.80	0.13	0.07	0.55	-0.20	1.1	93.85	93.82	1.89	0.07	0.55	-0.19	12.0	93.86	93.86	1.89	0.01	0.08	0.21	0.0	94.26	94.26	1.48
102	103	93.411	93.311	0.525	N/A	62.5	0.2	0.013	95.659	95.566	0.79	0.17	0.13	0.76	-0.12	1.1	93.82	93.82	1.84	0.13	0.76	-0.08	12.0	93.86	93.86	1.80	0.01	0.06	0.33	0.0	94.26	94.26	1.40
103	104	93.236	93.218	0.600	N/A	12.5	0.1	0.013	95.566	95.549	0.81	0.23	0.16	0.70	-0.02	1.1	93.82	93.82	1.75	0.16	0.70	0.02	12.0	93.86	93.86	1.71	0.01	0.04	0.43	109.0	94.26	94.26	1.30
104	105	93.068	92.989	0.750	N/A	79.0	0.1	0.013	95.549	95.431	0.80	0.35	0.27	0.77	0.00	1.1	93.82	93.82	1.73	0.26	0.74	0.04	12.0	93.86	93.86	1.69	0.02	0.06	0.45	109.0	94.26	94.26	1.29
105	106	92.764	92.661	0.975	N/A	68.5	0.2	0.013	95.431	95.329	1.16	0.87	0.74	0.85	0.08	1.2	93.82	93.82	1.61	0.73	0.84	0.12	12.0	93.86	93.86	1.57	0.06	0.07	0.52	109.0	94.26	94.26	1.17
106	107	92.436	92.368	1.200	N/A	68.0	0.1	0.013	95.329	95.300	1.09	1.23	1.12	0.91	0.18	1.1	93.82	93.82	1.51	1.08	0.88	0.22	12.0	93.86	93.86	1.47	0.09	0.07	0.63	109.0	94.26	94.26	1.07
107	Pond1	92.368	92.350	1.200	N/A	18.0	0.1	0.013	95.300	100.000	1.09	1.23	1.11	0.90	0.25	1.1	93.82	93.82	1.48	1.06	0.86	0.29	12.0	93.86	93.86	1.44	0.09	0.07	0.69	109.0	94.26	94.26	1.04
201	202	94.189	94.039	0.375	N/A	60.0	0.3	0.013	96.384	96.294	0.79	0.09	0.06	0.68	-0.13	1.1	94.44	94.20	1.95	0.06	0.68	-0.13	12.0	94.44	94.19	1.95	0.00	0.00	-0.23	109.1	94.33	94.33	2.05
202	203	93.739	93.623	0.675	N/A	97.0	0.1	0.013	96.294	96.149	0.81	0.29	0.22	0.76	-0.21	1.2	94.20	94.11	2.09	0.21	0.72	-0.22	12.1	94.19	94.10	2.10	0.02	0.07	-0.09	109.1	94.33	94.33	1.97
203	204	93.398	93.332	0.900	N/A	66.5	0.1	0.013	96.149	96.050	0.90	0.57	0.42	0.73	-0.19	1.2	94.11	94.07	2.04	0.41	0.72	-0.20	12.1	94.10	94.06	2.05	0.03	0.05	0.03	109.1	94.33	94.33	1.82
204	205	93.182	93.082	1.050	N/A	100.5	0.1	0.013	96.050	95.899	1.00	0.86	0.73	0.85	-0.16	1.2	94.07	94.00	1.98	0.70	0.81	-0.17	12.1	94.06	94.05	1.99	0.06	0.07	0.09	109.1	94.33	94.33	1.72
205	206	92.932	92.859	1.200	N/A	72.5	0.1	0.013	95.899	95.791	1.09	1.23	1.07	0.87	-0.13	1.2	94.00	93.95	1.90	1.03	0.84	-0.08	12.1	94.05	94.05	1.85	0.08	0.06	0.19	109.1	94.33	94.33	1.57
206	207	92.839	92.719	1.200	N/A	120.0	0.1	0.013	95.791	95.611	1.09	1.23	1.58	1.28	-0.09	1.2	93.95	93.90	1.84	1.52	1.23	0.02	12.1	94.05	94.05	1.74	0.12	0.10	0.29	109.1	94.33	94.33	1.46
207	208	92.699	92.579	1.200	N/A	120.0	0.1	0.013	95.611	95.431	1.09	1.23	1.74	1.41	0.00	1.2	93.90	93.90	1.71	1.66	1.35	0.16	12.1	94.05	94.05	1.56	0.13	0.11	0.43	109.1	94.33	94.33	1.29
208	209	92.529	92.497	1.200	N/A	32.5	0.1	0.013	95.431	95.422	1.09	1.23	1.78	1.44	0.17	1.2	93.90	93.90	1.53	1.69	1.37	0.32	12.1	94.05	94.05	1.38	0.13	0.11	0.60	109.1	94.33	94.32	1.11
209	210	92.417	92.360	1.200	1.800	57.0	0.1	0.013	95.422	95.522	1.23	2.66	3.31	1.24	0.29	2.9	93.90	94.28	1.52	4.12	1.55	0.44	13.6	94.05	93.88	1.37	2.30	0.86	0.71	110.4	94.32	94.27	1.10
210	Pond1	92.360	92.350	1.200	1.800	10.0	0.1	0.013	95.522	100.000	1.23	2.66	3.31	1.24	0.72	2.9	94.28	93.82	1.24	4.12	1.55	0.32	13.6	93.88	93.86	1.64	2.30	0.86	0.71	110.4	94.27	94.26	1.25
301	302	93.943	93.808	0.450	N/A	67.5	0.2	0.013	95.732	95.631	0.80	0.13	0.07	0.55	-0.21	1.1	94.18	94.05	1.55	0.07	0.55	-0.21	12.0	94.18	94.05	1.55	0.01	0.08	-0.13	0.1	94.26	94.26	1.47
302	303	93.733	93.643	0.525	N/A	56.5	0.2	0.013	95.631	95.546	0.79	0.17	0.12	0.70	-0.21	1.1	94.05	93.92	1.58	0.12	0.70	-0.21	12.0	94.05	93.92	1.58	0.01	0.06	0.00	109.1	94.26	94.26	1.37
303	304	93.568	93.546	0.600	N/A	15.5	0.1	0.013	95.546	95.523	0.81	0.23	0.16	0.70	-0.25	1.1	93.92	93.87	1.63	0.16	0.70	-0.25	12.1	93.92	93.86	1.63	0.01	0.04	0.10	108.9	94.26	94.26	1.28
304	305	93.396	93.284	0.750	N/A	101.5	0.1	0.013	95.523	95.370	0.84	0.37	0.30	0.81	-0.28	1.1	93.87	93.82	1.66	0.29	0.79	-0.28	12.1	93.86	93.86	1.66	0.02	0.05	0.12	109.1	94.26	94.26	1.26
305	306	92.984	92.894	1.050	N/A	90.0	0.1	0.013	95.370	95.236	1.00	0.86	0.79	0.91	-0.22	1.2	93.82	93.82	1.55	0.78	0.90	-0.17	12.1	93.86	93.86	1.51	0.06	0.07	0.23	109.1	94.26	94.26	1.11
306	307	92.744	92.688	1.200	N/A	56.0	0.1	0.013	95.236	95.151	1.09	1.23	1.10	0.89	-0.13	1.2	93.82	93.82	1.42	1.07	0.87	-0.09	12.1	93.86	93.86	1.38	0.08	0.06	0.32	109.0	94.26	94.26	0.97
307	308	92.608	92.518	1.200	N/A	90.0	0.1	0.013	95.151	95.197	1.09	1.23	1.10	0.89	0.01	1.2	93.82	93.82	1.33	1.06	0.86	0.05	12.1	93.86	93.86	1.29	0.08	0.06	0.45	109.0	94.26	94.26	0.89
308	309	92.468	92.438	1.200	N/A	30.0	0.1	0.013	95.197	95.197	1.09	1.23	1.10	0.89	0.15	1.2	93.82	93.82	1.38	1.04	0.84	0.19	12.1	93.86	93.86	1.34	0.08	0.06	0.59	109.0	94.26	94.26	0.94
309	Pond1	92.388	92.350	1.200	N/A	38.5	0.1	0.013	95.197	100.000	1.09	1.23	1.10	0.89	0.23	1.2	93.82	93.82	1.38	1.03	0.84	0.27	12.1	93.86	93.86	1.34	0.08	0.06	0.67	109.0	94.26	94.26	0.94
401	402	93.666	93.568	0.450	N/A	49.0	0.2	0.013	95.735	95.668	0.80	0.13	0.06	0.47	-0.22	1.1	93.90	93.82	1.84	0.06	0.47	-0.22	12.0	93.90	93.86	1.84	0.00	0.00	0.15	0.0	94.26	94.26	1.47
402	403	93.493	93.471	0.525	N/A	14.0	0.2	0.013	95.668	95.649	0.79	0.17	0.10	0.58	-0.20	1.1	93.82	93.82	1.85	0.10	0.58	-0.16	12.0	93.86	93.86	1.81	0.01	0.06	0.25	109.0	94.26	94.26	1.41
403	404	93.246	93.102	0.750	N/A	120.0	0.1	0.013	95.649	95.470	0.87	0.39	0.26	0.67	-0.18	1.1	93.82	93.82	1.83	0.26	0.67	-0.14	12.0	93.86	93.86	1.79	0.02	0.05	0.27	109.0	94.26	94.26	1.39
404	405	93.082	92.996	0.750	N/A	72.0	0.1	0.013	95.470	95.362	0.87	0.39	0.32	0.83	-0.01	1.2	93.82	93.82	1.65	0.31	0.80	0.03	12.1	93.86	93.86	1.61	0.02	0.05	0.43	109.0	94.26	94.26	1.21
405	406	92.771	92.705	0.975	N/A	66.0	0.1	0.013	95.362	95.263	0.95	0.71	0.70	0.99	0.07	1.2	93.82	93.82	1.55	0.68	0.96	0.11	12.1	93.86	93.86	1.50	0.05	0.07	0.52	109.0	94.26	94.26	1.10
406	407	92.630	92.552	1.050	N/A	78.0	0.1	0.013	95.263	95.153	1.00	0.86	0.79	0.91	0.14	1.2	93.82	93.82	1.45	0.76	0.88	0.18	12.1	93.86	93.86	1.40	0.06	0.07	0.58	109.0	94.26	94.26	1.00
407	Pond1	92.400	92.350	1.200	N/A	49.5	0.1	0.013	95.153	100.000	1.09	1.23	0.97	0.79	0.22	1.2	93.82	93.82	1.34	0.92	0.75	0.26	12.1	93.86	93.86	1.29	0.07	0.06	0.66	109.0	94.26	94.26	0.89
501	502	93.825	93.727	0.450	N/A	49.0	0.2	0.013	95.799	95.726	0.80	0.13	0.06	0.47	-0.22	1.1	94.06	93.96	1.74	0.06	0.47	-0.22	12.0	94.06	93.95	1.74	0.01	0.08	-0.01	0.1	94.26	94.26	1.54
502	503	93.652	93.630	0.525	N/A	13.5	0.2	0.013	95.726	95.708	0.79	0.17	0.10	0.58	-0.22	1.1	93.96	93.92	1.77	0.10	0.58	-0.23	12.0	93.95	93.92	1.77	0.01	0.06	0.09	0.1	94.26	94.26	1.46
503	504	93.480	93.365	0.675	N/A	96.0	0.1	0.013	95.708	95.566	0.81	0.29	0.23	0.79	-0.23	1.1	93.92	93.82	1.79	0.23	0.79	-0.24	12.0	93.92	93.86	1.79	0.02	0.07	0.11	108.7	94.26	94.27	1.44
504	505	93.140	93.044	0.900	N/A	96.0	0.1	0.013	95.566	95.421	0.90	0.57	0.48	0.84	-0.22	1.2	93.82	93.82	1.75	0.47	0.82	-0.18	12.1	93.86	93.86	1.71	0.04	0.07	0.22	108.9	94.27	94.26	1.30
505	506	92.894	92.770	1.050	N/A	123.5	0.1	0.013	95.421	95.236	1.00	0.86	0.92	1.07	-0.13	1.2	93.82	93.82	1.60	0.90	1.04	-0.09	12.1	93.86	93.86	1.56	0.07	0.08	0.32	109.0	94.26	94.26	1.16
506	507	92.620	92.561	1.200	N/A	59.0	0.1	0.013	95.236	95.153	1.09	1.23	0.99	0.80	0.00	1.2	93.82	93.82	1.42	0.96	0.78	0.04	12.1	93.86	93.86	1.38	0.08	0.06	0.44	109.0	94.26	94.26	0.97
507	508	92.511	92.429	1.200	N/A	82.0	0.1	0.013	95.153	95.224	1.09	1.23	1.22	0.99	0.11	1.2	93.82	93.82	1.34	1.17	0.95	0.15	12.1	93.86	93.86	1.29	0.09	0.07	0.55	109.0	94.26	94.26	0.89
508	Pond1	92.379	92.350	1.200	2.400	28.5	0.1	0.013	95.224	100.000	1.32	3.80	2.51	0.66	0.24	1.2	93.82	93.82	1.41	2.36	0.62	0.28	12.1	93.86	93.86	1.37	0.19	0.05	0.68	109.0	94.26	94.26	0.96
601	602	93.946	93.842	0.450	N/A	52.0	0.2	0.013	95.904	95.828	0.80	0.13	0.06	0.47	-0.22	1.1	94.18	94.05	1.72	0.06	0.47	-0.22	12.0	94.18	94.05	1.72	0.00	0.00	-0.13	0.1	94.26	94.26	1.64
602	603	93.767	93.741	0.525	N/A	16.5	0.2	0.013	95.828	95.804	0.79	0.17	0.11	0.64	-0.24	1.1	94.05	93.99	1.78	0.11	0.64	-0.25	12.0	94.05	93.99	1.78	0.01	0.06	-0.03	109.0	94.26	94.26	1.56
603	604	93.516	93.396	0.750	N/A	120.0	0.1	0.013	95.804	95.625	0.80	0.35	0.28	0.80	-0.27	1.1	93.99	93.84	1.81	0.27	0.77	-0.28	12.1	93.99	93.86	1.82	0.02	0.06	0.00	109.0	94.26	94.26	1.54
604	605	93.171	93.097	0.975	N/A	74.0	0.1	0.013	95.625	95.514	0.95	0.71	0.60	0.85	-0.30	1.2	93.84	93.82	1.78	0.58	0.82	-0.29	12.1	93.86	93.86	1.77	0.04	0.06	0.12	109.0	94.26	94.26	1.36
605	606	93.022	92.954	1.050	N/A	68.0	0.1	0.013	95.514	95.411	1.00	0.86	0.81	0.94	-0.25	1.2	93.82	93.82	1.70	0.79	0.91	-0.21	12.1	93.86	93.86	1.66	0.06	0.07	0.19	109.0	94.26	94.26	1.25
606	607	92.804	92.692	1.200	N/A	112.5	0.1	0.013	95.411	95.249	1.09	1.23	1.04	0.84	-0.19	1.2	93.82	93.82	1.59	1.01	0.82	-0.15	12.1	93.86	93.86	1.55	0.08	0.06	0.26	109.0	94.26	94.26	1.15
607	608	92.612	92.546	1.200	N/A	65.5	0.1	0.013	95.249	95.153	1.09	1.23	1.12	0.91	0.00	1.2	93.82	93.82	1.43	1.08	0.88	0.05	12.1	93.86	93.86	1.39	0.08	0.06	0.45	109.0	94.26	94.26	0.99
608	508	92.466	92.429	1.200	N/A	37.0	0.1	0.013	95.153	95.224	1.09	1.23	1.29	1.05	0.15	1.2	93.82	93.82	1.34	1.23	1.00	0.19	12.1	93.86	93.86	1.29	0.10	0.08	0.60	109.0	94.26	94.26	0.89
701	702	94.662	94.518	0.525	N/A	90.0	0.2	0.013	96.821	96.693	0.79	0.17	0.13	0.76	-0.20	1.1	94.99	94.79	1.83	0.13	0.76	-0.20	12.0	94.99	94.79	1.83	0.01	0.06	-0.44	109.0	94.75	94.49	2.07
702	703	94.368	94.250	0.675	N/A	90.5	0.1	0.013	96.693	96.557	0.85	0.30	0.25	0.82	-0.25	1.2	94.79	93.96	1.90	0.24	0.79	-0.25	12.1	94.79	94.05	1.90	0.02	0.07	-0.56	109.1	94.49	94.33	2.21
703	704	93.425	93.319	1.500	3.000	105.5	0.1	0.013	96.557	96.401	1.53	6.90	1.42	0.21	-0.97	4.6	93.96	93.90	2.60	1.90	0.28	-0.88	15.5	94.05	93.97	2.51	1.63	0.24	-0.59	112.4	94.33	94.32	2.22
704	705	93.269	93.257	1.500	3.000	12.0	0.1	0.013	96.401	96.386	1.53	6.90	1.43	0.21	-0.87	4.6	93.90	93.88	2.51	1.90	0.28	-0.80	15.5	93.97	93.96	2.43	1.63	0.24	-0.45	112.5	94.32	94.31	2.08
705	706	93.207	93.097	1.500	3.000	110.5	0.1	0.013	96.386	96.221	1.53	6.90	1.43	0.21	-0.82	4.6	93.88	93.86	2.50	1.91	0.28	-0.75	15.5	93.96	93.93	2.43	1.64	0.24	-0.39	112.5	94.31	94.31	2.07
706	707	93.077	92.988	1.500	3.000	88.5	0.1	0.013	96.221	96.089	1.53	6.90	1.43	0.21	-0.71	4.6	93.86	93.85	2.36	1.92	0.28	-0.65	15.6	93.93	93.91	2.29	1.65	0.24	-0.27	112.5	94.31	94.30	1.92
707	708	92.968	92.848	1.500	3.000	120.0	0.1	0.013	96.089	95.909	1.53	6.90	1.44	0.21	-0.61	4.7	93.85	93.85	2.24	1.93	0.28	-0.55	15.6	93.91	93.90	2.18	1.67	0.24	-0.17	112.2	94.30	94.30	1.79

Table 6A: Pipe Data and Hydraulic Simulation Results for Pond 1 [1]

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm							100-year, 12-hour SCS Type II Storm							100-year, 10-day Spring Snowmelt + Rainfall Event						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
708	709	92.828	92.768	1.500	3.000	59.5	0.1	0.013	95.909	95.820	1.53	6.90	1.45	0.21	-0.48	4.7	93.85	93.84	2.06	1.94	0.28	-0.43	15.6	93.90	93.90	2.01	1.68	0.24	-0.03	112.2	94.30	94.29	1.61
709	710	92.718	92.693	1.500	3.000	25.0	0.1	0.013	95.820	95.781	1.53	6.90	1.45	0.21	-0.38	4.7	93.84	93.84	1.98	1.94	0.28	-0.32	15.6	93.90	93.89	1.93	1.68	0.24	0.08	112.2	94.29	94.29	1.53
710	712	92.643	92.619	1.500	3.000	23.5	0.1	0.013	95.781	95.754	1.53	6.90	1.45	0.21	-0.31	4.7	93.84	93.83	1.94	1.94	0.28	-0.25	15.6	93.89	93.88	1.89	1.69	0.25	0.15	112.2	94.29	94.29	1.49
711	712	92.622	92.599	1.500	3.000	23.0	0.1	0.013	95.751	95.754	1.53	6.90	2.74	0.40	-0.29	1.2	93.83	93.83	1.92	2.68	0.39	-0.24	12.1	93.88	93.88	1.87	0.21	0.03	0.17	109.3	94.29	94.29	1.46
712	713	92.569	92.431	1.500	3.000	138.5	0.1	0.013	95.754	95.911	1.53	6.90	3.99	0.58	-0.24	1.2	93.83	93.82	1.92	3.99	0.58	-0.19	12.1	93.88	93.86	1.87	1.84	0.27	0.22	112.1	94.29	94.27	1.47
713	Pond1	92.381	92.350	1.500	3.000	31.0	0.1	0.013	95.911	100.000	1.53	6.90	3.98	0.58	-0.06	1.2	93.82	93.82	2.09	3.91	0.57	-0.02	12.1	93.86	93.86	2.05	1.84	0.27	0.38	112.1	94.27	94.26	1.65
801	802	94.412	94.293	0.300	N/A	35.0	0.3	0.013	96.236	96.115	0.80	0.06	0.04	0.71	-0.10	1.1	94.62	94.43	1.62	0.04	0.71	-0.10	12.0	94.62	94.43	1.62	0.00	0.00	-0.25	109.1	94.46	94.29	1.77
802	803	94.068	93.954	0.525	N/A	71.5	0.2	0.013	96.115	96.115	0.79	0.17	0.13	0.76	-0.16	1.1	94.43	94.13	1.68	0.13	0.76	-0.16	12.0	94.43	94.13	1.68	0.01	0.06	-0.31	108.5	94.29	94.29	1.83
803	804	93.654	93.582	0.825	N/A	71.5	0.1	0.013	96.115	96.008	0.85	0.45	0.34	0.75	-0.35	1.1	94.13	94.00	1.99	0.34	0.75	-0.35	12.0	94.13	94.00	1.99	0.03	0.07	-0.19	108.7	94.29	94.29	1.83
804	805	93.432	93.360	0.975	N/A	71.5	0.1	0.013	96.008	95.902	0.95	0.71	0.55	0.78	-0.41	1.1	94.00	93.86	2.01	0.54	0.76	-0.41	12.1	94.00	93.88	2.01	0.04	0.06	-0.12	108.8	94.29	94.29	1.72
805	806	92.835	92.747	1.500	N/A	88.0	0.1	0.013	95.902	95.772	1.26	2.24	2.27	1.02	-0.47	1.1	93.86	93.83	2.04	2.24	1.00	-0.45	12.1	93.88	93.88	2.02	0.17	0.08	-0.05	109.0	94.29	94.29	1.62
806	711	92.667	92.652	1.500	3.000	15.0	0.1	0.013	95.772	95.751	1.53	6.90	2.75	0.40	-0.34	1.1	93.83	93.83	1.94	2.69	0.39	-0.29	12.1	93.88	93.88	1.89	0.21	0.03	0.12	108.9	94.29	94.29	1.49
1500	1501	92.698	92.573	1.200	1.800	124.5	0.1	0.013	95.907	95.721	1.23	2.66	3.26	1.23	0.31	2.9	94.21	94.04	1.70	4.03	1.52	0.71	13.6	94.61	94.32	1.30	2.18	0.82	0.59	110.5	94.49	94.40	1.42
1501	209	92.573	92.467	1.200	1.800	105.5	0.1	0.013	95.721	95.422	1.23	2.66	3.26	1.23	0.27	2.9	94.04	93.90	1.68	4.03	1.52	0.55	13.6	94.32	94.05	1.40	2.18	0.82	0.63	110.5	94.40	94.32	1.32
Pond1	P1out	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.96	N/A	N/A	N/A	N/A	N/A	N/A	5.87	N/A	N/A	N/A	N/A	N/A	N/A	4.61	N/A	N/A	N/A	N/A	N/A	N/A

Note: [1] Based on restrictive downstream conditions; Summer = 93.68 m, Spring = 94.11 m.

[2] A negative surcharge implies that the pipe is not flowing full

Table 6A: Pipe Data and Hydraulic Simulation Results for Pond 1 [(1)]

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm + 20%							100-year, 12-hour SCS Type II Storm + 20%							July 1st, 1979 Historical Event						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [(2)] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
101	102	93.601	93.486	0.450	N/A	57.5	0.2	0.013	95.744	95.659	0.80	0.13	0.08	0.63	-0.19	1.1	93.86	93.86	1.88	0.08	0.63	-0.16	12.0	93.89	93.89	1.85	0.07	0.55	-0.20	1.7	93.86	93.86	1.89
102	103	93.411	93.311	0.525	N/A	62.5	0.2	0.013	95.659	95.566	0.79	0.17	0.14	0.81	-0.08	1.1	93.86	93.86	1.80	0.14	0.81	-0.04	12.0	93.89	93.89	1.77	0.12	0.70	-0.08	1.7	93.86	93.86	1.80
103	104	93.236	93.218	0.600	N/A	12.5	0.1	0.013	95.566	95.549	0.81	0.23	0.17	0.74	0.02	1.1	93.86	93.86	1.71	0.17	0.74	0.06	12.0	93.89	93.89	1.67	0.16	0.70	0.02	1.7	93.86	93.86	1.71
104	105	93.068	92.989	0.750	N/A	79.0	0.1	0.013	95.549	95.431	0.80	0.35	0.28	0.80	0.04	1.1	93.86	93.86	1.69	0.27	0.77	0.07	12.1	93.89	93.89	1.66	0.26	0.74	0.04	1.7	93.86	93.86	1.69
105	106	92.764	92.661	0.975	N/A	68.5	0.2	0.013	95.431	95.329	1.16	0.87	0.83	0.96	0.12	1.1	93.86	93.86	1.57	0.78	0.90	0.15	12.0	93.89	93.89	1.54	0.71	0.82	0.12	1.7	93.86	93.86	1.58
106	107	92.436	92.368	1.200	N/A	68.0	0.1	0.013	95.329	95.300	1.09	1.23	1.25	1.01	0.22	1.1	93.86	93.86	1.47	1.17	0.95	0.26	12.0	93.89	93.89	1.44	1.05	0.85	0.22	1.7	93.86	93.86	1.47
107	Pond1	92.368	92.350	1.200	N/A	18.0	0.1	0.013	95.300	100.000	1.09	1.23	1.25	1.01	0.29	1.1	93.86	93.86	1.44	1.16	0.94	0.32	12.0	93.89	93.89	1.41	1.04	0.84	0.29	1.7	93.86	93.86	1.44
201	202	94.189	94.039	0.375	N/A	60.0	0.3	0.013	96.384	96.294	0.79	0.09	0.06	0.68	-0.08	1.1	94.49	94.39	1.90	0.06	0.68	-0.07	12.0	94.50	94.42	1.89	0.06	0.68	-0.13	1.7	94.43	94.17	1.95
202	203	93.739	93.623	0.675	N/A	97.0	0.1	0.013	96.294	96.149	0.81	0.29	0.24	0.82	-0.02	1.2	94.39	94.32	1.90	0.22	0.76	0.00	12.1	94.42	94.35	1.88	0.21	0.72	-0.24	1.7	94.17	94.07	2.12
203	204	93.398	93.332	0.900	N/A	66.5	0.1	0.013	96.149	96.050	0.90	0.57	0.46	0.80	0.03	1.3	94.32	94.28	1.83	0.43	0.75	0.06	12.1	94.35	94.32	1.80	0.40	0.70	-0.23	1.7	94.07	94.07	2.08
204	205	93.182	93.082	1.050	N/A	100.5	0.1	0.013	96.050	95.899	1.00	0.86	0.81	0.94	0.05	1.1	94.28	94.20	1.77	0.76	0.88	0.09	12.1	94.32	94.26	1.73	0.70	0.81	-0.16	1.7	94.07	94.07	1.98
205	206	92.932	92.859	1.200	N/A	72.5	0.1	0.013	95.899	95.791	1.09	1.23	1.19	0.97	0.07	1.1	94.20	94.14	1.70	1.11	0.90	0.13	12.1	94.26	94.22	1.64	1.02	0.83	-0.06	1.7	94.07	94.07	1.83
206	207	92.839	92.719	1.200	N/A	120.0	0.1	0.013	95.791	95.611	1.09	1.23	1.76	1.43	0.10	1.1	94.14	94.07	1.65	1.66	1.35	0.18	12.1	94.22	94.22	1.57	1.50	1.22	0.03	1.7	94.07	94.07	1.72
207	208	92.699	92.579	1.200	N/A	120.0	0.1	0.013	95.611	95.431	1.09	1.23	1.93	1.57	0.17	1.2	94.07	94.07	1.54	1.80	1.46	0.32	12.1	94.22	94.22	1.39	1.65	1.34	0.17	1.7	94.07	94.09	1.54
208	209	92.529	92.497	1.200	N/A	32.5	0.1	0.013	95.431	95.422	1.09	1.23	1.97	1.60	0.34	1.2	94.07	94.24	1.36	1.82	1.48	0.49	12.1	94.22	94.22	1.21	1.67	1.35	0.36	1.7	94.09	94.07	1.34
209	210	92.417	92.360	1.200	1.800	57.0	0.1	0.013	95.422	95.522	1.23	2.66	4.37	1.64	0.62	2.9	94.24	94.13	1.19	5.29	1.99	0.60	13.6	94.22	93.94	1.20	4.46	1.68	0.45	3.1	94.07	93.99	1.35
210	Pond1	92.360	92.350	1.200	1.800	10.0	0.1	0.013	95.522	100.000	1.23	2.66	4.37	1.64	0.57	2.9	94.13	93.86	1.39	5.29	1.99	0.38	13.6	93.94	93.89	1.59	4.46	1.68	0.43	3.1	93.99	93.86	1.53
301	302	93.943	93.808	0.450	N/A	67.5	0.2	0.013	95.732	95.631	0.80	0.13	0.07	0.55	-0.20	1.1	94.19	94.07	1.54	0.07	0.55	-0.20	12.0	94.19	94.06	1.54	0.07	0.55	-0.22	1.7	94.18	94.04	1.56
302	303	93.733	93.643	0.525	N/A	56.5	0.2	0.013	95.631	95.546	0.79	0.17	0.12	0.70	-0.19	1.1	94.07	93.95	1.57	0.12	0.70	-0.20	12.0	94.06	93.95	1.57	0.11	0.64	-0.22	1.7	94.04	93.91	1.59
303	304	93.568	93.546	0.600	N/A	15.5	0.1	0.013	95.546	95.523	0.81	0.23	0.17	0.74	-0.22	1.1	93.95	93.90	1.60	0.16	0.70	-0.22	12.1	93.95	93.90	1.60	0.15	0.65	-0.26	1.7	93.91	93.86	1.64
304	305	93.396	93.284	0.750	N/A	101.5	0.1	0.013	95.523	95.370	0.84	0.37	0.33	0.89	-0.24	1.1	93.90	93.86	1.62	0.32	0.87	-0.25	12.1	93.90	93.89	1.62	0.28	0.76	-0.29	1.7	93.86	93.86	1.67
305	306	92.984	92.894	1.050	N/A	90.0	0.1	0.013	95.370	95.236	1.00	0.86	0.89	1.03	-0.18	1.1	93.86	93.86	1.51	0.85	0.98	-0.14	12.1	93.89	93.89	1.48	0.75	0.87	-0.18	1.7	93.86	93.86	1.51
306	307	92.744	92.688	1.200	N/A	56.0	0.1	0.013	95.236	95.151	1.09	1.23	1.24	1.01	-0.09	1.1	93.86	93.86	1.38	1.17	0.95	-0.05	12.1	93.89	93.89	1.34	1.04	0.84	-0.09	1.7	93.86	93.86	1.38
307	308	92.608	92.518	1.200	N/A	90.0	0.1	0.013	95.151	95.197	1.09	1.23	1.24	1.01	0.05	1.1	93.86	93.86	1.29	1.16	0.94	0.08	12.1	93.89	93.89	1.26	1.04	0.84	0.05	1.7	93.86	93.86	1.30
308	309	92.468	92.438	1.200	N/A	30.0	0.1	0.013	95.197	95.197	1.09	1.23	1.24	1.01	0.19	1.1	93.86	93.86	1.34	1.13	0.92	0.22	12.1	93.89	93.89	1.31	1.02	0.83	0.19	1.7	93.86	93.86	1.34
309	Pond1	92.388	92.350	1.200	N/A	38.5	0.1	0.013	95.197	100.000	1.09	1.23	1.24	1.01	0.27	1.1	93.86	93.86	1.34	1.12	0.91	0.30	12.1	93.89	93.89	1.31	1.01	0.82	0.27	1.7	93.86	93.86	1.34
401	402	93.666	93.568	0.450	N/A	49.0	0.2	0.013	95.735	95.668	0.80	0.13	0.07	0.55	-0.21	1.1	93.91	93.86	1.83	0.07	0.55	-0.21	12.0	93.91	93.89	1.83	0.06	0.47	-0.22	1.7	93.89	93.86	1.84
402	403	93.493	93.471	0.525	N/A	14.0	0.2	0.013	95.668	95.649	0.79	0.17	0.11	0.64	-0.16	1.1	93.86	93.86	1.81	0.11	0.64	-0.13	12.0	93.89	93.89	1.78	0.10	0.58	-0.16	1.7	93.86	93.86	1.81
403	404	93.246	93.102	0.750	N/A	120.0	0.1	0.013	95.649	95.470	0.87	0.39	0.29	0.75	-0.14	1.1	93.86	93.86	1.79	0.28	0.73	-0.10	12.0	93.89	93.89	1.76	0.25	0.65	-0.14	1.7	93.86	93.86	1.79
404	405	93.082	92.996	0.750	N/A	72.0	0.1	0.013	95.470	95.362	0.87	0.39	0.35	0.91	0.03	1.2	93.86	93.86	1.61	0.32	0.83	0.06	12.1	93.89	93.89	1.58	0.30	0.78	0.02	1.7	93.86	93.86	1.61
405	406	92.771	92.705	0.975	N/A	66.0	0.1	0.013	95.362	95.263	0.95	0.71	0.78	1.10	0.11	1.1	93.86	93.86	1.50	0.73	1.03	0.15	12.1	93.89	93.89	1.47	0.66	0.93	0.11	1.7	93.86	93.86	1.51
406	407	92.630	92.552	1.050	N/A	78.0	0.1	0.013	95.263	95.153	1.00	0.86	0.89	1.03	0.18	1.2	93.86	93.86	1.41	0.82	0.95	0.21	12.1	93.89	93.89	1.37	0.75	0.87	0.18	1.7	93.86	93.86	1.41
407	Pond1	92.400	92.350	1.200	N/A	49.5	0.1	0.013	95.153	100.000	1.09	1.23	1.09	0.88	0.26	1.2	93.86	93.86	1.30	1.00	0.81	0.29	12.0	93.89	93.89	1.26	0.90	0.73	0.26	1.6	93.86	93.86	1.30
501	502	93.825	93.727	0.450	N/A	49.0	0.2	0.013	95.799	95.726	0.80	0.13	0.07	0.55	-0.20	1.1	94.08	93.99	1.72	0.07	0.55	-0.20	12.0	94.07	93.99	1.73	0.06	0.47	-0.22	1.7	94.05	93.95	1.75
502	503	93.652	93.630	0.525	N/A	13.5	0.2	0.013	95.726	95.708	0.79	0.17	0.11	0.64	-0.19	1.1	93.99	93.96	1.74	0.11	0.64	-0.19	12.0	93.99	93.97	1.73	0.10	0.58	-0.23	1.7	93.95	93.91	1.78
503	504	93.480	93.365	0.675	N/A	96.0	0.1	0.013	95.708	95.566	0.81	0.29	0.25	0.86	-0.19	1.1	93.96	93.86	1.75	0.24	0.82	-0.19	12.0	93.97	93.89	1.74	0.23	0.79	-0.25	1.7	93.91	93.86	1.80
504	505	93.140	93.044	0.900	N/A	96.0	0.1	0.013	95.566	95.421	0.90	0.57	0.53	0.93	-0.18	1.1	93.86	93.86	1.71	0.50	0.87	-0.15	12.1	93.89	93.89	1.67	0.45	0.79	-0.18	1.7	93.86	93.86	1.71
505	506	92.894	92.770	1.050	N/A	123.5	0.1	0.013	95.421	95.236	1.00	0.86	1.03	1.19	-0.09	1.1	93.86	93.86	1.56	0.98	1.13	-0.05	12.1	93.89	93.89	1.53	0.88	1.02	-0.09	1.7	93.86	93.86	1.57
506	507	92.620	92.561	1.200	N/A	59.0	0.1	0.013	95.236	95.153	1.09	1.23	1.11	0.90	0.04	1.2	93.86	93.86	1.38	1.04	0.84	0.07	12.1	93.89	93.89	1.34	0.94	0.76	0.04	1.7	93.86	93.86	1.38
507	508	92.511	92.429	1.200	N/A	82.0	0.1	0.013	95.153	95.224	1.09	1.23	1.37	1.11	0.15	1.2	93.86	93.86	1.30	1.27	1.03	0.18	12.1	93.89	93.89	1.26	1.15	0.93	0.14	1.7	93.86	93.86	1.30
508	Pond1	92.379	92.350	1.200	2.400	28.5	0.1	0.013	95.224	100.000	1.32	3.80	2.81	0.74	0.28	1.2	93.86	93.86	1.37	2.57	0.68	0.31	12.1	93.89	93.89	1.33	2.36	0.62	0.28	1.7	93.86	93.86	1.37
601	602	93.946	93.842	0.450	N/A	52.0	0.2	0.013	95.904	95.828	0.80	0.13	0.07	0.55	-0.20	1.1	94.19	94.08	1.71	0.07	0.55	-0.21	12.0	94.19	94.07	1.72	0.06	0.47	-0.22	1.7	94.18	94.04	1.73
602	603	93.767	93.741	0.525	N/A	16.5	0.2	0.013	95.828	95.804	0.79	0.17	0.12	0.70	-0.21	1.1	94.08	94.04	1.74	0.11	0.64	-0.22	12.0	94.07	94.03	1.76	0.10	0.58	-0.25	1.6	94.04	93.97	1.79
603	604	93.516	93.396	0.750	N/A	120.0	0.1	0.013	95.804	95.625	0.80	0.35	0.30	0.85	-0.22	1.1	94.04	93.91	1.76	0.29	0.82	-0.24	12.0	94.03	93.90	1.77	0.26	0.74	-0.29	1.7	93.97	93.86	1.83
604	605	93.171	93.097	0.975	N/A	74.0	0.1	0.013	95.625	95.514	0.95	0.71	0.67	0.95	-0.23	1.1	93.91	93.86	1.71	0.64	0.90	-0.24	12.1	93.90	93.89	1.72	0.56	0.79	-0.29	1.7	93.86	93.86	1.77
605	606	93.022	92.954	1.050	N/A	68.0	0.1	0.013	95.514	95.411	1.00	0.86	0.91	1.05	-0.21	1.1	93.86	93.86	1.66	0.87	1.01	-0.18	12.1	93.89	93.89	1.62	0.76	0.88	-0.22	1.7	93.86	93.86	1.66
606	607	92.804	92.692	1.200	N/A	112.5	0.1	0.013	95.411	95.249	1.09	1.23	1.17	0.95	-0.15	1.1	93.86	93.86	1.55	1.11	0.90	-0.11	12.1	93.89	93.89	1.52	0.98	0.79	-0.15	1.7	93.86	93.86	1.56
607	608	92.612	92.546	1.200	N/A	65.5	0.1	0.013	95.249	95.153	1.09	1.23	1.26	1.02	0.05	1.1	93.86	93.86	1.39	1.17	0.95	0.08	12.1	93.89	93.89	1.36	1.06	0.86	0.04	1.7	93.86	93.86	1.39
608	508	92.466	92.429	1.200	N/A	37.0	0.1	0.013	95.153	95.224	1.09	1.23	1.46	1.18	0.19	1.1	93.86	93.86	1.30	1.34	1.09	0.23	12.1	93.89	93.89	1.26	1.22	0.99	0.19	1.7	93.86	93.86	1.30
701	702	94.662	94.518	0.525	N/A	90.0	0.2	0.013	96.821	96.693	0.79	0.17	0.14	0.81	-0.17	1.1	95.02	94.82	1.80	0.14	0.81	-0.18	12.0	95.01	94.81	1.81	0.12	0.70	-0.21	1.7	94.98	94.78	1.84
702	703	94.368	94.250	0.675	N/A	90.5	0.1	0.013	96.693	96.557	0.85	0.30	0.28	0.92	-0.22	1.1	94.82	94.04	1.87	0.27	0.89	-0.23	12.0	94.81	94.15	1.88	0.23	0.76	-0.26	1.7	94.78	94.04	1.91
703	704	93.425	93.319	1.500	3.000	105.5	0.1	0.013	96.557	96.401	1.53	6.90	1.89	0.27	-0.88	4.6	94.04	93.97	2.51	2.47	0.36	-0.78	15.5	94.15	94.06	2.41	1.85	0.27	-0.89	4.8	94.04	93.96	2.52
704	705	93.269	93.257	1.500	3.000	12.0	0.1	0.013	96.401	96.386	1.53	6.90	1.89	0.27	-0.80	4.6	93.97	93.95	2.43	2.48	0.36	-0.71	15.5	94.06	94.04	2.34	1.85	0.27	-0.81	4.8	93.96	93.95	2.44
705	706	93.207	93.097	1.500	3.000	110.5	0.1	0.013	96.386	96.221	1.53	6.90	1.90	0.28	-0.75	4.6	93.95	93.93	2.43	2.49	0.36	-0.67	15.5	94.04	94.00	2.35	1.86	0.27	-0.76	4.8	93.95	93.92	2.44
706	707	93.077	92.988	1.500	3.000	88.5	0.1	0.013	96.221	96.089	1.53	6.90	1.90	0.28	-0.65	4.6	93.93	93.91	2.30	2.50	0.36	-0.58	15.5	94.00	93.98	2.22	1.86	0.27	-0.66	4.8	93.92	93.91	2.30
707	708	92.968	92.848	1.500	3.000	120.0	0.1	0.013	96.089	95.909	1.53	6.90	1.91	0.28	-0.56	4.6	93.91	93.90	2.18	2.51	0.36	-0.49	15.5	93.98	93.96	2.11	1.87	0.27	-0.56	4.8	93.91	93.90	2.18

Table 6A: Pipe Data and Hydraulic Simulation Results for Pond 1 [1]

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm + 20%							100-year, 12-hour SCS Type II Storm + 20%							July 1st, 1979 Historical Event						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
708	709	92.828	92.768	1.500	3.000	59.5	0.1	0.013	95.909	95.820	1.53	6.90	1.91	0.28	-0.43	4.6	93.90	93.89	2.01	2.52	0.37	-0.37	15.5	93.96	93.95	1.95	1.88	0.27	-0.43	4.8	93.90	93.89	2.01
709	710	92.718	92.693	1.500	3.000	25.0	0.1	0.013	95.820	95.781	1.53	6.90	1.92	0.28	-0.33	4.6	93.89	93.89	1.93	2.52	0.37	-0.27	15.5	93.95	93.94	1.87	1.88	0.27	-0.33	4.8	93.89	93.88	1.93
710	712	92.643	92.619	1.500	3.000	23.5	0.1	0.013	95.781	95.754	1.53	6.90	1.92	0.28	-0.26	4.6	93.89	93.88	1.90	2.52	0.37	-0.20	15.5	93.94	93.93	1.84	1.88	0.27	-0.26	4.8	93.88	93.88	1.90
711	712	92.622	92.599	1.500	3.000	23.0	0.1	0.013	95.751	95.754	1.53	6.90	3.12	0.45	-0.24	1.1	93.88	93.88	1.87	2.99	0.43	-0.19	12.1	93.93	93.93	1.82	2.59	0.38	-0.25	1.7	93.88	93.88	1.88
712	713	92.569	92.431	1.500	3.000	138.5	0.1	0.013	95.754	95.911	1.53	6.90	4.48	0.65	-0.19	1.2	93.88	93.86	1.88	4.42	0.64	-0.14	12.1	93.93	93.90	1.83	3.88	0.56	-0.19	1.7	93.88	93.86	1.88
713	Pond1	92.381	92.350	1.500	3.000	31.0	0.1	0.013	95.911	100.000	1.53	6.90	4.47	0.65	-0.02	1.2	93.86	93.86	2.05	4.31	0.63	0.02	12.1	93.90	93.89	2.01	3.81	0.55	-0.02	1.7	93.86	93.86	2.05
801	802	94.412	94.293	0.300	N/A	35.0	0.3	0.013	96.236	96.115	0.80	0.06	0.04	0.71	-0.09	1.0	94.63	94.46	1.61	0.04	0.71	-0.09	12.0	94.62	94.45	1.61	0.04	0.71	-0.10	1.7	94.61	94.42	1.63
802	803	94.068	93.954	0.525	N/A	71.5	0.2	0.013	96.115	96.115	0.79	0.17	0.15	0.87	-0.13	1.1	94.46	94.18	1.65	0.14	0.81	-0.14	12.0	94.45	94.17	1.66	0.13	0.76	-0.17	1.7	94.42	94.11	1.69
803	804	93.654	93.582	0.825	N/A	71.5	0.1	0.013	96.115	96.008	0.85	0.45	0.39	0.86	-0.30	1.1	94.18	94.06	1.94	0.37	0.82	-0.31	12.0	94.17	94.06	1.95	0.32	0.70	-0.37	1.7	94.11	93.97	2.00
804	805	93.432	93.360	0.975	N/A	71.5	0.1	0.013	96.008	95.902	0.95	0.71	0.62	0.87	-0.35	1.1	94.06	93.94	1.95	0.60	0.85	-0.35	12.1	94.06	93.95	1.95	0.52	0.73	-0.43	1.7	93.97	93.88	2.04
805	806	92.835	92.747	1.500	N/A	88.0	0.1	0.013	95.902	95.772	1.26	2.24	2.58	1.15	-0.39	1.1	93.94	93.88	1.96	2.49	1.11	-0.38	12.1	93.95	93.93	1.95	2.13	0.95	-0.46	1.7	93.88	93.88	2.03
806	711	92.667	92.652	1.500	3.000	15.0	0.1	0.013	95.772	95.751	1.53	6.90	3.14	0.46	-0.29	1.1	93.88	93.88	1.89	3.01	0.44	-0.24	12.1	93.93	93.93	1.84	2.60	0.38	-0.29	1.7	93.88	93.88	1.90
1500	1501	92.698	92.573	1.200	1.800	124.5	0.1	0.013	95.907	95.721	1.23	2.66	4.28	1.61	0.80	2.9	94.69	94.37	1.21	5.18	1.95	1.24	13.6	95.14	94.67	0.77	4.40	1.65	1.33	3.1	95.23	94.45	0.68
1501	209	92.573	92.467	1.200	1.800	105.5	0.1	0.013	95.721	95.422	1.23	2.66	4.28	1.61	0.60	2.9	94.37	94.24	1.35	5.18	1.95	0.89	13.6	94.67	94.22	1.05	4.40	1.65	0.68	3.1	94.45	94.07	1.27
Pond1	P1out	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.78	N/A	N/A	N/A	N/A	N/A	N/A	7.57	N/A	N/A	N/A	N/A	N/A	N/A	5.70	N/A	N/A	N/A	N/A	N/A	N/A

Note: [1] Based on restrictive downstream conditions; Summer = 93.68 m, Spring = 94.11 m.

[2] A negative surcharge implies that the pipe is not flowing full

Table 6B: Pipe Data and Hydraulic Simulation Results for Pond 2

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm							100-year, 12-hour SCS Type II Storm							100-year, 10-day Spring Snowmelt + Rainfall Event [1]						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
901	902	94.108	94.018	0.750	N/A	90.0	0.1	0.013	96.291	96.268	0.80	0.35	0.24	0.68	-0.31	1.1	94.55	94.45	1.74	0.23	0.65	-0.31	12.0	94.55	94.45	1.75	0.02	0.06	0.17	109.1	95.03	95.03	1.26
902	903	93.998	93.928	0.750	N/A	70.0	0.1	0.013	96.268	96.373	0.80	0.35	0.24	0.68	-0.30	1.2	94.45	94.24	1.82	0.23	0.65	-0.30	12.1	94.45	94.45	1.82	0.02	0.06	0.28	110.0	95.03	95.03	1.24
903	904	93.703	93.631	0.975	N/A	71.5	0.1	0.013	96.373	96.424	0.95	0.71	0.55	0.78	-0.43	1.1	94.24	94.24	2.13	0.54	0.76	-0.23	12.1	94.45	94.45	1.92	0.04	0.06	0.35	109.1	95.03	95.03	1.35
904	905	93.406	93.363	1.200	2.400	43.0	0.1	0.013	96.424	96.359	1.32	3.80	1.39	0.37	-0.36	1.1	94.24	94.24	2.18	1.36	0.36	-0.16	12.0	94.45	94.45	1.98	0.11	0.03	0.42	109.1	95.03	95.03	1.40
905	906	93.343	93.268	1.200	2.400	74.5	0.1	0.013	96.359	96.252	1.32	3.80	1.78	0.47	-0.30	1.1	94.24	94.24	2.12	1.72	0.45	-0.09	12.0	94.45	94.45	1.91	0.13	0.03	0.48	109.0	95.03	95.03	1.33
906	Pond2	93.248	93.200	1.200	2.400	47.5	0.1	0.013	96.252	100.000	1.32	3.80	2.33	0.61	-0.21	1.1	94.24	94.24	2.01	2.26	0.59	0.00	12.0	94.45	94.45	1.80	0.18	0.05	0.58	109.1	95.03	95.03	1.23
1001	1002	94.369	94.236	0.900	N/A	88.5	0.2	0.013	97.040	96.907	1.10	0.70	0.47	0.67	-0.31	1.2	94.96	94.87	2.08	0.46	0.66	-0.32	12.0	94.95	94.86	2.09	0.03	0.04	-0.24	109.1	95.03	95.03	2.01
1002	1003	94.216	94.109	0.900	N/A	82.5	0.1	0.013	96.907	96.783	1.03	0.65	0.47	0.72	-0.24	1.2	94.87	94.73	2.04	0.45	0.69	-0.26	12.1	94.86	94.73	2.05	0.03	0.05	-0.08	109.1	95.03	95.03	1.87
1003	1004	94.029	93.959	0.900	N/A	70.0	0.1	0.013	96.783	96.678	0.90	0.57	0.47	0.82	-0.20	1.2	94.73	94.68	2.05	0.45	0.79	-0.20	12.1	94.73	94.68	2.06	0.03	0.05	0.10	111.1	95.03	95.03	1.75
1004	1005	93.939	93.867	0.900	N/A	71.5	0.1	0.013	96.678	96.571	0.90	0.57	0.47	0.82	-0.16	1.2	94.68	94.64	1.99	0.46	0.80	-0.16	12.2	94.68	94.64	1.99	0.03	0.05	0.19	111.1	95.03	95.03	1.65
1005	1006	93.717	93.642	1.050	N/A	74.5	0.1	0.013	96.571	96.462	1.00	0.86	0.77	0.89	-0.13	1.2	94.64	94.51	1.94	0.73	0.85	-0.12	12.1	94.64	94.54	1.93	0.05	0.06	0.27	110.0	95.03	95.03	1.54
1006	1007	93.492	93.417	1.200	N/A	75.0	0.1	0.013	96.462	96.352	1.09	1.23	1.27	1.03	-0.18	1.2	94.51	94.44	1.95	1.21	0.98	-0.15	12.1	94.54	94.49	1.92	0.09	0.07	0.34	109.2	95.03	95.03	1.43
1007	1008	93.397	93.325	1.200	N/A	72.0	0.1	0.013	96.352	96.261	1.09	1.23	1.63	1.32	-0.16	1.2	94.44	94.31	1.92	1.57	1.27	-0.11	12.1	94.49	94.46	1.87	0.12	0.10	0.43	109.1	95.03	95.03	1.32
1008	1009	93.275	93.236	1.200	N/A	74.5	0.1	0.013	96.261	96.169	1.09	1.23	1.63	1.32	-0.17	1.2	94.31	94.25	1.95	1.55	1.26	-0.02	12.1	94.46	94.46	1.80	0.12	0.10	0.56	109.1	95.03	95.03	1.23
1009	Pond2	93.236	93.236	1.200	2.400	36.0	0.1	0.013	96.169	100.000	1.32	3.80	1.63	0.43	-0.19	3.4	94.25	94.24	1.92	2.09	0.55	0.02	14.1	94.46	94.45	1.71	1.40	0.37	0.60	110.9	95.03	95.03	1.14
1100	1101	95.539	95.461	0.750	N/A	52.0	0.2	0.013	97.755	97.679	0.98	0.43	0.30	0.70	-0.23	1.1	96.06	95.98	1.70	0.29	0.67	-0.25	12.0	96.04	95.97	1.72	0.02	0.05	-0.63	109.0	95.66	95.51	2.09
1101	1102	95.386	95.372	0.825	N/A	14.0	0.1	0.013	97.679	97.661	0.85	0.45	0.30	0.66	-0.23	1.1	95.98	95.97	1.70	0.29	0.64	-0.25	12.0	95.97	95.95	1.71	0.02	0.04	-0.70	109.0	95.51	95.48	2.17
1102	1103	95.352	95.290	0.825	N/A	61.5	0.1	0.013	97.661	97.569	0.85	0.45	0.30	0.66	-0.21	1.2	95.97	95.94	1.70	0.29	0.64	-0.23	12.1	95.95	95.92	1.71	0.02	0.04	-0.70	109.1	95.48	95.38	2.18
1103	1104	95.215	95.107	0.900	N/A	107.5	0.1	0.013	97.569	97.408	0.90	0.57	0.48	0.84	-0.18	1.2	95.94	95.80	1.63	0.46	0.80	-0.20	12.1	95.92	95.78	1.65	0.04	0.07	-0.74	109.1	95.38	95.21	2.19
1104	1105	95.032	94.968	0.975	N/A	64.0	0.1	0.013	97.408	97.313	0.95	0.71	0.66	0.93	-0.21	1.2	95.80	95.71	1.61	0.64	0.90	-0.23	12.1	95.78	95.70	1.63	0.05	0.07	-0.80	109.1	95.21	95.12	2.20
1105	1106	94.948	94.934	0.975	N/A	13.5	0.1	0.013	97.313	97.295	0.95	0.71	0.66	0.93	-0.21	1.2	95.71	95.68	1.60	0.64	0.90	-0.23	12.1	95.70	95.66	1.62	0.05	0.07	-0.81	109.1	95.12	95.10	2.20
1106	1107	94.914	94.881	0.975	N/A	33.0	0.1	0.013	97.295	97.246	0.95	0.71	0.66	0.93	-0.21	1.2	95.68	95.62	1.62	0.64	0.90	-0.23	12.1	95.66	95.60	1.64	0.05	0.07	-0.79	109.1	95.10	95.08	2.20
1107	1108	94.861	94.853	0.975	N/A	7.5	0.1	0.013	97.246	97.234	0.95	0.71	0.66	0.93	-0.22	1.2	95.62	95.59	1.63	0.64	0.90	-0.23	12.1	95.60	95.57	1.64	0.05	0.07	-0.76	111.3	95.08	95.08	2.17
1108	1109	94.833	94.809	0.975	N/A	24.5	0.1	0.013	97.234	97.198	0.95	0.71	0.66	0.93	-0.22	1.2	95.59	95.54	1.65	0.64	0.90	-0.24	12.1	95.57	95.52	1.66	0.06	0.08	-0.73	111.3	95.08	95.07	2.16
1109	1110	94.789	94.775	0.975	N/A	13.5	0.1	0.013	97.198	97.180	0.95	0.71	0.66	0.93	-0.23	1.2	95.54	95.50	1.66	0.64	0.90	-0.24	12.1	95.52	95.48	1.68	0.07	0.10	-0.69	111.3	95.07	95.07	2.13
1110	1111	94.695	94.661	0.975	N/A	34.0	0.1	0.013	97.180	97.128	0.95	0.71	0.66	0.93	-0.17	1.2	95.50	95.38	1.69	0.64	0.90	-0.19	12.2	95.48	95.37	1.70	0.08	0.11	-0.60	111.3	95.07	95.06	2.11
1111	1112	94.549	94.481	1.200	N/A	68.5	0.1	0.013	97.128	97.025	1.09	1.23	1.21	0.98	-0.37	1.2	95.38	95.20	1.75	1.18	0.96	-0.38	12.1	95.37	95.19	1.76	0.16	0.13	-0.69	111.3	95.06	95.06	2.06
1112	1113	94.431	94.417	1.200	N/A	13.5	0.1	0.013	97.025	97.005	1.09	1.23	1.33	1.08	-0.44	1.2	95.20	95.03	1.83	1.29	1.05	-0.45	12.1	95.19	95.02	1.84	0.18	0.15	-0.57	111.3	95.06	95.06	1.96
1113	1114	94.367	94.312	1.200	2.400	55.0	0.1	0.013	97.005	96.925	1.32	3.80	1.46	0.38	-0.54	1.2	95.03	94.99	1.98	1.42	0.37	-0.55	12.1	95.02	94.98	1.99	0.25	0.07	-0.51	111.3	95.06	95.06	1.94
1114	1115	94.262	94.248	1.200	2.400	14.0	0.1	0.013	96.925	96.906	1.32	3.80	1.45	0.38	-0.48	1.2	94.99	94.97	1.94	1.41	0.37	-0.48	12.1	94.98	94.96	1.94	0.29	0.08	-0.40	111.3	95.06	95.06	1.87
1115	1116	94.168	94.081	1.200	2.400	86.5	0.1	0.013	96.906	96.779	1.32	3.80	1.44	0.38	-0.40	1.2	94.97	94.91	1.94	1.41	0.37	-0.40	12.2	94.96	94.91	1.94	0.37	0.10	-0.31	111.3	95.06	95.06	1.85
1116	1117	94.001	93.933	1.200	2.400	68.0	0.1	0.013	96.779	96.677	1.32	3.80	2.49	0.65	-0.29	1.2	94.91	94.88	1.87	2.42	0.64	-0.29	12.2	94.91	94.88	1.87	0.57	0.15	-0.15	111.2	95.06	95.06	1.72
1117	1119	93.913	93.842	1.200	2.400	71.0	0.1	0.013	96.677	96.564	1.32	3.80	2.49	0.65	-0.23	1.2	94.88	94.76	1.80	2.42	0.64	-0.23	12.2	94.88	94.77	1.80	0.75	0.20	-0.05	111.3	95.06	95.09	1.62
1119	1120	93.762	93.680	1.200	2.400	82.0	0.1	0.013	96.564	96.442	1.32	3.80	3.51	0.92	-0.20	1.2	94.76	94.64	1.80	3.43	0.90	-0.19	12.2	94.77	94.66	1.79	0.69	0.18	0.13	111.3	95.09	95.16	1.47
1120	1121	93.600	93.586	1.200	2.400	13.5	0.1	0.013	96.442	96.424	1.32	3.80	3.65	0.96	-0.16	1.2	94.64	94.58	1.80	3.56	0.94	-0.14	12.2	94.66	94.61	1.78	0.71	0.19	0.36	110.8	95.16	95.17	1.28
1121	1122	93.536	93.472	1.200	2.400	64.5	0.1	0.013	96.424	96.328	1.32	3.80	3.65	0.96	-0.16	1.2	94.58	94.30	1.85	3.55	0.93	-0.13	12.2	94.61	94.45	1.82	0.60	0.16	0.44	111.3	95.17	95.15	1.25
1122	1123	93.392	93.320	1.200	2.400	71.5	0.1	0.013	96.328	96.279	1.32	3.80	4.22	1.11	-0.30	1.2	94.30	94.24	2.03	4.10	1.08	-0.14	12.2	94.45	94.45	1.88	0.63	0.17	0.55	111.3	95.15	95.11	1.18
1123	1124	93.300	93.232	1.200	2.400	68.0	0.1	0.013	96.279	96.224	1.32	3.80	4.19	1.10	-0.26	1.2	94.24	94.24	2.04	4.06	1.07	-0.05	12.2	94.45	94.45	1.83	0.64	0.17	0.61	111.3	95.11	95.05	1.17
1124	Pond2	93.232	93.200	1.200	2.400	32.0	0.1	0.013	96.224	100.000	1.32	3.80	4.16	1.09	-0.19	1.2	94.24	94.24	1.98	4.02	1.06	0.02	12.2	94.45	94.45	1.78	0.65	0.17	0.62	111.3	95.05	95.03	1.18
1201	1202	95.097	95.015	0.825	N/A	55.0	0.2	0.013	97.368	97.287	1.04	0.56	0.36	0.65	-0.34	1.1	95.58	95.45	1.79	0.35	0.63	-0.35	12.0	95.57	95.44	1.79	0.03	0.05	-0.69	109.1	95.23	95.10	2.14
1202	1203	94.965	94.951	0.825	N/A	13.5	0.1	0.013	97.287	97.269	0.85	0.45	0.36	0.79	-0.34	1.1	95.45	95.39	1.84	0.35	0.77	-0.35	12.0	95.44	95.38	1.85	0.03	0.07	-0.70	109.1	95.10	95.08	2.19
1203	1204	94.901	94.803	0.825	N/A	98.0	0.1	0.013	97.269	97.123	0.85	0.45	0.36	0.79	-0.34	1.1	95.39	95.17	1.88	0.35	0.77	-0.35	12.1	95.38	95.16	1.89	0.03	0.07	-0.65	111.3	95.08	95.07	2.19
1204	1205	94.428	94.360	1.200	N/A	68.5	0.1	0.013	97.123	97.021	1.09	1.23	0.82	0.67	-0.45	1.1	95.17	95.12	1.95	0.80	0.65	-0.47	12.0	95.16	95.11	1.96	0.13	0.11	-0.56	110.7	95.07	95.06	2.06
1205	1206	94.340	94.276	1.200	N/A	64.5	0.1	0.013	97.021	96.925	1.09	1.23	0.80	0.65	-0.42	1.1	95.12	95.05	1.90	0.78	0.63	-0.43	12.1	95.11	95.04	1.91	0.16	0.13	-0.48	110.7	95.06	95.06	1.96
1206	1207	94.226	94.212	1.200	N/A	14.0	0.1	0.013	96.925	96.906	1.09	1.23	0.80	0.65	-0.38	1.2	95.05	95.02	1.88	0.77	0.62	-0.39	12.1	95.04	95.01	1.88	0.15	0.12	-0.36	110.7	95.06	95.06	1.86
1207	1116	94.162	94.081	1.200	N/A	81.0	0.1	0.013	96.906	96.779	1.09	1.23	0.79	0.64	-0.34	1.2	95.02	94.91	1.89	0.77	0.62	-0.35	12.2	95.01	94.91	1.89	0.16	0.13	-0.30	111.3	95.06	95.06	1.84
1600	1601	94.197	94.025	1.200	N/A	107.5	0.2	0.013	97.015	96.875	1.38	1.56	1.60	1.03	-0.12	3.4	95.27	95.11	1.74	2.01	1.29	0.73	14.1	96.13	95.84	0.89	1.30	0.83	0.33	110.9	95.73	95.61	1.29
1601	1602	94.025	93.873	1.200	N/A	95.0	0.2	0.013	96.875	96.627	1.38	1.56	1.60	1.03	-0.11	3.4	95.11	94.97	1.76	2.01	1.29	0.61	14.1	95.84	95.58	1.04	1.30	0.83	0.38	110.9	95.61	95.50	1.27
1602	1603	93.873	93.721	1.200	N/A	95.0	0.2	0.013	96.627	96.665	1.38	1.56	1.60	1.03	-0.10	3.4	94.97	94.83	1.66	2.01	1.29	0.51	14.1	95.58	95.33	1.04	1.30	0.83	0.43	110.9	95.50	95.40	1.12
1603	1604	93.721	93.569	1.200	N/A	95.0	0.2	0.013	96.665	96.891	1.38	1.56	1.60	1.03	-0.09	3.4	94.83	94.69	1.83	2.01	1.29	0.41	14.1	95.33	95.07	1.34	1.30	0.83	0.48	110.9	95.40	95.29	1.27
1604	1605	93.569	93.431	1.200	N/A	86.5	0.2	0.013	96.891	96.699	1.38	1.56	1.60	1.03	-0.08	3.4	94.69	94.37	2.20	2.01	1.29	0.30	14.1	95.07	94.65	1.82	1.30	0.83	0.52	111.3	95.29	95.12	1.60
1605	1009	93.351	93.236	1.200	N/A	72.0	0.2	0.013	96.699	96.169	1.38	1.56	1.60	1.03	-0.18	3.4	94.37	94.25	2.33	2.02	1.30	0.10	14.1	94.65	94.46	2.05	1.30	0.83	0.57	111.0	95.12	95.03	1.58
Pond2	P2out	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.72	N/A	N/A	N/A	N/A	N/A	N/A	2.20	N/A	N/A	N/A	N/A	N/A	N/A	1.59	N/A	N/A	N/A	N/A	N/A	N/A

Note: [1] Based on restrictive downstream conditions; Spring = 94.11 m. All other results based on free outfall conditions.

[2] A negative surcharge implies that the pipe is not flowing full

-0.50 Freeboard less than 0.5 m.

Table 6B: Pipe Data and Hydraulic Simulation Results for Pond 2

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	Pipe Diameter / Height (m)	Pipe Width (m)	Pipe Length (m)	Pipe Slope (%)	n	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Design Velocity (m/s)	Design Flow (m^3/s)	100-year, 3-hour Chicago Storm + 20%							100-year, 12-hour SCS Type II Storm + 20%							July 1st, 1979 Historical Event						
													Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)	Peak Pipe Flow (m^3/s)	Peak / Design Flow	Surcharge U/S [2] (m)	Time to Peak (h)	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and MH Cover (m)
901	902	94.108	94.018	0.750	N/A	90.0	0.1	0.013	96.291	96.268	0.80	0.35	0.27	0.77	-0.27	1.1	94.59	94.48	1.70	0.26	0.74	-0.16	12.0	94.70	94.70	1.59	0.22	0.62	-0.33	1.7	94.53	94.47	1.76
902	903	93.998	93.928	0.750	N/A	70.0	0.1	0.013	96.268	96.373	0.80	0.35	0.27	0.77	-0.27	1.1	94.48	94.45	1.79	0.26	0.74	-0.05	12.1	94.70	94.70	1.57	0.22	0.62	-0.28	1.7	94.47	94.47	1.80
903	904	93.703	93.631	0.975	N/A	71.5	0.1	0.013	96.373	96.424	0.95	0.71	0.63	0.89	-0.22	1.1	94.45	94.45	1.92	0.59	0.83	0.02	12.1	94.70	94.70	1.68	0.52	0.73	-0.21	1.7	94.47	94.47	1.90
904	905	93.406	93.363	1.200	2.400	43.0	0.1	0.013	96.424	96.359	1.32	3.80	1.52	0.40	-0.15	1.1	94.45	94.45	1.97	1.45	0.38	0.09	12.0	94.70	94.70	1.73	1.32	0.35	-0.14	1.7	94.47	94.47	1.95
905	906	93.343	93.268	1.200	2.400	74.5	0.1	0.013	96.359	96.252	1.32	3.80	1.93	0.51	-0.09	1.1	94.45	94.45	1.91	1.82	0.48	0.16	12.0	94.70	94.70	1.66	1.66	0.44	-0.07	1.7	94.47	94.47	1.89
906	Pond2	93.248	93.200	1.200	2.400	47.5	0.1	0.013	96.252	100.000	1.32	3.80	2.56	0.67	0.01	1.1	94.45	94.45	1.80	2.41	0.63	0.25	12.0	94.70	94.70	1.55	2.17	0.57	0.02	1.7	94.47	94.47	1.78
1001	1002	94.369	94.236	0.900	N/A	88.5	0.2	0.013	97.040	96.907	1.10	0.70	0.53	0.76	-0.20	1.1	95.07	95.00	1.97	0.52	0.74	-0.22	12.0	95.05	95.00	1.99	0.45	0.64	-0.33	1.7	94.94	94.85	2.10
1002	1003	94.216	94.109	0.900	N/A	82.5	0.1	0.013	96.907	96.783	1.03	0.65	0.52	0.80	-0.12	1.2	95.00	94.88	1.91	0.50	0.77	-0.12	12.1	95.00	94.91	1.91	0.44	0.67	-0.27	1.7	94.85	94.71	2.06
1003	1004	94.029	93.959	0.900	N/A	70.0	0.1	0.013	96.783	96.678	0.90	0.57	0.53	0.93	-0.05	1.2	94.88	94.83	1.91	0.48	0.84	-0.02	12.1	94.91	94.86	1.88	0.44	0.77	-0.22	1.7	94.71	94.66	2.08
1004	1005	93.939	93.867	0.900	N/A	71.5	0.1	0.013	96.678	96.571	0.90	0.57	0.54	0.94	-0.01	1.2	94.83	94.77	1.85	0.47	0.82	0.03	12.1	94.86	94.82	1.81	0.44	0.77	-0.18	1.8	94.66	94.62	2.02
1005	1006	93.717	93.642	1.050	N/A	74.5	0.1	0.013	96.571	96.462	1.00	0.86	0.87	1.01	0.00	1.2	94.77	94.62	1.81	0.80	0.93	0.05	12.1	94.82	94.74	1.75	0.72	0.83	-0.15	1.7	94.62	94.51	1.95
1006	1007	93.492	93.417	1.200	N/A	75.0	0.1	0.013	96.462	96.352	1.09	1.23	1.43	1.16	-0.07	1.2	94.62	94.53	1.84	1.34	1.09	0.05	12.1	94.74	94.71	1.72	1.19	0.97	-0.18	1.7	94.51	94.48	1.95
1007	1008	93.397	93.325	1.200	N/A	72.0	0.1	0.013	96.352	96.261	1.09	1.23	1.81	1.47	-0.06	1.2	94.53	94.47	1.82	1.71	1.39	0.12	12.1	94.71	94.71	1.64	1.54	1.25	-0.12	1.7	94.48	94.48	1.87
1008	1009	93.275	93.236	1.200	N/A	74.5	0.1	0.013	96.261	96.169	1.09	1.23	1.81	1.47	-0.01	1.2	94.47	94.47	1.80	1.69	1.37	0.24	12.1	94.71	94.71	1.55	1.53	1.24	0.01	1.7	94.48	94.48	1.78
1009	Pond2	93.236	93.236	1.200	2.400	36.0	0.1	0.013	96.169	100.000	1.32	3.80	2.15	0.57	0.03	3.1	94.47	94.45	1.70	2.68	0.70	0.28	14.0	94.71	94.70	1.46	2.15	0.57	0.05	3.5	94.48	94.47	1.69
1100	1101	95.539	95.461	0.750	N/A	52.0	0.2	0.013	97.755	97.679	0.98	0.43	0.34	0.79	-0.15	1.1	96.14	96.08	1.62	0.33	0.77	-0.19	12.0	96.10	96.04	1.65	0.28	0.65	-0.26	1.7	96.03	95.95	1.73
1101	1102	95.386	95.372	0.825	N/A	14.0	0.1	0.013	97.679	97.661	0.85	0.45	0.34	0.75	-0.14	1.1	96.08	96.06	1.60	0.32	0.70	-0.17	12.0	96.04	96.02	1.64	0.28	0.62	-0.26	1.7	95.95	95.93	1.73
1102	1103	95.352	95.290	0.825	N/A	61.5	0.1	0.013	97.661	97.569	0.85	0.45	0.34	0.75	-0.12	1.1	96.06	96.03	1.60	0.32	0.70	-0.16	12.1	96.02	95.99	1.64	0.28	0.62	-0.25	1.7	95.93	95.90	1.73
1103	1104	95.215	95.107	0.900	N/A	107.5	0.1	0.013	97.569	97.408	0.90	0.57	0.54	0.94	-0.09	1.2	96.03	95.89	1.54	0.51	0.89	-0.13	12.1	95.99	95.85	1.58	0.45	0.79	-0.22	1.7	95.90	95.76	1.67
1104	1105	95.032	94.968	0.975	N/A	64.0	0.1	0.013	97.408	97.313	0.95	0.71	0.74	1.04	-0.12	1.2	95.89	95.80	1.52	0.71	1.00	-0.16	12.1	95.85	95.77	1.56	0.61	0.86	-0.25	1.7	95.76	95.68	1.65
1105	1106	94.948	94.934	0.975	N/A	13.5	0.1	0.013	97.313	97.295	0.95	0.71	0.74	1.04	-0.12	1.2	95.80	95.76	1.52	0.71	1.00	-0.16	12.1	95.77	95.73	1.55	0.61	0.86	-0.25	1.7	95.68	95.64	1.64
1106	1107	94.914	94.881	0.975	N/A	33.0	0.1	0.013	97.295	97.246	0.95	0.71	0.74	1.04	-0.13	1.2	95.76	95.70	1.54	0.71	1.00	-0.16	12.1	95.73	95.67	1.57	0.61	0.86	-0.25	1.7	95.64	95.59	1.66
1107	1108	94.861	94.853	0.975	N/A	7.5	0.1	0.013	97.246	97.234	0.95	0.71	0.74	1.04	-0.14	1.2	95.70	95.67	1.55	0.71	1.00	-0.17	12.1	95.67	95.63	1.58	0.61	0.86	-0.25	1.7	95.59	95.55	1.66
1108	1109	94.833	94.809	0.975	N/A	24.5	0.1	0.013	97.234	97.198	0.95	0.71	0.74	1.04	-0.14	1.2	95.67	95.61	1.57	0.71	1.00	-0.17	12.1	95.63	95.58	1.60	0.61	0.86	-0.26	1.7	95.55	95.50	1.68
1109	1110	94.789	94.775	0.975	N/A	13.5	0.1	0.013	97.198	97.180	0.95	0.71	0.74	1.04	-0.15	1.2	95.61	95.57	1.58	0.71	1.00	-0.18	12.1	95.58	95.54	1.61	0.61	0.86	-0.26	1.7	95.50	95.46	1.69
1110	1111	94.695	94.661	0.975	N/A	34.0	0.1	0.013	97.180	97.128	0.95	0.71	0.74	1.04	-0.10	1.2	95.57	95.45	1.61	0.71	1.00	-0.13	12.1	95.54	95.42	1.64	0.62	0.87	-0.21	1.7	95.46	95.35	1.72
1111	1112	94.549	94.481	1.200	N/A	68.5	0.1	0.013	97.128	97.025	1.09	1.23	1.37	1.11	-0.30	1.2	95.45	95.26	1.68	1.30	1.05	-0.33	12.1	95.42	95.24	1.71	1.15	0.93	-0.40	1.7	95.35	95.17	1.77
1112	1113	94.431	94.417	1.200	N/A	13.5	0.1	0.013	97.025	97.005	1.09	1.23	1.50	1.22	-0.37	1.2	95.26	95.11	1.77	1.43	1.16	-0.39	12.1	95.24	95.10	1.79	1.26	1.02	-0.46	1.7	95.17	95.00	1.85
1113	1114	94.367	94.312	1.200	2.400	55.0	0.1	0.013	97.005	96.925	1.32	3.80	1.64	0.43	-0.45	1.2	95.11	95.08	1.89	1.57	0.41	-0.47	12.1	95.10	95.07	1.91	1.38	0.36	-0.57	1.7	95.00	94.96	2.00
1114	1115	94.262	94.248	1.200	2.400	14.0	0.1	0.013	96.925	96.906	1.32	3.80	1.63	0.43	-0.38	1.2	95.08	95.06	1.85	1.56	0.41	-0.40	12.1	95.07	95.05	1.86	1.37	0.36	-0.50	1.7	94.96	94.95	1.96
1115	1116	94.168	94.081	1.200	2.400	86.5	0.1	0.013	96.906	96.779	1.32	3.80	1.62	0.43	-0.31	1.2	95.06	95.01	1.85	1.55	0.41	-0.32	12.1	95.05	95.00	1.86	1.37	0.36	-0.42	1.7	94.95	94.89	1.96
1116	1117	94.001	93.933	1.200	2.400	68.0	0.1	0.013	96.779	96.677	1.32	3.80	2.79	0.73	-0.20	1.2	95.01	94.98	1.77	2.66	0.70	-0.20	12.1	95.00	94.97	1.78	2.37	0.62	-0.31	1.7	94.89	94.86	1.89
1117	1119	93.913	93.842	1.200	2.400	71.0	0.1	0.013	96.677	96.564	1.32	3.80	2.79	0.73	-0.14	1.2	94.98	94.85	1.70	2.65	0.70	-0.14	12.2	94.97	94.86	1.71	2.37	0.62	-0.25	1.8	94.86	94.75	1.82
1119	1120	93.762	93.680	1.200	2.400	82.0	0.1	0.013	96.564	96.442	1.32	3.80	3.89	1.02	-0.11	1.2	94.85	94.73	1.71	3.72	0.98	-0.10	12.1	94.86	94.79	1.70	3.36	0.88	-0.22	1.7	94.75	94.64	1.82
1120	1121	93.600	93.586	1.200	2.400	13.5	0.1	0.013	96.442	96.424	1.32	3.80	4.05	1.06	-0.07	1.2	94.73	94.66	1.71	3.87	1.02	-0.01	12.1	94.79	94.75	1.65	3.49	0.92	-0.16	1.7	94.64	94.58	1.80
1121	1122	93.536	93.472	1.200	2.400	64.5	0.1	0.013	96.424	96.328	1.32	3.80	4.05	1.06	-0.07	1.2	94.66	94.45	1.76	3.85	1.01	0.01	12.1	94.75	94.70	1.68	3.48	0.92	-0.16	1.7	94.58	94.47	1.84
1122	1123	93.392	93.320	1.200	2.400	71.5	0.1	0.013	96.328	96.279	1.32	3.80	4.69	1.23	-0.14	1.2	94.45	94.45	1.87	4.46	1.17	0.11	12.1	94.70	94.70	1.63	4.03	1.06	-0.12	1.7	94.47	94.47	1.86
1123	1124	93.300	93.232	1.200	2.400	68.0	0.1	0.013	96.279	96.224	1.32	3.80	4.65	1.22	-0.05	1.2	94.45	94.45	1.83	4.41	1.16	0.20	12.1	94.70	94.70	1.58	4.00	1.05	-0.03	1.7	94.47	94.47	1.81
1124	Pond2	93.232	93.200	1.200	2.400	32.0	0.1	0.013	96.224	100.000	1.32	3.80	4.61	1.21	0.02	1.2	94.45	94.45	1.77	4.36	1.15	0.27	12.1	94.70	94.70	1.53	3.96	1.04	0.04	1.7	94.47	94.47	1.75
1201	1202	95.097	95.015	0.825	N/A	55.0	0.2	0.013	97.368	97.287	1.04	0.56	0.41	0.74	-0.30	1.1	95.62	95.49	1.74	0.39	0.70	-0.31	12.0	95.61	95.48	1.76	0.34	0.61	-0.36	1.7	95.56	95.43	1.80
1202	1203	94.965	94.951	0.825	N/A	13.5	0.1	0.013	97.287	97.269	0.85	0.45	0.41	0.90	-0.30	1.1	95.49	95.43	1.80	0.39	0.86	-0.31	12.0	95.48	95.42	1.81	0.34	0.75	-0.36	1.7	95.43	95.37	1.86
1203	1204	94.901	94.803	0.825	N/A	98.0	0.1	0.013	97.269	97.123	0.85	0.45	0.41	0.90	-0.29	1.1	95.43	95.26	1.84	0.39	0.86	-0.31	12.1	95.42	95.23	1.85	0.34	0.75	-0.36	1.7	95.37	95.15	1.90
1204	1205	94.428	94.360	1.200	N/A	68.5	0.1	0.013	97.123	97.021	1.09	1.23	0.92	0.75	-0.37	1.1	95.26	95.21	1.87	0.88	0.71	-0.39	12.1	95.23	95.18	1.89	0.77	0.62	-0.48	1.7	95.15	95.10	1.97
1205	1206	94.340	94.276	1.200	N/A	64.5	0.1	0.013	97.021	96.925	1.09	1.23	0.90	0.73	-0.33	1.2	95.21	95.14	1.82	0.86	0.70	-0.36	12.1	95.18	95.12	1.84	0.77	0.62	-0.44	1.7	95.10	95.03	1.93
1206	1207	94.226	94.212	1.200	N/A	14.0	0.1	0.013	96.925	96.906	1.09	1.23	0.90	0.73	-0.28	1.2	95.14	95.11	1.78	0.86	0.70	-0.30	12.1	95.12	95.10	1.80	0.76	0.62	-0.40	1.7	95.03	95.00	1.90
1207	1116	94.162	94.081	1.200	N/A	81.0	0.1	0.013	96.906	96.779	1.09	1.23	0.89	0.72	-0.25	1.2	95.11	95.01	1.79	0.85	0.69	-0.27	12.1	95.10	95.00	1.81	0.76	0.62	-0.36	1.7	95.00	94.89	1.91
1600	1601	94.197	94.025	1.200	N/A	107.5	0.2	0.013	97.015	96.875	1.38	1.56	2.10	1.35	0.89	3.4	96.29	95.97	0.73	2.60	1.67	2.12	14.1	97.52	97.04	-0.50	2.12	1.36	0.93	3.5	96.32	96.01	0.69
1601	1602	94.025	93.873	1.200	N/A	95.0	0.2	0.013	96.875	96.627	1.38	1.56	2.10	1.35	0.75	3.4	95.97	95.70	0.90	2.60	1.67	1.82	14.1	97.04	96.62	-0.17	2.12	1.36	0.78	3.5	96.01	95.73	0.87
1602	1603	93.873	93.721	1.200	N/A	95.0	0.2	0.013	96.627	96.665	1.38	1.56	2.10	1.35	0.62	3.4	95.70	95.42	0.93	2.60	1.67	1.55	14.1	96.62	96.20	0.00	2.12	1.36	0.65	3.5	95.73	95.44	0.90
1603	1604	93.721	93.569	1.200	N/A	95.0	0.2	0.013	96.665	96.891	1.38	1.56	2.10	1.35	0.50	3.4	95.42	95.14	1.25	2.60	1.67	1.28	14.1	96.20	95.78	0.46	2.12	1.36	0.52	3.5	95.44	95.16	1.22
1604	1605	93.569	93.431	1.200	N/A	86.5	0.2	0.013	96.891	96.699	1.38	1.56	2.10	1.35	0.37	3.4	95.14	94.68	1.75	2.60	1.67	1.01	14.1	95.78	95.04	1.11	2.12	1.36	0.39	3.5	95.16	94.70	1.73
1605	1009	93.351	93.236	1.200	N/A	72.0	0.2	0.013	96.699	96.169	1.38	1.56	2.10	1.35	0.13	3.4	94.68	94.47	2.02	2.60	1.67	0.49	14.0	95.04	94.71	1.66	2.12	1.36	0.15	3.5	94.70	94.48	2.00
Pond2	P2out	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.21	N/A	N/A	N/A	N/A	N/A	N/A	2.78	N/A	N/A	N/A	N/A	N/A	N/A	2.25	N/A	N/A	N/A	N/A	N/A

Note: [1] Based on restrictive downstream conditions; Spring = 94.11 m. All other results based on free outfall conditions.

[2] A negative surcharge implies that the pipe is not flowing full

-0.50 Freeboard less than 0.5 m.

ATTACHMENT

6

Flows and Water Levels on the Van Gaal Drain Under Existing and Proposed Conditions

JFSA Water Resources and Environmental Consultants

Table 7A: Existing and Proposed Conditions Flows on the Van Gaal Drain, Arbuckle Drain and Jock River [1]

River	Reach	River Station	Flow (m^3/s)						Difference in Flow (%)		
			Existing Conditions			Proposed Conditions					
			1	2	4	1	2	4	1	2	4
Jock River	Reach 1	22026	5.540	167.682	156.00	5.759	167.682	156.00	4.0	0.0	0.0
Jock River	Reach 2	21359	5.773	74.628	161.76	6.064	74.628	161.76	5.0	0.0	0.0
Jock River	Reach 3	18677	17.624	88.341	166.76	15.029	85.955	166.76	-14.7	-2.7	0.0
Jock River	Reach 4	16872	15.385	85.979	181.76	13.119	83.571	181.76	-14.7	-2.8	0.0
Jock River	Reach 5	16112	16.168	143.467	180.00	13.939	141.057	180.00	-13.8	-1.7	0.0
Jock River	Reach 6	11769	10.864	153.565	185.00	10.141	151.277	185.00	-6.7	-1.5	0.0
Jock River	Reach 7	10144	8.741	152.939	196.00	8.641	150.659	196.00	-1.1	-1.5	0.0
Jock River	Reach 7	6550	9.652	189.823	201.00	9.549	187.543	201.00	-1.1	-1.2	0.0
Jock River	Reach 7	3699	5.067	211.402	205.00	5.726	209.287	205.00	13.0	-1.0	0.0
Joys Road Trib	Reach 1	705	2.619	3.166	0.883	1.934	3.166	0.681	-26.1	0.0	-22.9
Van Gaal Drain	Reach 3	3494	3.701	4.228	1.636	2.711	4.127	1.319	-26.8	-2.4	-19.4
Van Gaal Drain	Reach 3	3322	4.021	4.588	1.651	2.980	4.532	1.327	-25.9	-1.2	-19.6
Van Gaal Drain	Reach 3	3175	4.813	5.235	1.653	3.502	5.235	1.327	-27.2	0.0	-19.7
Van Gaal Drain	Reach 2	2554	7.272	8.316	2.857	5.438	8.251	2.275	-25.2	-0.8	-20.4
Van Gaal Drain	Reach 2	2076	9.543	10.808	3.286	7.138	10.038	2.606	-25.2	-7.1	-20.7
Van Gaal Drain	Reach 2	1340	11.434	11.619	3.426	7.221	10.113	2.720	-36.8	-13.0	-20.6
Van Gaal Drain	Reach 2	1312	12.2	12.204	3.439	7.221	10.113	2.720	-40.8	-17.1	-20.9
Van Gaal Drain	Reach 1	746	16.377	15.739	4.056	9.561	13.380	3.266	-41.6	-15.0	-19.5
Van Gaal Drain	Reach 1	666	16.377	15.739	4.056	9.561	13.380	3.266	-41.6	-15.0	-19.5
Van Gaal Drain	Reach 1	226	16.419	15.777	4.371	9.547	13.365	3.481	-41.9	-15.3	-20.4

[1] Scenario Descriptions:

1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

Table 7B: Existing and Proposed Conditions Water Levels on the Van Gaal and Arbuckle Drains [(1)]

River	Reach	River Station	Maximum Water Surface Elevation (m)								
			Existing Conditions			Proposed Conditions			Difference		
			1	*2*	*4*	*1*	*2*	*4*	*1*	*2*	*4*
Van Gaal Drain	Reach 3	3494	97.56	97.60	97.16	97.40	97.59	97.09	-0.16	-0.01	-0.08
Van Gaal Drain	Reach 3	3322	97.43	97.47	97.06	97.29	97.47	96.99	-0.14	0.00	-0.07
Van Gaal Drain	Reach 3	3312	97.42	97.45	97.05	97.28	97.45	96.99	-0.14	0.00	-0.06
Van Gaal Drain	Reach 3	3311	Culvert								
Van Gaal Drain	Reach 3	3302	97.33	97.35	97.01	97.18	97.35	96.97	-0.15	0.00	-0.05
Van Gaal Drain	Reach 3	3297	97.27	97.32	96.98	97.12	97.32	96.94	-0.15	0.00	-0.04
Van Gaal Drain	Reach 3	3185	97.17	97.25	96.56	96.92	97.26	96.50	-0.25	0.01	-0.06
Van Gaal Drain	Reach 3	3175	97.16	97.23	96.59	96.92	97.23	96.53	-0.24	0.00	-0.06
Van Gaal Drain	Reach 3	3174	Culvert								
Van Gaal Drain	Reach 3	3165	96.75	96.74	96.55	96.72	96.74	96.50	-0.03	0.00	-0.05
Van Gaal Drain	Reach 3	3149	96.72	96.71	96.51	96.66	96.72	96.46	-0.06	0.01	-0.05
Van Gaal Drain	Reach 3	3086	96.65	96.63	96.40	96.58	96.63	96.35	-0.07	0.00	-0.05
Van Gaal Drain	Reach 3	3016	96.61	96.59	96.33	96.54	96.59	96.26	-0.07	0.00	-0.07
Van Gaal Drain	Reach 3	2980	96.57	96.56	96.28	96.51	96.56	96.21	-0.06	0.00	-0.07
Van Gaal Drain	Reach 3	2851	96.41	96.42	96.03	96.31	96.42	95.94	-0.10	0.00	-0.09
Van Gaal Drain	Reach 3	2808	96.38	96.39	96.01	96.28	96.39	95.91	-0.10	0.00	-0.10
Van Gaal Drain	Reach 3	2658	96.28	96.29	95.95	96.20	96.29	95.85	-0.08	-0.01	-0.10
Van Gaal Drain	Reach 2	2554	96.27	96.29	95.94	96.19	96.28	95.84	-0.08	-0.01	-0.10
Van Gaal Drain	Reach 2	2478	96.16	96.15	95.88	96.10	96.16	95.78	-0.06	0.01	-0.10
Van Gaal Drain	Reach 2	2157	95.47	95.48	95.03	95.38	95.47	94.97	-0.09	-0.01	-0.06
Van Gaal Drain	Reach 2	2076	95.26	95.27	94.84	95.18	95.25	94.72	-0.08	-0.02	-0.12
Van Gaal Drain	Reach 2	1974	95.10	95.11	94.73	95.02	95.10	94.60	-0.08	-0.01	-0.13
Van Gaal Drain	Reach 2	1922	94.99	94.99	94.68	94.92	94.98	94.55	-0.07	-0.01	-0.13
Van Gaal Drain	Reach 2	1833	94.85	94.85	94.62	94.79	94.84	94.48	-0.06	-0.02	-0.14
Van Gaal Drain	Reach 2	1796	94.80	94.81	94.59	94.75	94.80	94.46	-0.05	-0.01	-0.13
Van Gaal Drain	Reach 2	1735	94.71	94.72	94.57	94.68	94.71	94.43	-0.03	-0.01	-0.14
Van Gaal Drain	Reach 2	1728	94.69	94.69	94.57	94.67	94.69	94.43	-0.02	0.00	-0.14
Van Gaal Drain	Reach 2	1727	Culvert								
Van Gaal Drain	Reach 2	1717	94.69	94.69	94.31	94.60	94.67	94.25	-0.09	-0.02	-0.06
Van Gaal Drain	Reach 2	1615	94.60	94.61	94.24	94.46	94.58	94.19	-0.14	-0.03	-0.05
Van Gaal Drain	Reach 2	1555	94.53	94.55	94.21	94.38	94.51	94.17	-0.15	-0.04	-0.04
Van Gaal Drain	Reach 2	1488	94.45	94.45	94.18	94.30	94.40	94.15	-0.15	-0.05	-0.03
Van Gaal Drain	Reach 2	1416	94.39	94.41	94.14	94.11	94.28	94.12	-0.28	-0.13	-0.02

Table 7B: Existing and Proposed Conditions Water Levels on the Van Gaal and Arbuckle Drains [(1)]

River	Reach	River Station	Maximum Water Surface Elevation (m)								
			Existing Conditions			Proposed Conditions			Difference		
			1	*2*	*4*	*1*	*2*	*4*	*1*	*2*	*4*
Van Gaal Drain	Reach 2	1400	94.36	94.36	94.14	94.12	94.25	94.12	-0.25	-0.11	-0.02
Van Gaal Drain	Reach 2	1364	94.31	94.29	94.13	94.06	94.17	94.12	-0.25	-0.12	-0.02
Van Gaal Drain	Reach 2	1340	94.21	94.19	94.13	94.02	94.10	94.11	-0.19	-0.09	-0.02
Van Gaal Drain	Reach 2	1339	Culvert								
Van Gaal Drain	Reach 2	1312	94.14	94.12	94.12	93.99	94.04	94.11	-0.15	-0.08	-0.01
Van Gaal Drain	Reach 2	1302	94.15	94.14	94.12	93.97	94.04	94.11	-0.18	-0.10	-0.01
Van Gaal Drain	Reach 2	1268	94.14	94.14	94.12	93.94	94.01	94.11	-0.20	-0.13	-0.01
Van Gaal Drain	Reach 2	1212	94.10	94.11	94.12	93.84	93.95	94.11	-0.26	-0.16	-0.01
Van Gaal Drain	Reach 2	1169	94.04	94.08	94.12	93.76	93.89	94.10	-0.28	-0.19	-0.02
Van Gaal Drain	Reach 2	1091	93.97	94.04	94.12	93.64	93.82	94.10	-0.33	-0.23	-0.02
Van Gaal Drain	Reach 2	1002	93.93	94.02	94.12	93.47	93.76	94.10	-0.46	-0.26	-0.02
Van Gaal Drain	Reach 2	961	93.92	94.02	94.12	93.39	93.75	94.10	-0.53	-0.27	-0.02
Van Gaal Drain	Reach 2	910	93.91	94.02	94.12	93.33	93.75	94.10	-0.58	-0.27	-0.02
Van Gaal Drain	Reach 2	840	93.91	94.02	94.12	93.30	93.74	94.10	-0.61	-0.28	-0.02
Van Gaal Drain	Reach 1	746	93.90	94.01	94.12	93.22	93.73	94.10	-0.68	-0.28	-0.02
Van Gaal Drain	Reach 1	705	93.89	94.01	94.11	93.16	93.72	94.10	-0.73	-0.29	-0.01
Van Gaal Drain	Reach 1	668	93.84	93.99	94.11	92.71	93.70	94.10	-1.14	-0.29	-0.01
Van Gaal Drain	Reach 1	666	93.32	93.68	94.10	92.67	93.57	94.10	-0.65	-0.12	0.00
Van Gaal Drain	Reach 1	656	Culvert								
Van Gaal Drain	Reach 1	647	93.07	93.58	94.10	92.80	93.56	94.10	-0.27	-0.02	0.00
Van Gaal Drain	Reach 1	645	93.23	93.67	94.10	92.79	93.58	94.10	-0.44	-0.09	0.00
Van Gaal Drain	Reach 1	592	93.28	93.70	94.10	92.77	93.60	94.10	-0.51	-0.10	0.00
Van Gaal Drain	Reach 1	521	93.26	93.70	94.10	92.75	93.60	94.10	-0.51	-0.10	0.00
Van Gaal Drain	Reach 1	277	92.96	93.66	94.10	92.50	93.57	94.10	-0.46	-0.09	0.00
Van Gaal Drain	Reach 1	275	92.87	93.51	94.09	92.48	93.46	94.09	-0.39	-0.05	0.00
Van Gaal Drain	Reach 1	269	Culvert								
Van Gaal Drain	Reach 1	263	92.58	93.39	94.09	92.37	93.37	94.09	-0.21	-0.02	0.00
Van Gaal Drain	Reach 1	226	92.40	93.44	94.09	92.21	93.41	94.09	-0.19	-0.03	0.00
Van Gaal Drain	Reach 1	0	91.28	93.45	94.09	91.20	93.42	94.09	-0.09	-0.03	0.00
Joys Road Trib	Reach 1	705	97.59	97.79	97.10	97.37	97.79	97.07	-0.22	0.00	-0.03
Joys Road Trib	Reach 1	664	97.60	97.79	97.04	97.38	97.79	96.98	-0.22	0.00	-0.06
Joys Road Trib	Reach 1	635	97.50	97.68	97.00	97.29	97.68	96.94	-0.21	-0.01	-0.06
Joys Road Trib	Reach 1	634	Culvert								

Table 7B: Existing and Proposed Conditions Water Levels on the Van Gaal and Arbuckle Drains [1]

River	Reach	River Station	Maximum Water Surface Elevation (m)								
			Existing Conditions			Proposed Conditions			Difference		
			1	*2*	*4*	*1*	*2*	*4*	*1*	*2*	*4*
Joys Road Trib	Reach 1	622	97.21	97.26	96.96	97.13	97.26	96.92	-0.08	0.00	-0.04
Joys Road Trib	Reach 1	602	97.21	97.27	96.95	97.13	97.27	96.90	-0.08	0.00	-0.05
Joys Road Trib	Reach 1	322	96.65	96.71	96.45	96.58	96.71	96.41	-0.08	0.00	-0.04
Joys Road Trib	Reach 1	275	96.50	96.56	96.20	96.39	96.56	96.18	-0.11	0.00	-0.02
Joys Road Trib	Reach 1	30	96.29	96.30	95.96	96.21	96.29	95.85	-0.08	-0.01	-0.11

[1] Scenario Descriptions:

1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

APPENDIX J

JFSA Water Balance

```
00001> 2     Metric units
00002> *#******************************************************************************
00003> *#  SWMHYMO Ver:5.02/Jan 2001 <BETA> / INPUT DATA FILE
00004> *#******************************************************************************
00005> *#  Project Name: [Richmond FPM]    Project Number: [709]
00006> *#  Date        : 04-21-2009
00007> *#  Revised     : 05-27-2009; 07-22-2009; 08-06-2009; 08-31-2009; 11-16-2009
00008> *#                02-16-2010; 03-04-2010 (LP)
00009> *#  Modeller    : [Bryan Willcott B.Eng.]
00010> *#  Company     : J.F. Sabourin and Associates
00011> *#  License #   : 3410370
00012> *#******************************************************************************
00013>
00014> *#******************************************************************************
00015> *#  [BW] May 27, 2009
00016> *#  This model has been updated using revised values for Tp. Previous versions
00017> *#  of this model used a calculated Tp=0.6Tc.  This model used a calculated
00018> *#  Tp=0.67Tc.
00019> *#******************************************************************************
00020> *#  [BW] July 22, 2009
00021> *#  This model has been revised to include "existing" cross section information
00022> *#  received from Robinson Consultants.  The Cross section revised in the model
00023> *#  is Sec 5.2 (channel receiving flow from "arbuck"). Also, channel and
00024> *#  floodplain slopes for ROUTE CHANNEL commands were updated to be equal
00025> *#******************************************************************************
00026> *#  [BW] August 6, 2009
00027> *#  This model has been revised to include cross section information
00028> *#  from Robinson Consultants Engineer's Report July 2003.  The cross
00029> *#  section revised in the model is Sec 5.1.  Cross sections Sec 1.03
00030> *#  and Sec 5.3 have also been revised
00031> *#******************************************************************************
00032> *#  [BW] August 31, 2009
00033> *#  Model updated to include the proposed DSEL berm. This affects the geometry
00034> *#  of Route Channel Sect 5.2 located on the Arbuckle drain.  Route Channels 5.2
00035> *#  and 1.03 have also been revised to reduce the number of values in the
00036> *#  x-y matrix.
00037> *#******************************************************************************
00038> *#  [BW] November 16, 2009
00039> *#  Model updated to include revised CN and Tp values subsequent to review of
00040> *#  memo received from AECOM on Oct. 2, 2009
00041> *#******************************************************************************
00042> *#  [BW] February 16, 2010
00043> *#  Model updated to check cross sections proposed to convey flow from VG-6,
00044> *#  and VG-7
00045> *#******************************************************************************
00046> *#  [LP] March 4, 2010
00047> *#  Model updated to reflect post-development conditions for Mattamy Lands
00048> *#  Addition of JR-1, JR-2 and JR-3
00049> *#  Removal of Post-Development Mattamy Lands from Pre-Development Areas:
00050> *#      VG-3: 40.6 ha to 9.88 ha
00051> *#      VG-8: 91.8 ha to 10.30 ha
00052> *#      JR-2: 20.5 ha to 4.96 ha
00053> *#      JR-3: 10.6 ha to 6.86 ha
00054> *#  Addition of Pond 1 and Pond 2 outflow hydrographs
00055> *#  (100-year SCS event, free outfall conditions)
00056> *#******************************************************************************
00057> *#  [BW] March 5, 2010
00058> *#  Model converted to continuous model for water balance analysis
00059> *#******************************************************************************
00060> *#
00061> * 100 year 24 Hour SCS Type II Storm
00062> START               TZERO=[1967.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[67]
00063> *                    ["SC24100x.stm"]
00064> *%-----------------|-------------------------------------------------------|
00065> READ AES DATA       AES_FILENAME=["6106000.123"], IELEM=[123],
00066>                     START_DATE=[0], END_DATE=[-183]
00067> *%-----------------|-------------------------------------------------------|
00068> COMPUTE API         APII=[50], APIK=[0.90]/day
00069> *%-----------------|-------------------------------------------------------|
00070> *#******************************************************************************
00071> *# Van Gaal / Arbuckle Drain
00072> *#******************************************************************************
00073> *# DSEL SUBCATCHMENT VG-1 HAS BEEN BROKEN INTO 6 SUB-AREAS (BW)
00074> *#******************************************************************************
00075> *%-----------------|-------------------------------------------------------|
00076> CONTINUOUS NASHYD   ID=[1], NHYD=["VG-1A"], DT=[15]min, AREA=[311.9](ha),
00077>                     DWF=[0](cms),  CN/C=[73], IA=[3.9](mm),
00078>                     N=[3], TP=[5.3]hrs,
00079>                     Continuous simulation parameters:
00080>                     IaRECper=[6](hrs),
00081>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00082>                     InterEventTime=[12](hrs)
00083>                     Baseflow simulation parameters:
00084>                     BaseFlowOption=[1] ,
00085>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00086>                     VHydCond=[1](mm/hr),   END=-1
00087> *%-----------------|-------------------------------------------------------|
00088> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00089>                     HYD_COMMENT=["VG-1A"]
00090> *%-----------------|-------------------------------------------------------|
00091> *#******************************************************************************
00092> *# Tp FOR VG-1B HAS BEEN REVISED TO REFLECT A HYDRAULIC LENGTH OF 1710 m, A
00093> *# LENGTH THAT INCLUDES DISTANCE TO THE VG1-1 CONFLUENCE IN ADDITION TO THE
00094> *# LONGEST FLOW PATH WITHIN VG-1B. THIS IS DONE TO SIMULATE CHANNEL ROUTING
00095> *#******************************************************************************
00096> CONTINUOUS NASHYD   ID=[2], NHYD=["VG-1B"], DT=[15]min, AREA=[24.8](ha),
00097>                     DWF=[0](cms),  CN/C=[73], IA=[4.0](mm),
00098>                     N=[3], TP=[2.7]hrs,
00099>                     Continuous simulation parameters:
00100>                     IaRECper=[6](hrs),
00101>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00102>                     InterEventTime=[12](hrs)
00103>                     Baseflow simulation parameters:
00104>                     BaseFlowOption=[1] ,
00105>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00106>                     VHydCond=[1](mm/hr),   END=-1
00107> *%-----------------|-------------------------------------------------------|
00108> *#******************************************************************************
00109> *# VG1-1 IS THE SUM OF FLOWS TO THE CONFLUENCE OF NORTHERN MOST WATERCOURSE IN
00110> *# OUR AREA OF STUDY WITH THE ROADSIDE DITCH ON GARVIN ROAD
00111> *#******************************************************************************
00112> *#
00113> ADD HYD             IDsum=[3], NHYD=["VG1-1"], IDs to add=[1 2]
00114> *%-----------------|-------------------------------------------------------|
00115> SAVE HYD            ID=[3],  # OF PCYCLES=[-1],  ICASEsh=[1]
00116>                     HYD_COMMENT=["VG1-1"]
00117> *%-----------------|-------------------------------------------------------|
00118> CONTINUOUS NASHYD   ID=[4], NHYD=["VG-1D"], DT=[15]min, AREA=[47.8](ha),
00119>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00120>                     N=[3], TP=[1.8]hrs,
00121>                     Continuous simulation parameters:
00122>                     IaRECper=[6](hrs),
00123>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00124>                     InterEventTime=[12](hrs)
00125>                     Baseflow simulation parameters:
00126>                     BaseFlowOption=[1] ,
00127>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00128>                     VHydCond=[1](mm/hr),   END=-1
00129> *%-----------------|-------------------------------------------------------|
00130> *#******************************************************************************
00131> *# VG1-2 IS THE SUM OF FLOWS AT THE GARVIN ROAD CROSS CULVERT AND
00132> *# CONSERVATIVELY INCLUDES THE AREA VG-1D,  WHICH IS LOCATED JUST DOWNSTREAM
00133> *# OF THE CULVERT
00134> *#******************************************************************************
00135> *#
00136> ADD HYD             IDsum=[5], NHYD=["VG1-2"], IDs to add=[3 4]
00137> *%-----------------|-------------------------------------------------------|
00138> SAVE HYD            ID=[5],  # OF PCYCLES=[-1],  ICASEsh=[1]
00139>                     HYD_COMMENT=["VG1-2"]
00140> *%-----------------|-------------------------------------------------------|
00141> ROUTE CHANNEL       IDout=[6], NHYD=["VG1R-2"],IDin=[5],
00142>                     RDT=[15](min),
```

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00143>                    CHLGTH=[865](m),  CHSLOPE=[0.15](%),
00144>                                       FPSLOPE=[0.15](%),
00145>                    SECNUM=[1.01],       NSEG=[3]
00146>                    ( SEGROUGH, SEGDIST (m))=[0.08,51.41 -0.035,55.58 0.08,228.3
00147>                    ( DISTANCE (m), ELEVATION (m))=[0,         96.719]
00148>                                                   [22.98,      96.598]
00149>                                                   [42.45,      96.66]
00150>                                                   [47.63,      96.5]
00151>                                                   [49.64,      96.424]
00152>                                                   [51.41,      96]
00153>                                                   [53.36,      95.79]
00154>                                                   [55.58,      95.887]
00155>                                                   [57.42,      96.242]
00156>                                                   [87.69,      96.5]
00157>                                                   [119.62,     96.509]
00158>                                                   [140.1,      96.601]
00159>                                                   [179.39,     96.722]
00160>                                                   [200.6,      96.89]
00161>                                                   [228.39,     97]
00162> *%-----------------|-------------------------------------------------------------|
00163> CONTINUOUS NASHYD   ID=[7], NHYD=["VG-1C"], DT=[15]min, AREA=[211.8](ha),
00164>                    DWF=[0](cms),  CN/C=[70], IA=[3.9](mm),
00165>                    N=[3], TP=[4.7]hrs,
00166>                    Continuous simulation parameters:
00167>                    IaRECper=[6](hrs),
00168>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00169>                    InterEventTime=[12](hrs)
00170>                    Baseflow simulation parameters:
00171>                    BaseFlowOption=[1] ,
00172>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00173>                    VHydCond=[1](mm/hr),   END=-1
00174> *%-----------------|-------------------------------------------------------------|
00175> CONTINUOUS NASHYD   ID=[8], NHYD=["VG-1E"], DT=[15]min, AREA=[13.4](ha),
00176>                    DWF=[0](cms),  CN/C=[73], IA=[4.0](mm),
00177>                    N=[3], TP=[0.64]hrs,
00178>                    Continuous simulation parameters:
00179>                    IaRECper=[6](hrs),
00180>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00181>                    InterEventTime=[12](hrs)
00182>                    Baseflow simulation parameters:
00183>                    BaseFlowOption=[1] ,
00184>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00185>                    VHydCond=[1](mm/hr),   END=-1
00186> *%-----------------|-------------------------------------------------------------|
00187> *#*****************************************************************************
00188> *# VG1-3 IS THE SUM OF FLOWS TO JOY'S ROAD CROSS CULVERT AND CONSERVATIVELY
00189> *# INCLUDES THE AREA VG-1E, WHICH IS LOCATED JUST DOWNSTREAM OF THE CULVERT
00190> *#*****************************************************************************
00191> *#
00192> ADD HYD             IDsum=[9], NHYD=["VG1-3"], IDs to add=[7 8]
00193> *%-----------------|-------------------------------------------------------------|
00194> SAVE HYD            ID=[9],  # OF PCYCLES=[-1],  ICASEsh=[1]
00195>                    HYD_COMMENT=["VG1-3"]
00196> *%-----------------|-------------------------------------------------------------|
00197> ROUTE CHANNEL       IDout=[10], NHYD=["VG1R-3"],IDin=[9],
00198>                    RDT=[15](min),
00199>                    CHLGTH=[630](m),  CHSLOPE=[0.20](%),
00200>                                       FPSLOPE=[0.20](%),
00201>                    SECNUM=[1.02],       NSEG=[3]
00202>                    ( SEGROUGH, SEGDIST (m))=[0.08,80.53 -0.035,82.4 0.08,124.53
00203>                    ( DISTANCE (m), ELEVATION (m))=[0          97
00204>                                                   0.61       97.01
00205>                                                   3.8 97.03
00206>                                                   17.49      97.18
00207>                                                   19.18      97.17
00208>                                                   26.62      97.15
00209>                                                   46.29      97.12
00210>                                                   73.97      97.17
00211>                                                   76.3       97.04
00212>                                                   77.53      97
00213>                                                   80.53      96.86
00214>                                                   81.38  96.5
00215>                                                   82.4   96.07
00216>                                                   87.91  96.07
00217>                                                   89.65  96.5
00218>                                                   90.75  96.78
00219>                                                   91.88  96.91
00220>                                                   96.2   97
00221>                                                   99.01  97.1
00222>                                                   119.73 97.14
00223>                                                   124.53 97]
00224> *%-----------------|-------------------------------------------------------------|
00225> *#*****************************************************************************
00226> *# VG1-4 IS THE SUM OF FLOWS AT THE CONFLUENCE OF THE WATERCOURSE FROM JOY'S
00227> *# ROAD WITH THE MAIN DRAIN
00228> *#*****************************************************************************
00229> *#
00230> ADD HYD             IDsum=[1], NHYD=["VG1-4"], IDs to add=[6 10]
00231> *%-----------------|-------------------------------------------------------------|
00232> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00233>                    HYD_COMMENT=["VG1-4"]
00234> *%-----------------|-------------------------------------------------------------|
00235> ROUTE CHANNEL       IDout=[2], NHYD=["VG1R-4"],IDin=[1],
00236>                    RDT=[15](min),
00237>                    CHLGTH=[485](m),  CHSLOPE=[0.20](%),
00238>                                       FPSLOPE=[0.20](%),
00239>                    SECNUM=[1.03],       NSEG=[3]
00240>                    ( SEGROUGH, SEGDIST (m))=[0.08,44.17 -0.035,53.58 0.08,243.3
00241>                    ( DISTANCE (m), ELEVATION (m))=
00242>                    [-44.2, 95.7
00243>                    0, 95.5
00244>                    19.69, 95.421
00245>                    27.91, 95.5
00246>                    31.73, 95.5
00247>                    32.29, 95.325
00248>                    32.71, 95.5
00249>                    41.04, 95.5
00250>                    44.17, 95.449
00251>                    45.63, 95.389
00252>                    48.22, 95
00253>                    48.54, 94.882
00254>                    49.35, 94.5
00255>                    49.64, 94.311
00256>                    50.46, 94.497
00257>                    52.21, 94.993
00258>                    53.58, 95.406
00259>                    55.08, 95.333
00260>                    55.94, 95.157
00261>                    76.35, 95.275
00262>                    131, 95.403
00263>                    213.2, 95.5
00264>                    243.3, 95.8]
00265> *%-----------------|-------------------------------------------------------------|
00266> CONTINUOUS NASHYD   ID=[3], NHYD=["VG-1F"], DT=[15]min, AREA=[117.7](ha),
00267>                    DWF=[0](cms),  CN/C=[86], IA=[2.6](mm),
00268>                    N=[3], TP=[2.9]hrs,
00269>                    Continuous simulation parameters:
00270>                    IaRECper=[6](hrs),
00271>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00272>                    InterEventTime=[12](hrs)
00273>                    Baseflow simulation parameters:
00274>                    BaseFlowOption=[1] ,
00275>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00276>                    VHydCond=[1](mm/hr),   END=-1
00277> *%-----------------|-------------------------------------------------------------|
00278> *#*****************************************************************************
00279> *# VG1 IS THE SUM OF FLOWS AT THE CONFLUENCE OF THE VAN GAAL WEST MAIN DRAIN
00280> *# WITH VAN GAAL WEST TRIBUTARY
00281> *#*****************************************************************************
00282> *#
00283> ADD HYD             IDsum=[4], NHYD=["VG1"], IDs to add=[2 3]
00284> *%-----------------|-------------------------------------------------------------|
```

```
00285> SAVE HYD            ID=[4],  # OF PCYCLES=[-1],  ICASEsh=[1]
00286>                     HYD_COMMENT=["VG1"]
00287> *%-----------------|-----------------------------------------------------------|
00288> ROUTE CHANNEL       IDout=[5], NHYD=["VGR2-1"], IDin=[4],
00289>                     RDT=[15](min),
00290>                     CHLGTH=[755](m),    CHSLOPE=[0.2](%),
00291>                                         FPSLOPE=[0.2](%),
00292>                     SECNUM=[5.1],       NSEG=[3]
00293>                     ( SEGROUGH, SEGDIST (m))=[0.08,98.046 -0.035,105.496 0.08,51
00294>                     ( DISTANCE (m), ELEVATION (m))=[0,         96.11
00295>                                                    20,         94.4
00296>                                                    26.106,      94.5
00297>                                                    41.686,      94.465
00298>                                                    63.506,      94.427
00299>                                                    84.666,      94.492
00300>                                                    95.476,      94.363
00301>                                                    97.736,      94
00302>                                                    98.046,      93.967
00303>                                                    100.336,     92.8193
00304>                                                    101.536,     92.8193
00305>                                                    102.736,     92.8193
00306>                                                    105.496,     94.199
00307>                                                    127.006,     94.345
00308>                                                    142.116,     94.5
00309>                                                    148.376,     94.568
00310>                                                    478.406,     94.7
00311>                                                    518.306,     95]
00312> *%-----------------|-----------------------------------------------------------|
00313> CONTINUOUS NASHYD   ID=[6], NHYD=["VG-2"], DT=[15]min, AREA=[63.1](ha),
00314>                     DWF=[0](cms),  CN/C=[81], IA=[2.8](mm),
00315>                     N=[3], TP=[1.6]hrs,
00316>                     Continuous simulation parameters:
00317>                     IaRECper=[6](hrs),
00318>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00319>                     InterEventTime=[12](hrs)
00320>                     Baseflow simulation parameters:
00321>                     BaseFlowOption=[1] ,
00322>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00323>                     VHydCond=[1](mm/hr),   END=-1
00324> *%-----------------|-----------------------------------------------------------|
00325> ROUTE CHANNEL       IDout=[7], NHYD=["PerN"], IDin=[6],
00326>                     RDT=[15](min),
00327>                     CHLGTH=[550](m),  CHSLOPE=[0.2](%),
00328>                                         FPSLOPE=[0.2](%),
00329>                     SECNUM=[1.1],       NSEG=[3]
00330>                     ( SEGROUGH, SEGDIST (m))=[0.08,70 -0.035,72 0.08,77] NSEG ti
00331>                     ( DISTANCE (m), ELEVATION (m))=[0,  94.4]
00332>                                                    [70, 94.0]
00333>                                                    [71, 93.5]
00334>                                                    [72, 94.0]
00335>                                                    [77, 94.4]
00336> *%-----------------|-----------------------------------------------------------|
00337> *##########################################################################
00338> *# DUMMY SECTION - FOR UNDEVELOPED
00339> *##########################################################################
00340> CONTINUOUS STANDHYD ID=[8], NHYD=["VG-3"], DT=[15](min), AREA=[10.0](ha),
00341>                     XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
00342>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00343>                             DCAY=[4.14](/hr), F=[0](mm),
00344>                     Pervious   surfaces: IAper=[2.5](mm), SLPP=[1.5](%),
00345>                                           LGP=[35](m), MNP=[0.250], SCP=[0](min),
00346>                     Impervious surfaces: IAimp=[2.5](mm), SLPI=[0.3](%),
00347>                                           LGI=[1000](m), MNI=[0.013], SCI=[0](min
00348>                     Continuous simulation parameters:
00349>                     IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00350>                     InterEventTime=[12](hrs),   END=-1
00351> *%-----------------|-----------------------------------------------------------|
00352> CONTINUOUS NASHYD   ID=[8], NHYD=["VG-3"], DT=[15]min, AREA=[9.88](ha),
00353>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00354>                     N=[3], TP=[0.5]hrs,
00355>                     Continuous simulation parameters:
00356>                     IaRECper=[6](hrs),
00357>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00358>                     InterEventTime=[12](hrs)
00359>                     Baseflow simulation parameters:
00360>                     BaseFlowOption=[1] ,
00361>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00362>                     VHydCond=[1](mm/hr),   END=-1
00363> *%-----------------|-----------------------------------------------------------|
00364> *##########################################################################
00365> *# DUMMY SECTION - - FOR DEVELOPED
00366> *##########################################################################
00367> CONTINUOUS STANDHYD ID=[9], NHYD=["VG-3D"], DT=[15](min), AREA=[10.0](ha),
00368>                     XIMP=[0.427], TIMP=[0.577], DWF=[0](cms), LOSS=[1],
00369>                     Horton: Fo=[0.00001](mm/hr), Fc=[0.000005](mm/hr),
00370>                             DCAY=[4.14](/hr), F=[0](mm),
00371>                     Pervious   surfaces: IAper=[4.67](mm), SLPP=[0.5](%),
00372>                                           LGP=[40](m), MNP=[0.250], SCP=[0](min),
00373>                     Impervious surfaces: IAimp=[1.57](mm), SLPI=[0.5](%),
00374>                                           LGI=[453](m), MNI=[0.013], SCI=[0](min)
00375>                     Continuous simulation parameters:
00376>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00377>                     InterEventTime=[12](hrs),   END=-1
00378> *%-----------------|-----------------------------------------------------------|
00379> CONTINUOUS STANDHYD ID=[9], NHYD=["VG-3D"], DT=[15](min), AREA=[30.72](ha),
00380>                     XIMP=[0.427], TIMP=[0.577], DWF=[0](cms), LOSS=[1],
00381>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00382>                             DCAY=[4.14](/hr), F=[0](mm),
00383>                     Pervious   surfaces: IAper=[2.5](mm), SLPP=[1.5](%),
00384>                                           LGP=[35](m), MNP=[0.250], SCP=[0](min),
00385>                     Impervious surfaces: IAimp=[2.5](mm), SLPI=[0.3](%),
00386>                                           LGI=[453](m), MNI=[0.013], SCI=[0](min)
00387>                     Continuous simulation parameters:
00388>                     IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00389>                     InterEventTime=[12](hrs),   END=-1
00390> *%-----------------|-----------------------------------------------------------|
00391> CONTINUOUS STANDHYD ID=[10], NHYD=["VG-4"], DT=[15](min), AREA=[24.6](ha),
00392>                     XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00393>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00394>                             DCAY=[4.14](/hr), F=[0](mm),
00395>                     Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00396>                                           LGP=[35](m), MNP=[0.250], SCP=[0](min),
00397>                     Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00398>                                           LGI=[1000](m), MNI=[0.013], SCI=[0](min
00399>                     Continuous simulation parameters:
00400>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00401>                     InterEventTime=[12](hrs),   END=-1
00402> *%-----------------|-----------------------------------------------------------|
00403> ADD HYD             IDsum=[1], NHYD=["perthst"], IDs to add=[5 7 8 10]
00404> *%-----------------|-----------------------------------------------------------|
00405> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00406>                     HYD_COMMENT=["perthst"]
00407> *%-----------------|-----------------------------------------------------------|
00408> CONTINUOUS NASHYD   ID=[2], NHYD=["VG-5"], DT=[15]min, AREA=[34.4](ha),
00409>                     DWF=[0](cms),  CN/C=[76], IA=[3.0](mm),
00410>                     N=[3], TP=[2.3]hrs,
00411>                     Continuous simulation parameters:
00412>                     IaRECper=[6](hrs),
00413>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00414>                     InterEventTime=[12](hrs)
00415>                     Baseflow simulation parameters:
00416>                     BaseFlowOption=[1] ,
00417>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00418>                     VHydCond=[1](mm/hr),   END=-1
00419> *%-----------------|-----------------------------------------------------------|
00420> ROUTE CHANNEL       IDout=[3], NHYD=["PerS"], IDin=[2],
00421>                     RDT=[15](min),
00422>                     CHLGTH=[550](m),  CHSLOPE=[0.2](%),
00423>                                         FPSLOPE=[0.2](%),
00424>                     SECNUM=[1.1],       NSEG=[3]
00425>                     ( SEGROUGH, SEGDIST (m))=[0.08,70 -0.035,72 0.08,77] NSEG ti
00426>                     ( DISTANCE (m), ELEVATION (m))=[0,  94.4]
```

```
00427>                                                  [70, 94.0]
00428>                                                  [71, 93.5]
00429>                                                  [72, 94.0]
00430>                                                  [77, 94.4]
00431> *%-----------------|-------------------------------------------------------------|
00432> ADD HYD             IDsum=[2], NHYD=["arbuck"], IDs to add=[1 3]
00433> *%-----------------|-------------------------------------------------------------|
00434> SAVE HYD            ID=[2],  # OF PCYCLES=[-1],  ICASEsh=[1]
00435>                     HYD_COMMENT=["arbuck"]
00436> *%-----------------|-------------------------------------------------------------|
00437> ROUTE CHANNEL       IDout=[9], NHYD=["VGR2-2"], IDin=[2],
00438>                     RDT=[15](min),
00439>                     CHLGTH=[520](m),    CHSLOPE=[0.15](%),
00440>                                         FPSLOPE=[0.15](%),
00441>                     SECNUM=[5.2],       NSEG=[3]
00442>                     ( SEGROUGH, SEGDIST (m))=[0.08,65.27 -0.035,72.03 0.08,317.3
00443>                     ( DISTANCE (m), ELEVATION (m))=
00444>                     [1.87      94
00445>                     3.26       93.815
00446>                     25.32      93.589
00447>                     40.32      93.586
00448>                     53.15      93.49
00449>                     65.27      92.99
00450>                     67.31      92.06
00451>                     69.39      91.93
00452>                     69.99      92.03
00453>                     70.75      92.68
00454>                     72.03      93
00455>                     78.14      93
00456>                     87.57      92.828
00457>                     98.82      93
00458>                     131.96     93.341
00459>                     152.55     93.318
00460>                     220.7      93.525
00461>                     262.64     93.983
00462>                     274.22     94
00463>                     286.88     94
00464>                     297.86     93.981
00465>                     314.39     94.09
00466>                     317.39, 95.09]
00467> *%-----------------|-------------------------------------------------------------|
00468> CONTINUOUS NASHYD   ID=[1], NHYD=["VG-6"], DT=[15]min, AREA=[94.2](ha),
00469>                     DWF=[0](cms),  CN/C=[77], IA=[2.9](mm),
00470>                     N=[3], TP=[3.2]hrs,
00471>                     Continuous simulation parameters:
00472>                     IaRECper=[6](hrs),
00473>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00474>                     InterEventTime=[12](hrs)
00475>                     Baseflow simulation parameters:
00476>                     BaseFlowOption=[1] ,
00477>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00478>                     VHydCond=[1](mm/hr),   END=-1
00479> *%-----------------|-------------------------------------------------------------|
00480> *# ROUTE CHANNEL      IDout=[2], NHYD=["VG-6"], IDin=[1],
00481> *#                    RDT=[15](min),
00482> *#                    CHLGTH=[600](m),  CHSLOPE=[0.18](%),
00483> *#                                      FPSLOPE=[0.18](%),
00484> *#                    SECNUM=[2.1],       NSEG=[3]
00485> *#                    ( SEGROUGH, SEGDIST (m))=[0.05,700 -0.035,703 0.05,1000] N
00486> *#                    ( DISTANCE (m), ELEVATION (m))=[0,     94.6]
00487> *#                                                   [700,   94.5]
00488> *#                                                   [701.4, 94.1]
00489> *#                                                   [701.6, 94.1]
00490> *#                                                   [703,   94.5]
00491> *#                                                   [1000,  95.1]
00492> *%-----------------|-------------------------------------------------------------|
00493> *# SAVE HYD           ID=[2],  # OF PCYCLES=[-1],  ICASEsh=[1]
00494> *#                    HYD_COMMENT=["VG-6"]
00495> *%-----------------|-------------------------------------------------------------|
00496> CONTINUOUS NASHYD   ID=[2], NHYD=["VG-7"], DT=[15]min, AREA=[39.2](ha),
00497>                     DWF=[0](cms),  CN/C=[80], IA=[3.5](mm),
00498>                     N=[3], TP=[2.9]hrs,
00499>                     Continuous simulation parameters:
00500>                     IaRECper=[6](hrs),
00501>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00502>                     InterEventTime=[12](hrs)
00503>                     Baseflow simulation parameters:
00504>                     BaseFlowOption=[1] ,
00505>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00506>                     VHydCond=[1](mm/hr),   END=-1
00507> *%-----------------|-------------------------------------------------------------|
00508> SAVE HYD            ID=[2],  # OF PCYCLES=[-1],  ICASEsh=[1]
00509>                     HYD_COMMENT=["VG-7"]
00510> *%-----------------|-------------------------------------------------------------|
00511> *#*****************************************************************************
00512> *# "JR-1" Added February 16, 2010
00513> *#*****************************************************************************
00514> CONTINUOUS NASHYD   ID=[3], NHYD=["JR-1"], DT=[15]min, AREA=[32.6](ha),
00515>                     DWF=[0](cms),  CN/C=[82], IA=[3.5](mm),
00516>                     N=[3], TP=[1.6]hrs,
00517>                     Continuous simulation parameters:
00518>                     IaRECper=[6](hrs),
00519>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00520>                     InterEventTime=[12](hrs)
00521>                     Baseflow simulation parameters:
00522>                     BaseFlowOption=[1] ,
00523>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00524>                     VHydCond=[1](mm/hr),   END=-1
00525> *%-----------------|-------------------------------------------------------------|
00526> ADD HYD             IDsum=[4], NHYD=["EX-1"], IDs to add=[2 3](maximum ten)
00527> *%-----------------|-------------------------------------------------------------|
00528> SAVE HYD            ID=[4],  # OF PCYCLES=[-1],  ICASEsh=[1]
00529>                     HYD_COMMENT=["EX-1"]
00530> *%-----------------|-------------------------------------------------------------|
00531> ROUTE CHANNEL       IDout=[5], NHYD=["VG-7"], IDin=[4],
00532>                     RDT=[15](min),
00533>                     CHLGTH=[625](m),  CHSLOPE=[0.1](%),
00534>                                       FPSLOPE=[0.1](%),
00535>                     SECNUM=[5.3],       NSEG=[3]
00536>                     ( SEGROUGH, SEGDIST (m))=[0.08,7.6 -0.035,11.2 0.08,18.8] NS
00537>                     ( DISTANCE (m), ELEVATION (m))=[0,95.45]
00538>                                                    [5,95.35]
00539>                                                    [7.1,94.70]
00540>                                                    [7.6,94.70]
00541>                                                    [7.9,94.35]
00542>                                                    [10.9,94.35]
00543>                                                    [11.2,94.70]
00544>                                                    [11.7,94.70]
00545>                                                    [13.8,95.35]
00546>                                                    [18.8,95.45]
00547> *%-----------------|-------------------------------------------------------------|
00548> CONTINUOUS NASHYD   ID=[6], NHYD=["MD"], DT=[15]min, AREA=[1.3](ha),
00549>                     DWF=[0](cms),  CN/C=[88], IA=[2.6](mm),
00550>                     N=[3], TP=[1.0]hrs,
00551>                     Continuous simulation parameters:
00552>                     IaRECper=[6](hrs),
00553>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00554>                     InterEventTime=[12](hrs)
00555>                     Baseflow simulation parameters:
00556>                     BaseFlowOption=[1] ,
00557>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00558>                     VHydCond=[1](mm/hr),   END=-1
00559> *%-----------------|-------------------------------------------------------------|
00560> ADD HYD             IDsum=[7], NHYD=["MAT-A"], IDs to add=[1 5 6](maximum ten)
00561> *%-----------------|-------------------------------------------------------------|
00562> SAVE HYD            ID=[7],  # OF PCYCLES=[-1],  ICASEsh=[1]
00563>                     HYD_COMMENT=["MAT-A"]
00564> *%-----------------|-------------------------------------------------------------|
00565> ROUTE CHANNEL       IDout=[8], NHYD=["MOORE"], IDin=[7],
00566>                     RDT=[15](min),
00567>                     CHLGTH=[600](m),  CHSLOPE=[0.1](%),
00568>                                       FPSLOPE=[0.1](%),
```

```
00569>                    SECNUM=[2.1],       NSEG=[3]
00570>                    ( SEGROUGH, SEGDIST (m))=[0.08,8.43 -0.035,12.53 0.08,20.96]
00571>                    ( DISTANCE (m), ELEVATION (m))=[0, 95.23]
00572>                                                   [5, 95.13]
00573>                                                   [7.43, 94.32]
00574>                                                   [8.43, 94.30]
00575>                                                   [8.98, 93.75]
00576>                                                   [11.98, 93.75]
00577>                                                   [12.53, 94.30]
00578>                                                   [13.53, 94.32]
00579>                                                   [15.96, 95.13]
00580>                                                   [20.96, 95.23]
00581> *%-----------------|-----------------------------------------------------------|
00582> SAVE HYD            ID=[8],  # OF PCYCLES=[-1],  ICASEsh=[1]
00583>                    HYD_COMMENT=["MOORE"]
00584> *%-----------------|-----------------------------------------------------------|
00585> *##############################################################################
00586> *# DUMMY SECTION - FOR UNDEVELOPED
00587> *##############################################################################
00588> CONTINUOUS STANDHYD ID=[7], NHYD=["VG-8"], DT=[15](min), AREA=[10.0](ha),
00589>                    XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
00590>                    Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00591>                            DCAY=[4.14](/hr), F=[0](mm),
00592>                    Pervious   surfaces: IAper=[2.6](mm), SLPP=[1.5](%),
00593>                                         LGP=[35](m), MNP=[0.250], SCP=[0](min),
00594>                    Impervious surfaces: IAimp=[2.6](mm), SLPI=[0.3](%),
00595>                                         LGI=[1000](m), MNI=[0.013], SCI=[0](min
00596>                    Continuous simulation parameters:
00597>                    IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00598>                    InterEventTime=[12](hrs),   END=-1
00599> *%-----------------|-----------------------------------------------------------|
00600> CONTINUOUS NASHYD   ID=[7], NHYD=["VG-8"], DT=[15]min, AREA=[10.30](ha),
00601>                    DWF=[0](cms),  CN/C=[88], IA=[2.6](mm),
00602>                    N=[3], TP=[1.1]hrs,
00603>                    Continuous simulation parameters:
00604>                    IaRECper=[6](hrs),
00605>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00606>                    InterEventTime=[12](hrs)
00607>                    Baseflow simulation parameters:
00608>                    BaseFlowOption=[1] ,
00609>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00610>                    VHydCond=[1](mm/hr),   END=-1
00611> *%-----------------|-----------------------------------------------------------|
00612> *##############################################################################
00613> *# DUMMY SECTION - FOR DEVELOPED
00614> *##############################################################################
00615> CONTINUOUS STANDHYD ID=[8], NHYD=["VG-8D"], DT=[15](min), AREA=[10.0](ha),
00616>                    XIMP=[0.372], TIMP=[0.522], DWF=[0](cms), LOSS=[1],
00617>                    Horton: Fo=[0.00001](mm/hr), Fc=[0.000005](mm/hr),
00618>                            DCAY=[4.14](/hr), F=[0](mm),
00619>                    Pervious   surfaces: IAper=[4.67](mm), SLPP=[0.5](%),
00620>                                         LGP=[40](m), MNP=[0.250], SCP=[0](min),
00621>                    Impervious surfaces: IAimp=[1.57](mm), SLPI=[0.5](%),
00622>                                         LGI=[2.58](m), MNI=[0.013], SCI=[0](min
00623>                    Continuous simulation parameters:
00624>                    IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00625>                    InterEventTime=[12](hrs),   END=-1
00626> *%-----------------|-----------------------------------------------------------|
00627> CONTINUOUS STANDHYD ID=[8], NHYD=["VG-8D"], DT=[15](min), AREA=[80.2](ha),
00628>                    XIMP=[0.372], TIMP=[0.522], DWF=[0](cms), LOSS=[1],
00629>                    Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00630>                            DCAY=[4.14](/hr), F=[0](mm),
00631>                    Pervious   surfaces: IAper=[4.67](mm), SLPP=[0.5](%),
00632>                                         LGP=[40](m), MNP=[0.250], SCP=[0](min),
00633>                    Impervious surfaces: IAimp=[1.57](mm), SLPI=[0.5](%),
00634>                                         LGI=[731](m), MNI=[0.013], SCI=[0](min)
00635>                    Continuous simulation parameters:
00636>                    IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00637>                    InterEventTime=[12](hrs),   END=-1
00638> *%-----------------|-----------------------------------------------------------|
00639> CONTINUOUS STANDHYD ID=[3], NHYD=["VG-9"], DT=[15](min), AREA=[11.4](ha),
00640>                    XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00641>                    Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00642>                            DCAY=[4.14](/hr), F=[0](mm),
00643>                    Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00644>                                         LGP=[50](m), MNP=[0.250], SCP=[0](min),
00645>                    Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00646>                                         LGI=[731](m), MNI=[0.013], SCI=[0](min)
00647>                    Continuous simulation parameters:
00648>                    IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00649>                    InterEventTime=[12](hrs),   END=-1
00650> *%-----------------|-----------------------------------------------------------|
00651> STORE HYD           ID=[4],NHYD=["POND1"],  DT=[15](min),  AREA=[84.67](ha),
00652>                    FLOW=[0
00653>                        0.000335072
00654>                        0.000806107
00655>                        0.00116479
00656>                        0.00169205
00657>                        0.00212901
00658>                        0.00259202
00659>                        0.00309396
00660>                        0.00352556
00661>                        0.00399587
00662>                        0.00445046
00663>                        0.00488934
00664>                        0.00534811
00665>                        0.00578199
00666>                        0.00622907
00667>                        0.00667562
00668>                        0.0071083
00669>                        0.0076057
00670>                        0.00822551
00671>                        0.00888475
00672>                        0.00954992
00673>                        0.0102305
00674>                        0.0109053
00675>                        0.0115818
00676>                        0.0122566
00677>                        0.0129357
00678>                        0.0136457
00679>                        0.0143661
00680>                        0.0150764
00681>                        0.0157913
00682>                        0.0165033
00683>                        0.0172122
00684>                        0.0179216
00685>                        0.0186271
00686>                        0.0193318
00687>                        0.0200351
00688>                        0.0207356
00689>                        0.0214354
00690>                        0.0221328
00691>                        0.0228285
00692>                        0.0235228
00693>                        0.0242148
00694>                        0.0249056
00695>                        0.0255943
00696>                        0.0262814
00697>                        0.026967
00698>                        0.0276506
00699>                        0.0283326
00700>                        0.0290252
00701>                        0.0303692
00702>                        0.0317814
00703>                        0.0332017
00704>                        0.0346181
00705>                        0.0360405
00706>                        0.0374515
00707>                        0.0388585
00708>                        0.0402612
00709>                        0.0416546
00710>                        0.0430456
```

00711>	0.0444292
00712>	0.0458091
00713>	0.0471844
00714>	0.0485517
00715>	0.0499151
00716>	0.0512716
00717>	0.0526224
00718>	0.0539683
00719>	0.0553073
00720>	0.0566416
00721>	0.0579698
00722>	0.0592924
00723>	0.0606098
00724>	0.0619211
00725>	0.0632434
00726>	0.0646223
00727>	0.0660108
00728>	0.0673951
00729>	0.0687816
00730>	0.0701569
00731>	0.0715285
00732>	0.0728955
00733>	0.0742539
00734>	0.0756095
00735>	0.0769576
00736>	0.0783004
00737>	0.0796657
00738>	0.0811311
00739>	0.0826224
00740>	0.0840973
00741>	0.0855867
00742>	0.0870873
00743>	0.088568
00744>	0.0900345
00745>	0.0914983
00746>	0.0929614
00747>	0.0944156
00748>	0.0958694
00749>	0.0973545
00750>	0.0989171
00751>	0.1005
00752>	0.102083
00753>	0.103672
00754>	0.105246
00755>	0.106837
00756>	0.108478
00757>	0.110109
00758>	0.111735
00759>	0.113366
00760>	0.11498
00761>	0.116633
00762>	0.118375
00763>	0.120125
00764>	0.121862
00765>	0.123614
00766>	0.125347
00767>	0.127116
00768>	0.128986
00769>	0.130859
00770>	0.132721
00771>	0.134591
00772>	0.136438
00773>	0.138423
00774>	0.140636
00775>	0.142868
00776>	0.145071
00777>	0.147307
00778>	0.149518
00779>	0.151977
00780>	0.154833
00781>	0.157663
00782>	0.160484
00783>	0.163331
00784>	0.166139
00785>	0.169428
00786>	0.173629
00787>	0.177739
00788>	0.181838
00789>	0.185999
00790>	0.190128
00791>	0.196653
00792>	0.209522
00793>	0.230769
00794>	0.269278
00795>	0.327265
00796>	2.5691
00797>	3.22018
00798>	3.59295
00799>	3.90364
00800>	4.13985
00801>	4.24291
00802>	4.258
00803>	4.21601
00804>	4.10015
00805>	3.95259
00806>	3.79305
00807>	3.67752
00808>	3.58552
00809>	3.4904
00810>	3.39068
00811>	3.2983
00812>	3.20724
00813>	3.11887
00814>	3.03267
00815>	2.94388
00816>	2.85663
00817>	2.77507
00818>	2.69573
00819>	2.61762
00820>	2.53428
00821>	2.44911
00822>	2.36556
00823>	2.28777
00824>	2.21255
00825>	2.13997
00826>	1.8867
00827>	1.65847
00828>	1.46915
00829>	1.31352
00830>	1.18455
00831>	1.07815
00832>	0.990485
00833>	0.918025
00834>	0.858265
00835>	0.809098
00836>	0.771244
00837>	0.739495
00838>	0.712829
00839>	0.690314
00840>	0.671377
00841>	0.655583
00842>	0.642458
00843>	0.631472
00844>	0.622292
00845>	0.608619
00846>	0.584205
00847>	0.560635
00848>	0.542493
00849>	0.524996
00850>	0.511334
00851>	0.49978
00852>	0.489767

```
00853>                          0.481719
00854>                          0.474942
00855>                          0.469285
00856>                          0.464526
00857>                          0.460681
00858>                          0.457349
00859>                          0.454626
00860>                          0.45235
00861>                          0.450371
00862>                          0.448826
00863>                          0.447461
00864>                          0.446327
00865>                          0.445421
00866>                          0.444607
00867>                          0.443972
00868>                          0.44342
00869>                          0.442959
00870>                          0.442588
00871>                          0.442265
00872>                          0.442
00873>                          0.441777
00874>                          0.441593
00875>                          0.441441
00876>                          0.44131
00877>                          0.441204
00878>                          0.441115
00879>                          0.441039
00880>                          0.440977
00881>                          0.440924
00882>                          0.440881
00883>                          0.440845
00884>                          0.440814
00885>                          0.440789
00886>                          0.440768
00887>                          0.44075
00888>                          0.440734
00889>                          0.440722
00890>                          0.440713
00891>                          0.440704
00892>                          0.440695
00893>                          0.437672
00894>                          0.428432
00895>                          0.419335
00896>                          0.41207
00897>                          0.40504
00898>                          0.399762
00899>                          0.395059
00900>                          0.391176
00901>                          0.388003
00902>                          0.385321
00903>                          0.383076
00904>                          0.381113
00905>                          0.379649
00906>                          0.378288
00907>                          0.377186
00908>                          0.376308
00909>                          0.375491
00910>                          0.374915
00911>                          0.374353
00912>                          0.373894
00913>                          0.37355
00914>                          0.373216
00915>                          0.372975
00916>                          0.37275
00917>                          0.372568
00918>                          0.372426
00919>                          0.372292
00920>                          0.372192
00921>                          0.372101
00922>                          0.37203
00923>                          0.37197
00924>                          0.371916
00925>                          0.371876
00926>                          0.371839
00927>                          0.371811
00928>                          0.371786
00929>                          0.371764
00930>                          0.371749
00931>                          0.371732
00932>                          0.371721
00933>                          0.371711
00934>                          0.371701
00935>                          0.371696
00936>                          0.371689
00937>                          0.371684
00938>                          0.371681
00939>                          0.371677](cms)  END=-1
00940> *%-----------------|-------------------------------------------------------|
00941> ADD HYD             IDsum=[1], NHYD=["Fortune"], IDs to add=[3 4 7 8 9]
00942> *%-----------------|-------------------------------------------------------|
00943> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00944>                     HYD_COMMENT=["Fortune"]
00945> *%-----------------|-------------------------------------------------------|
00946> ROUTE CHANNEL       IDout=[3], NHYD=["VGR2-3"], IDin=[1],
00947>                     RDT=[15](min),
00948>                     CHLGTH=[750](m),    CHSLOPE=[0.2](%),
00949>                                         FPSLOPE=[0.2](%),
00950>                     SECNUM=[5.3],       NSEG=[3]
00951>                     ( SEGROUGH, SEGDIST (m))=[0.05,3.22 -0.035,47.84 0.05,77.80]
00952>                     ( DISTANCE (m), ELEVATION (m))=[0,            93.5
00953>                                                    3.22,  93
00954>                                                    20.87, 92.5
00955>                                                    42.19, 92
00956>                                                    47.84, 92
00957>                                                    48.60, 92.5
00958>                                                    50.14, 93
00959>                                                    72.67, 93.526
00960>                                                    77.80, 93.5]
00961> *%-----------------|-------------------------------------------------------|
00962> CONTINUOUS STANDHYD ID=[2], NHYD=["VG-10"], DT=[15](min), AREA=[20.3](ha),
00963>                     XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00964>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00965>                             DCAY=[4.14](/hr), F=[0](mm),
00966>                     Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00967>                                           LGP=[50](m), MNP=[0.250], SCP=[0](min),
00968>                     Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00969>                                           LGI=[560](m), MNI=[0.013], SCI=[0](min)
00970>                     Continuous simulation parameters:
00971>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00972>                     InterEventTime=[12](hrs),   END=-1
00973> *%-----------------|-------------------------------------------------------|
00974> ADD HYD             IDsum=[9], NHYD=["VG"], IDs to add=[2 3]
00975> *%-----------------|-------------------------------------------------------|
00976> SAVE HYD            ID=[9],  # OF PCYCLES=[-1],  ICASEsh=[1]
00977>                     HYD_COMMENT=["Flow from Van Gaal Drain at Jock River"]
00978> *%-----------------|-------------------------------------------------------|
00979> ****************************************************************************
00980> * Jock River
00981> ****************************************************************************
00982> ############################################################################
00983> *# DUMMY SECTION - FOR UNDEVELOPED
00984> ############################################################################
00985> CONTINUOUS STANDHYD ID=[3], NHYD=["JR-2"], DT=[15](min), AREA=[10.0](ha),
00986>                     XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
00987>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00988>                             DCAY=[4.14](/hr), F=[0](mm),
00989>                     Pervious   surfaces: IAper=[2.5](mm), SLPP=[1.5](%),
00990>                                           LGP=[35](m), MNP=[0.250], SCP=[0](min),
00991>                     Impervious surfaces: IAimp=[2.5](mm), SLPI=[0.3](%),
00992>                                           LGI=[182](m), MNI=[0.013], SCI=[0](min)
00993>                     Continuous simulation parameters:
00994>                     IaRECper=[6](hrs),  IaRECimp=[6](hrs),
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00995>                      InterEventTime=[12](hrs),   END=-1
00996> *%-----------------|-----------------------------------------------------------|
00997> CONTINUOUS NASHYD   ID=[3], NHYD=["JR-2"], DT=[15]min, AREA=[4.96](ha),
00998>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00999>                     N=[3], TP=[0.8]hrs,
01000>                     Continuous simulation parameters:
01001>                     IaRECper=[6](hrs),
01002>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
01003>                     InterEventTime=[12](hrs)
01004>                     Baseflow simulation parameters:
01005>                     BaseFlowOption=[1] ,
01006>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
01007>                     VHydCond=[1](mm/hr),   END=-1
01008> *%-----------------|-----------------------------------------------------------|
01009> *##############################################################################
01010> *# DUMMY SECTION - FOR DEVELOPED
01011> *##############################################################################
01012> CONTINUOUS STANDHYD ID=[4], NHYD=["JR-2D"], DT=[15](min), AREA=[10.0](ha),
01013>                     XIMP=[0.395], TIMP=[0.545], DWF=[0](cms), LOSS=[1],
01014>                     Horton: Fo=[0.00001](mm/hr), Fc=[0.000005](mm/hr),
01015>                             DCAY=[4.14](/hr), F=[0](mm),
01016>                     Pervious   surfaces: IAper=[4.67](mm), SLPP=[0.5](%),
01017>                                          LGP=[40](m), MNP=[0.250], SCP=[0](min),
01018>                     Impervious surfaces: IAimp=[1.57](mm), SLPI=[0.5](%),
01019>                                          LGI=[182](m), MNI=[0.013], SCI=[0](min)
01020>                     Continuous simulation parameters:
01021>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
01022>                     InterEventTime=[12](hrs),   END=-1
01023> *%-----------------|-----------------------------------------------------------|
01024> CONTINUOUS STANDHYD ID=[4], NHYD=["JR-2D"], DT=[15](min), AREA=[15.54](ha),
01025>                     XIMP=[0.395], TIMP=[0.545], DWF=[0](cms), LOSS=[1],
01026>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
01027>                             DCAY=[4.14](/hr), F=[0](mm),
01028>                     Pervious   surfaces: IAper=[4.67](mm), SLPP=[0.5](%),
01029>                                          LGP=[40](m), MNP=[0.250], SCP=[0](min),
01030>                     Impervious surfaces: IAimp=[1.57](mm), SLPI=[0.5](%),
01031>                                          LGI=[182](m), MNI=[0.013], SCI=[0](min)
01032>                     Continuous simulation parameters:
01033>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
01034>                     InterEventTime=[12](hrs),   END=-1
01035> *%-----------------|-----------------------------------------------------------|
01036> CONTINUOUS NASHYD   ID=[4], NHYD=["JR-3"], DT=[15]min, AREA=[6.86](ha),
01037>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
01038>                     N=[3], TP=[0.2]hrs,
01039>                     Continuous simulation parameters:
01040>                     IaRECper=[6](hrs),
01041>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
01042>                     InterEventTime=[12](hrs)
01043>                     Baseflow simulation parameters:
01044>                     BaseFlowOption=[1] ,
01045>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
01046>                     VHydCond=[1](mm/hr),   END=-1
01047> *%-----------------|-----------------------------------------------------------|
01048> STORE HYD           ID=[6],NHYD=["POND2"],  DT=[15](min),  AREA=[45.53](ha),
01049>                     FLOW=[0
01050>                         0.000213196
01051>                         0.000591786
01052>                         0.000824112
01053>                         0.00124469
01054>                         0.00153586
01055>                         0.00193772
01056>                         0.00229613
01057>                         0.00266183
01058>                         0.00304262
01059>                         0.00338897
01060>                         0.0037697
01061>                         0.00411594
01062>                         0.00448491
01063>                         0.0048382
01064>                         0.00519446
01065>                         0.00555005
01066>                         0.00592218
01067>                         0.00639754
01068>                         0.00687827
01069>                         0.00737418
01070>                         0.00787848
01071>                         0.00838576
01072>                         0.008896
01073>                         0.00939925
01074>                         0.00990832
01075>                         0.0104317
01076>                         0.0109529
01077>                         0.0114726
01078>                         0.0119929
01079>                         0.012508
01080>                         0.0130224
01081>                         0.0135319
01082>                         0.0140391
01083>                         0.0145425
01084>                         0.0150428
01085>                         0.0155401
01086>                         0.016034
01087>                         0.016525
01088>                         0.0170118
01089>                         0.0174965
01090>                         0.0179778
01091>                         0.0267977
01092>                         0.0355742
01093>                         0.0439165
01094>                         0.0518424
01095>                         0.0593813
01096>                         0.0665465
01097>                         0.0733614
01098>                         0.0799492
01099>                         0.0867407
01100>                         0.0933065
01101>                         0.0996152
01102>                         0.105764
01103>                         0.111522
01104>                         0.117074
01105>                         0.122334
01106>                         0.12735
01107>                         0.132142
01108>                         0.136695
01109>                         0.141049
01110>                         0.145193
01111>                         0.149149
01112>                         0.152923
01113>                         0.15652
01114>                         0.159956
01115>                         0.163232
01116>                         0.166359
01117>                         0.169344
01118>                         0.172193
01119>                         0.174913
01120>                         0.177509
01121>                         0.179989
01122>                         0.182394
01123>                         0.184982
01124>                         0.187359
01125>                         0.189696
01126>                         0.192036
01127>                         0.194221
01128>                         0.196366
01129>                         0.198383
01130>                         0.200324
01131>                         0.202178
01132>                         0.203944
01133>                         0.205638
01134>                         0.207389
01135>                         0.209827
01136>                         0.212088
```

01137>	0.214296
01138>	0.216564
01139>	0.218598
01140>	0.220636
01141>	0.222535
01142>	0.224364
01143>	0.226118
01144>	0.227781
01145>	0.229384
01146>	0.231036
01147>	0.233302
01148>	0.235683
01149>	0.237977
01150>	0.240333
01151>	0.242511
01152>	0.244676
01153>	0.246984
01154>	0.249176
01155>	0.251295
01156>	0.253383
01157>	0.255355
01158>	0.257422
01159>	0.260244
01160>	0.262977
01161>	0.265575
01162>	0.268168
01163>	0.270591
01164>	0.273073
01165>	0.276047
01166>	0.278978
01167>	0.28174
01168>	0.284496
01169>	0.287072
01170>	0.289954
01171>	0.294483
01172>	0.299078
01173>	0.303521
01174>	0.308057
01175>	0.312305
01176>	0.317042
01177>	0.324107
01178>	0.331142
01179>	0.337939
01180>	0.344767
01181>	0.351207
01182>	0.358946
01183>	0.371816
01184>	0.384751
01185>	0.397523
01186>	0.410111
01187>	0.422037
01188>	0.442679
01189>	0.499107
01190>	0.593179
01191>	0.777332
01192>	1.07755
01193>	1.48294
01194>	1.81223
01195>	1.99911
01196>	2.12227
01197>	2.19389
01198>	2.22797
01199>	2.235
01200>	2.22757
01201>	2.19838
01202>	2.15774
01203>	2.11235
01204>	2.06387
01205>	2.0141
01206>	1.96324
01207>	1.91082
01208>	1.86155
01209>	1.81249
01210>	1.76516
01211>	1.71931
01212>	1.67316
01213>	1.62686
01214>	1.58311
01215>	1.54079
01216>	1.4996
01217>	1.45993
01218>	1.41967
01219>	1.37905
01220>	1.34079
01221>	1.30372
01222>	1.26795
01223>	1.23347
01224>	1.20018
01225>	1.16793
01226>	1.13686
01227>	1.10699
01228>	1.07813
01229>	1.05029
01230>	1.02341
01231>	0.997482
01232>	0.972466
01233>	0.948367
01234>	0.925132
01235>	0.902708
01236>	0.881083
01237>	0.860224
01238>	0.840104
01239>	0.820703
01240>	0.80199
01241>	0.783937
01242>	0.765747
01243>	0.746438
01244>	0.727697
01245>	0.709794
01246>	0.692125
01247>	0.675109
01248>	0.658667
01249>	0.642701
01250>	0.627331
01251>	0.612456
01252>	0.598095
01253>	0.584238
01254>	0.570858
01255>	0.557967
01256>	0.545591
01257>	0.533642
01258>	0.522125
01259>	0.511027
01260>	0.500328
01261>	0.490025
01262>	0.4801
01263>	0.470544
01264>	0.461344
01265>	0.45249
01266>	0.44397
01267>	0.435774
01268>	0.427891
01269>	0.420307
01270>	0.413018
01271>	0.406011
01272>	0.399277
01273>	0.392806
01274>	0.38659
01275>	0.380619
01276>	0.374884
01277>	0.369377
01278>	0.36409

```
01279>                          0.359014
01280>                          0.354142
01281>                          0.349466
01282>                          0.344983
01283>                          0.340691
01284>                          0.336571
01285>                          0.332619
01286>                          0.328828
01287>                          0.325192
01288>                          0.321705
01289>                          0.31836
01290>                          0.314956
01291>                          0.310745
01292>                          0.306505
01293>                          0.302383
01294>                          0.298187
01295>                          0.294295
01296>                          0.290439
01297>                          0.286787
01298>                          0.28328
01299>                          0.279896
01300>                          0.276686
01301>                          0.273577
01302>                          0.270623
01303>                          0.267779
01304>                          0.265059
01305>                          0.262455
01306>                          0.259956
01307>                          0.257568
01308>                          0.255276
01309>                          0.253085
01310>                          0.250985
01311>                          0.248975
01312>                          0.247051
01313>                          0.245208
01314>                          0.243444
01315>                          0.241755
01316>                          0.240139
01317>                          0.238592
01318>                          0.237111
01319>                          0.235694
01320>                          0.234337
01321>                          0.233039
01322>                          0.231797
01323>                          0.230608
01324>                          0.229471
01325>                          0.228382
01326>                          0.227341
01327>                          0.226344
01328>                          0.225391
01329>                          0.224479
01330>                          0.223606
01331>                          0.222771
01332>                          0.221973
01333>                          0.221209
01334>                          0.220478
01335>                          0.219778
01336>                          0.21911](cms)  END=-1
01337> *%-----------------|-------------------------------------------------------|
01338> ADD HYD             IDsum=[5], NHYD=["JockVG"], IDs to add=[3 4 6 9]
01339> *%-----------------|-------------------------------------------------------|
01340> SAVE HYD            ID=[5],   # OF PCYCLES=[-1],  ICASEsh=[1]
01341>                     HYD_COMMENT=["Flow From Subject Area At Jock River"]
01342> *%-----------------|-------------------------------------------------------|
01343> START               TZERO=[1968.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[68]
01344> START               TZERO=[1969.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[69]
01345> START               TZERO=[1970.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[70]
01346> START               TZERO=[1971.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[71]
01347> START               TZERO=[1972.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[72]
01348> START               TZERO=[1973.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[73]
01349> START               TZERO=[1974.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[74]
01350> START               TZERO=[1975.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[75]
01351> START               TZERO=[1976.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[76]
01352> START               TZERO=[1977.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[77]
01353> START               TZERO=[1978.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[78]
01354> START               TZERO=[1979.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[79]
01355> START               TZERO=[1980.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[80]
01356> START               TZERO=[1981.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[81]
01357> START               TZERO=[1982.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[82]
01358> START               TZERO=[1983.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[83]
01359> START               TZERO=[1984.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[84]
01360> START               TZERO=[1985.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[85]
01361> START               TZERO=[1986.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[86]
01362> START               TZERO=[1987.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[87]
01363> START               TZERO=[1988.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[88]
01364> START               TZERO=[1989.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[89]
01365> START               TZERO=[1990.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[90]
01366> START               TZERO=[1991.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[91]
01367> START               TZERO=[1992.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[92]
01368> START               TZERO=[1993.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[93]
01369> START               TZERO=[1994.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[94]
01370> START               TZERO=[1995.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[95]
01371> START               TZERO=[1996.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[96]
01372> START               TZERO=[1997.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[97]
01373> START               TZERO=[1998.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[98]
01374> START               TZERO=[1999.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[99]
01375> START               TZERO=[2000.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[200]
01376> START               TZERO=[2001.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[201]
01377> START               TZERO=[2002.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[202]
01378> START               TZERO=[2003.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[203]
01379> *%-----------------|-------------------------------------------------------|
01380> FINISH
```

```
00001> 2     Metric units
00002> *#******************************************************************************
00003> *#  SWMHYMO Ver:5.02/Jan 2001 <BETA> / INPUT DATA FILE
00004> *#******************************************************************************
00005> *#  Project Name: [Richmond FPM]    Project Number: [709]
00006> *#  Date        : 04-21-2009
00007> *#  Revised     : 05-27-2009; 07-22-2009; 08-06-2009; 08-31-2009; 11-16-2009
00008> *#  Modeller    : [Bryan Willcott B.Eng.]
00009> *#  Company     : J.F. Sabourin and Associates
00010> *#  License #   : 3410370
00011> *#******************************************************************************
00012>
00013> *#******************************************************************************
00014> *#  [BW] May 27, 2009
00015> *#  This model has been updated using revised values for Tp. Previous versions
00016> *#  of this model used a calculated Tp=0.6Tc.  This model used a calculated
00017> *#  Tp=0.67Tc.
00018> *#******************************************************************************
00019> *#  [BW] July 22, 2009
00020> *#  This model has been revised to include "existing" cross section information
00021> *#  received from Robinson Consultants.  The Cross section revised in the model
00022> *#  is Sec 5.2 (channel receiving flow from "arbuck"). Also, channel and
00023> *#  floodplain slopes for ROUTE CHANNEL commands were updated to be equal
00024> *#******************************************************************************
00025> *#  [BW] August 6, 2009
00026> *#  This model has been revised to include cross section information
00027> *#  from Robinson Consultants Engineer's Report July 2003.  The cross
00028> *#  section revised in the model is Sec 5.1.  Cross sections Sec 1.03
00029> *#  and Sec 5.3 have also been revised
00030> *#******************************************************************************
00031> *#  [BW] August 31, 2009
00032> *#  Model updated to include the proposed DSEL berm. This affects the geometry
00033> *#  of Route Channel Sect 5.2 located on the Arbuckle drain.  Route Channels 5.2
00034> *#  and 1.03 have also been revised to reduce the number of values in the
00035> *#  x-y matrix.
00036> *#******************************************************************************
00037> *#  [BW] November 16, 2009
00038> *#  Model updated to include revised CN and Tp values subsequent to review of
00039> *#  memo received from AECOM on Oct. 2, 2009
00040> *#******************************************************************************
00041> *#  [BW] March 4, 2010
00042> *#  Model converted to continuous model for water balance analysis
00043> *#******************************************************************************
00044> *#
00045> *% 25mm 4HR Chicago Storm
00046> START               TZERO=[1967.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[67]
00047> *                    ["4HR-25mm.stm"]
00048> *%----------------|------------------------------------------------------------|
00049> *# READ STORM          STORM_FILENAME=["STORM.001"]
00050> *%----------------|------------------------------------------------------------|
00051> READ AES DATA       AES_FILENAME=["6106000.123"], IELEM=[123],
00052>                     START_DATE=[0], END_DATE=[-183]
00053> *%----------------|------------------------------------------------------------|
00054> COMPUTE API         APII=[50], APIK=[0.90]/day
00055> *%----------------|------------------------------------------------------------|
00056> *#*****************************************************************************
00057> *# Van Gaal / Arbuckle Drain
00058> *#*****************************************************************************
00059> *# DSEL SUBCATCHMENT VG-1 HAS BEEN BROKEN INTO 6 SUB-AREAS (BW)
00060> *#*****************************************************************************
00061> *%----------------|------------------------------------------------------------|
00062> CONTINUOUS NASHYD   ID=[1], NHYD=["VG-1A"], DT=[15]min, AREA=[311.9](ha),
00063>                     DWF=[0](cms),  CN/C=[73], IA=[3.9](mm),
00064>                     N=[3], TP=[5.3]hrs,
00065>                     Continuous simulation parameters:
00066>                     IaRECper=[6](hrs),
00067>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00068>                     InterEventTime=[12](hrs)
00069>                     Baseflow simulation parameters:
00070>                     BaseFlowOption=[1] ,
00071>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00072>                     VHydCond=[1](mm/hr),   END=-1
00073> *%----------------|------------------------------------------------------------|
00074> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00075>                     HYD_COMMENT=["VG-1A"]
00076> *%----------------|------------------------------------------------------------|
00077> *#*****************************************************************************
00078> *# Tp FOR VG-1B HAS BEEN REVISED TO REFLECT A HYDRAULIC LENGTH OF 1710 m, A
00079> *# LENGTH THAT INCLUDES DISTANCE TO THE VG1-1 CONFLUENCE IN ADDITION TO THE
00080> *# LONGEST FLOW PATH WITHIN VG-1B. THIS IS DONE TO SIMULATE CHANNEL ROUTING
00081> *#*****************************************************************************
00082> CONTINUOUS NASHYD   ID=[2], NHYD=["VG-1B"], DT=[15]min, AREA=[24.8](ha),
00083>                     DWF=[0](cms),  CN/C=[73], IA=[4.0](mm),
00084>                     N=[3], TP=[2.7]hrs,
00085>                     Continuous simulation parameters:
00086>                     IaRECper=[6](hrs),
00087>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00088>                     InterEventTime=[12](hrs)
00089>                     Baseflow simulation parameters:
00090>                     BaseFlowOption=[1] ,
00091>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00092>                     VHydCond=[1](mm/hr),   END=-1
00093> *%----------------|------------------------------------------------------------|
00094> *#*****************************************************************************
00095> *# VG1-1 IS THE SUM OF FLOWS TO THE CONFLUENCE OF NORTHERN MOST WATERCOURSE IN
00096> *# OUR AREA OF STUDY WITH THE ROADSIDE DITCH ON GARVIN ROAD
00097> *#*****************************************************************************
00098> *#
00099> ADD HYD             IDsum=[3], NHYD=["VG1-1"], IDs to add=[1 2]
00100> *%----------------|------------------------------------------------------------|
00101> SAVE HYD            ID=[3],  # OF PCYCLES=[-1],  ICASEsh=[1]
00102>                     HYD_COMMENT=["VG1-1"]
00103> *%----------------|------------------------------------------------------------|
00104> CONTINUOUS NASHYD   ID=[4], NHYD=["VG-1D"], DT=[15]min, AREA=[47.8](ha),
00105>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00106>                     N=[3], TP=[1.8]hrs,
00107>                     Continuous simulation parameters:
00108>                     IaRECper=[6](hrs),
00109>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00110>                     InterEventTime=[12](hrs)
00111>                     Baseflow simulation parameters:
00112>                     BaseFlowOption=[1] ,
00113>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00114>                     VHydCond=[1](mm/hr),   END=-1
00115> *%----------------|------------------------------------------------------------|
00116> *#*****************************************************************************
00117> *# VG1-2 IS THE SUM OF FLOWS AT THE GARVIN ROAD CROSS CULVERT AND
00118> *# CONSERVATIVELY INCLUDES THE AREA VG-1D,  WHICH IS LOCATED JUST DOWNSTREAM
00119> *# OF THE CULVERT
00120> *#*****************************************************************************
00121> *#
00122> ADD HYD             IDsum=[5], NHYD=["VG1-2"], IDs to add=[3 4]
00123> *%----------------|------------------------------------------------------------|
00124> SAVE HYD            ID=[5],  # OF PCYCLES=[-1],  ICASEsh=[1]
00125>                     HYD_COMMENT=["VG1-2"]
00126> *%----------------|------------------------------------------------------------|
00127> ROUTE CHANNEL       IDout=[6], NHYD=["VG1R-2"],IDin=[5],
00128>                     RDT=[15](min),
00129>                     CHLGTH=[865](m),  CHSLOPE=[0.15](%),
00130>                                          FPSLOPE=[0.15](%),
00131>                     SECNUM=[1.01],       NSEG=[3]
00132>                     ( SEGROUGH, SEGDIST (m))=[0.08,51.41 -0.035,55.58 0.08,228.3
00133>                     ( DISTANCE (m), ELEVATION (m))=[0,            96.719]
00134>                                                   [22.98, 96.598]
00135>                                                   [42.45, 96.66]
00136>                                                   [47.63, 96.5]
00137>                                                   [49.64, 96.424]
00138>                                                   [51.41, 96]
00139>                                                   [53.36, 95.79]
00140>                                                   [55.58, 95.887]
00141>                                                   [57.42, 96.242]
00142>                                                   [87.69, 96.5]
```

```
                                                    [119.62,     96.509]
                                                    [140.1,      96.601]
                                                    [179.39,     96.722]
                                                    [200.6,      96.89]
                                                    [228.39,     97]
*%-----------------|-------------------------------------------------------------|
CONTINUOUS NASHYD   ID=[7], NHYD=["VG-1C"], DT=[15]min, AREA=[211.8](ha),
                    DWF=[0](cms),  CN/C=[70], IA=[3.9](mm),
                    N=[3], TP=[4.7]hrs,
                    Continuous simulation parameters:
                    IaRECper=[6](hrs),
                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
                    InterEventTime=[12](hrs)
                    Baseflow simulation parameters:
                    BaseFlowOption=[1] ,
                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
                    VHydCond=[1](mm/hr),   END=-1
*%-----------------|-------------------------------------------------------------|
CONTINUOUS NASHYD   ID=[8], NHYD=["VG-1E"], DT=[15]min, AREA=[13.4](ha),
                    DWF=[0](cms),  CN/C=[73], IA=[4.0](mm),
                    N=[3], TP=[0.64]hrs,
                    Continuous simulation parameters:
                    IaRECper=[6](hrs),
                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
                    InterEventTime=[12](hrs)
                    Baseflow simulation parameters:
                    BaseFlowOption=[1] ,
                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
                    VHydCond=[1](mm/hr),   END=-1
*%-----------------|-------------------------------------------------------------|
*#*****************************************************************************
*# VG1-3 IS THE SUM OF FLOWS TO JOY'S ROAD CROSS CULVERT AND CONSERVATIVELY
*# INCLUDES THE AREA VG-1E, WHICH IS LOCATED JUST DOWNSTREAM OF THE CULVERT
*#*****************************************************************************
*#
ADD HYD             IDsum=[9], NHYD=["VG1-3"], IDs to add=[7 8]
*%-----------------|-------------------------------------------------------------|
SAVE HYD            ID=[9],  # OF PCYCLES=[-1],  ICASEsh=[1]
                    HYD_COMMENT=["VG1-3"]
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDout=[10], NHYD=["VG1R-3"],IDin=[9],
                    RDT=[15](min),
                    CHLGTH=[630](m),  CHSLOPE=[0.20](%),
                                        FPSLOPE=[0.20](%),
                    SECNUM=[1.02],       NSEG=[3]
                    ( SEGROUGH, SEGDIST (m))=[0.08,80.53 -0.035,82.4 0.08,124.53
                    ( DISTANCE (m), ELEVATION (m))=[0         97
                                                    0.61       97.01
                                                    3.8 97.03
                                                    17.49      97.18
                                                    19.18      97.17
                                                    26.62      97.15
                                                    46.29      97.12
                                                    73.97      97.17
                                                    76.3       97.04
                                                    77.53      97
                                                    80.53      96.86
                                                    81.38      96.5
                                                    82.4       96.07
                                                    87.91      96.07
                                                    89.65      96.5
                                                    90.75      96.78
                                                    91.88      96.91
                                                    96.2       97
                                                    99.01      97.1
                                                    119.73     97.14
                                                    124.53     97]
*%-----------------|-------------------------------------------------------------|
*#*****************************************************************************
*# VG1-4 IS THE SUM OF FLOWS AT THE CONFLUENCE OF THE WATERCOURSE FROM JOY'S
*# ROAD WITH THE MAIN DRAIN
*#*****************************************************************************
*#
ADD HYD             IDsum=[1], NHYD=["VG1-4"], IDs to add=[6 10]
*%-----------------|-------------------------------------------------------------|
SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
                    HYD_COMMENT=["VG1-4"]
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDout=[2], NHYD=["VG1R-4"],IDin=[1],
                    RDT=[15](min),
                    CHLGTH=[485](m),  CHSLOPE=[0.20](%),
                                        FPSLOPE=[0.20](%),
                    SECNUM=[1.03],       NSEG=[3]
                    ( SEGROUGH, SEGDIST (m))=[0.08,44.17 -0.035,53.58 0.08,243.3
                    ( DISTANCE (m), ELEVATION (m))=
                    [-44.2, 95.7
                    0, 95.5
                    19.69, 95.421
                    27.91, 95.5
                    31.73, 95.5
                    32.29, 95.325
                    32.71, 95.5
                    41.04, 95.5
                    44.17, 95.449
                    45.63, 95.389
                    48.22, 95
                    48.54, 94.882
                    49.35, 94.5
                    49.64, 94.311
                    50.46, 94.497
                    52.21, 94.993
                    53.58, 95.406
                    55.08, 95.333
                    55.94, 95.157
                    76.35, 95.275
                    131, 95.403
                    213.2, 95.5
                    243.3, 95.8]
*%-----------------|-------------------------------------------------------------|
CONTINUOUS NASHYD   ID=[3], NHYD=["VG-1F"], DT=[15]min, AREA=[117.7](ha),
                    DWF=[0](cms),  CN/C=[86], IA=[2.6](mm),
                    N=[3], TP=[2.9]hrs,
                    Continuous simulation parameters:
                    IaRECper=[6](hrs),
                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
                    InterEventTime=[12](hrs)
                    Baseflow simulation parameters:
                    BaseFlowOption=[1] ,
                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
                    VHydCond=[1](mm/hr),   END=-1
*%-----------------|-------------------------------------------------------------|
*#*****************************************************************************
*# VG1 IS THE SUM OF FLOWS AT THE CONFLUENCE OF THE VAN GAAL WEST MAIN DRAIN
*# WITH VAN GAAL WEST TRIBUTARY
*#*****************************************************************************
*#
ADD HYD             IDsum=[4], NHYD=["VG1"], IDs to add=[2 3]
*%-----------------|-------------------------------------------------------------|
SAVE HYD            ID=[4],  # OF PCYCLES=[-1],  ICASEsh=[1]
                    HYD_COMMENT=["VG1"]
*%-----------------|-------------------------------------------------------------|
ROUTE CHANNEL       IDout=[5], NHYD=["VGR2-1"], IDin=[4],
                    RDT=[15](min),
                    CHLGTH=[755](m),    CHSLOPE=[0.2](%),
                                        FPSLOPE=[0.2](%),
                    SECNUM=[5.1],       NSEG=[3]
                    ( SEGROUGH, SEGDIST (m))=[0.08,98.046 -0.035,105.496 0.08,51
                    ( DISTANCE (m), ELEVATION (m))=[0,            96.11
                                                    20,           94.4
                                                    26.106, 94.5
                                                    41.686, 94.465
                                                    63.506, 94.427
```

```
00285>                                                  84.666,     94.492
00286>                                                  95.476,     94.363
00287>                                                  97.736,     94
00288>                                                  98.046,     93.967
00289>                                                  100.336,    92.8193
00290>                                                  101.536,    92.8193
00291>                                                  102.736,    92.8193
00292>                                                  105.496,    94.199
00293>                                                  127.006,    94.345
00294>                                                  142.116,    94.5
00295>                                                  148.376,    94.568
00296>                                                  478.406,    94.7
00297>                                                  518.306,    95]
00298> *%-----------------|-------------------------------------------------------------|
00299> CONTINUOUS NASHYD   ID=[6], NHYD=["VG-2"], DT=[15]min, AREA=[63.1](ha),
00300>                    DWF=[0](cms),  CN/C=[81], IA=[2.8](mm),
00301>                    N=[3], TP=[1.6]hrs,
00302>                    Continuous simulation parameters:
00303>                    IaRECper=[6](hrs),
00304>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00305>                    InterEventTime=[12](hrs)
00306>                    Baseflow simulation parameters:
00307>                    BaseFlowOption=[1] ,
00308>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00309>                    VHydCond=[1](mm/hr),   END=-1
00310> *%-----------------|-------------------------------------------------------------|
00311> ROUTE CHANNEL       IDout=[7], NHYD=["PerN"], IDin=[6],
00312>                    RDT=[15](min),
00313>                    CHLGTH=[550](m),  CHSLOPE=[0.2](%),
00314>                                      FPSLOPE=[0.2](%),
00315>                    SECNUM=[1.1],       NSEG=[3]
00316>                    ( SEGROUGH, SEGDIST (m))=[0.08,70 -0.035,72 0.08,77] NSEG ti
00317>                    ( DISTANCE (m), ELEVATION (m))=[0,  94.4]
00318>                                                   [70, 94.0]
00319>                                                   [71, 93.5]
00320>                                                   [72, 94.0]
00321>                                                   [77, 94.4]
00322> *%-----------------|-------------------------------------------------------------|
00323> *##############################################################################
00324> *# DUMMY SECTION
00325> *##############################################################################
00326> CONTINUOUS STANDHYD ID=[8], NHYD=["VG-3"], DT=[15](min), AREA=[10.0](ha),
00327>                    XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
00328>                    Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00329>                            DCAY=[4.14](/hr), F=[0](mm),
00330>                    Pervious   surfaces: IAper=[2.5](mm), SLPP=[1.5](%),
00331>                                         LGP=[35](m), MNP=[0.250], SCP=[0](min),
00332>                    Impervious surfaces: IAimp=[2.5](mm), SLPI=[0.3](%),
00333>                                         LGI=[1000](m), MNI=[0.013], SCI=[0](min
00334>                    Continuous simulation parameters:
00335>                    IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00336>                    InterEventTime=[12](hrs),   END=-1
00337> *%-----------------|-------------------------------------------------------------|
00338> CONTINUOUS NASHYD   ID=[8], NHYD=["VG-3"], DT=[15]min, AREA=[40.6](ha),
00339>                    DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00340>                    N=[3], TP=[1.6]hrs,
00341>                    Continuous simulation parameters:
00342>                    IaRECper=[6](hrs),
00343>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00344>                    InterEventTime=[12](hrs)
00345>                    Baseflow simulation parameters:
00346>                    BaseFlowOption=[1] ,
00347>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00348>                    VHydCond=[1](mm/hr),   END=-1
00349> *%-----------------|-------------------------------------------------------------|
00350> CONTINUOUS STANDHYD ID=[9], NHYD=["VG-4"], DT=[15](min), AREA=[24.6](ha),
00351>                    XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00352>                    Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00353>                            DCAY=[4.14](/hr), F=[0](mm),
00354>                    Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00355>                                         LGP=[35](m), MNP=[0.250], SCP=[0](min),
00356>                    Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00357>                                         LGI=[1000](m), MNI=[0.013], SCI=[0](min
00358>                    Continuous simulation parameters:
00359>                    IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00360>                    InterEventTime=[12](hrs),   END=-1
00361> *%-----------------|-------------------------------------------------------------|
00362> ADD HYD             IDsum=[1], NHYD=["perthst"], IDs to add=[5 7 8 9]
00363> *%-----------------|-------------------------------------------------------------|
00364> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00365>                    HYD_COMMENT=["perthst"]
00366> *%-----------------|-------------------------------------------------------------|
00367> CONTINUOUS NASHYD   ID=[2], NHYD=["VG-5"], DT=[15]min, AREA=[34.4](ha),
00368>                    DWF=[0](cms),  CN/C=[76], IA=[3.0](mm),
00369>                    N=[3], TP=[2.3]hrs,
00370>                    Continuous simulation parameters:
00371>                    IaRECper=[6](hrs),
00372>                    SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00373>                    InterEventTime=[12](hrs)
00374>                    Baseflow simulation parameters:
00375>                    BaseFlowOption=[1] ,
00376>                    InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00377>                    VHydCond=[1](mm/hr),   END=-1
00378> *%-----------------|-------------------------------------------------------------|
00379> ROUTE CHANNEL       IDout=[3], NHYD=["PerS"], IDin=[2],
00380>                    RDT=[15](min),
00381>                    CHLGTH=[550](m),  CHSLOPE=[0.2](%),
00382>                                      FPSLOPE=[0.2](%),
00383>                    SECNUM=[1.1],       NSEG=[3]
00384>                    ( SEGROUGH, SEGDIST (m))=[0.08,70 -0.035,72 0.08,77] NSEG ti
00385>                    ( DISTANCE (m), ELEVATION (m))=[0,  94.4]
00386>                                                   [70, 94.0]
00387>                                                   [71, 93.5]
00388>                                                   [72, 94.0]
00389>                                                   [77, 94.4]
00390> *%-----------------|-------------------------------------------------------------|
00391> ADD HYD             IDsum=[2], NHYD=["arbuck"], IDs to add=[1 3]
00392> *%-----------------|-------------------------------------------------------------|
00393> SAVE HYD            ID=[2],  # OF PCYCLES=[-1],  ICASEsh=[1]
00394>                    HYD_COMMENT=["arbuck"]
00395> *%-----------------|-------------------------------------------------------------|
00396> ROUTE CHANNEL       IDout=[9], NHYD=["VGR2-2"], IDin=[2],
00397>                    RDT=[15](min),
00398>                    CHLGTH=[520](m),    CHSLOPE=[0.15](%),
00399>                                        FPSLOPE=[0.15](%),
00400>                    SECNUM=[5.2],       NSEG=[3]
00401>                    ( SEGROUGH, SEGDIST (m))=[0.08,65.27 -0.035,72.03 0.08,317.3
00402>                    ( DISTANCE (m), ELEVATION (m))=
00403>                    [1.87  94
00404>                    3.26   93.815
00405>                    25.32  93.589
00406>                    40.32  93.586
00407>                    53.15  93.49
00408>                    65.27  92.99
00409>                    67.31  92.06
00410>                    69.39  91.93
00411>                    69.99  92.03
00412>                    70.75  92.68
00413>                    72.03  93
00414>                    78.14  93
00415>                    87.57  92.828
00416>                    98.82  93
00417>                    131.96 93.341
00418>                    152.55 93.318
00419>                    220.7  93.525
00420>                    262.64 93.983
00421>                    274.22 94
00422>                    286.88 94
00423>                    297.86 93.981
00424>                    314.39 94.09
00425>                    317.39, 95.09]
00426> *%-----------------|-------------------------------------------------------------|
```

```
00427> CONTINUOUS NASHYD   ID=[1], NHYD=["VG-6"], DT=[15]min, AREA=[94.2](ha),
00428>                     DWF=[0](cms),  CN/C=[77], IA=[2.9](mm),
00429>                     N=[3], TP=[3.2]hrs,
00430>                     Continuous simulation parameters:
00431>                     IaRECper=[6](hrs),
00432>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00433>                     InterEventTime=[12](hrs)
00434>                     Baseflow simulation parameters:
00435>                     BaseFlowOption=[1] ,
00436>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00437>                     VHydCond=[1](mm/hr),   END=-1
00438> *%-----------------|-------------------------------------------------------|
00439> ROUTE CHANNEL       IDout=[2], NHYD=["VG-6"], IDin=[1],
00440>                     RDT=[15](min),
00441>                     CHLGTH=[600](m),  CHSLOPE=[0.18](%),
00442>                                       FPSLOPE=[0.18](%),
00443>                     SECNUM=[2.1],       NSEG=[3]
00444>                     ( SEGROUGH, SEGDIST (m))=[0.08,700 -0.035,703 0.08,1000] NSE
00445>                     ( DISTANCE (m), ELEVATION (m))=[0,     94.6]
00446>                                                    [700,   94.5]
00447>                                                    [701.4, 94.1]
00448>                                                    [701.6, 94.1]
00449>                                                    [703,   94.5]
00450>                                                    [1000,  95.1]
00451> *%-----------------|-------------------------------------------------------|
00452> SAVE HYD            ID=[2],  # OF PCYCLES=[-1],  ICASEsh=[1]
00453>                     HYD_COMMENT=["VG-6"]
00454> *%-----------------|-------------------------------------------------------|
00455> CONTINUOUS NASHYD   ID=[3], NHYD=["VG-7"], DT=[15]min, AREA=[39.2](ha),
00456>                     DWF=[0](cms),  CN/C=[80], IA=[3.5](mm),
00457>                     N=[3], TP=[2.9]hrs,
00458>                     Continuous simulation parameters:
00459>                     IaRECper=[6](hrs),
00460>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00461>                     InterEventTime=[12](hrs)
00462>                     Baseflow simulation parameters:
00463>                     BaseFlowOption=[1] ,
00464>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00465>                     VHydCond=[1](mm/hr),   END=-1
00466> *%-----------------|-------------------------------------------------------|
00467> SAVE HYD            ID=[3],  # OF PCYCLES=[-1],  ICASEsh=[1]
00468>                     HYD_COMMENT=["VG-7"]
00469> *%-----------------|-------------------------------------------------------|
00470> ROUTE CHANNEL       IDout=[4], NHYD=["VG-7"], IDin=[3],
00471>                     RDT=[15](min),
00472>                     CHLGTH=[1480](m),  CHSLOPE=[0.2](%),
00473>                                        FPSLOPE=[0.2](%),
00474>                     SECNUM=[3.1],       NSEG=[3]
00475>                     ( SEGROUGH, SEGDIST (m))=[0.08,50 -0.035,52 0.08,102] NSEG t
00476>                     ( DISTANCE (m), ELEVATION (m))=[0,95.2]
00477>                                                    [50,95.0]
00478>                                                    [51,94.5]
00479>                                                    [52,95.0]
00480>                                                    [102,95.2]
00481> *%-----------------|-------------------------------------------------------|
00482> ADD HYD             IDsum=[5], NHYD=["Moore"], IDs to add=[2 4](maximum ten)
00483> *%-----------------|-------------------------------------------------------|
00484> SAVE HYD            ID=[5],  # OF PCYCLES=[-1],  ICASEsh=[1]
00485>                     HYD_COMMENT=["Moore"]
00486> *%-----------------|-------------------------------------------------------|
00487> *##############################################################################
00488> *# DUMMY SECTION
00489> *##############################################################################
00490> CONTINUOUS STANDHYD ID=[5], NHYD=["VG-8"], DT=[15](min), AREA=[10.0](ha),
00491>                     XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
00492>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00493>                             DCAY=[4.14](/hr), F=[0](mm),
00494>                     Pervious   surfaces: IAper=[2.6](mm), SLPP=[1.5](%),
00495>                                          LGP=[35](m), MNP=[0.250], SCP=[0](min),
00496>                     Impervious surfaces: IAimp=[2.6](mm), SLPI=[0.3](%),
00497>                                          LGI=[1000](m), MNI=[0.013], SCI=[0](min
00498>                     Continuous simulation parameters:
00499>                     IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00500>                     InterEventTime=[12](hrs),   END=-1
00501> *%-----------------|-------------------------------------------------------|
00502> CONTINUOUS NASHYD   ID=[5], NHYD=["VG-8"], DT=[15]min, AREA=[91.8](ha),
00503>                     DWF=[0](cms),  CN/C=[88], IA=[2.6](mm),
00504>                     N=[3], TP=[2.1]hrs,
00505>                     Continuous simulation parameters:
00506>                     IaRECper=[6](hrs),
00507>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00508>                     InterEventTime=[12](hrs)
00509>                     Baseflow simulation parameters:
00510>                     BaseFlowOption=[1] ,
00511>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00512>                     VHydCond=[1](mm/hr),   END=-1
00513> *%-----------------|-------------------------------------------------------|
00514> CONTINUOUS STANDHYD ID=[6], NHYD=["VG-9"], DT=[15](min), AREA=[11.4](ha),
00515>                     XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00516>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00517>                             DCAY=[4.14](/hr), F=[0](mm),
00518>                     Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00519>                                          LGP=[50](m), MNP=[0.250], SCP=[0](min),
00520>                     Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00521>                                          LGI=[530](m), MNI=[0.013], SCI=[0](min)
00522>                     Continuous simulation parameters:
00523>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00524>                     InterEventTime=[12](hrs),   END=-1
00525> *%-----------------|-------------------------------------------------------|
00526> ADD HYD             IDsum=[1], NHYD=["Fortune"], IDs to add=[2 4 5 6 9]
00527> *%-----------------|-------------------------------------------------------|
00528> SAVE HYD            ID=[1],  # OF PCYCLES=[-1],  ICASEsh=[1]
00529>                     HYD_COMMENT=["Fortune"]
00530> *%-----------------|-------------------------------------------------------|
00531> ROUTE CHANNEL       IDout=[3], NHYD=["VGR2-3"], IDin=[1],
00532>                     RDT=[15](min),
00533>                     CHLGTH=[750](m),    CHSLOPE=[0.2](%),
00534>                                         FPSLOPE=[0.2](%),
00535>                     SECNUM=[5.3],       NSEG=[3]
00536>                     ( SEGROUGH, SEGDIST (m))=[0.05,3.22 -0.035,47.84 0.05,77.80]
00537>                     ( DISTANCE (m), ELEVATION (m))=[0,           93.5
00538>                                                    3.22,  93
00539>                                                    20.87, 92.5
00540>                                                    42.19, 92
00541>                                                    47.84, 92
00542>                                                    48.60, 92.5
00543>                                                    50.14, 93
00544>                                                    72.67, 93.526
00545>                                                    77.80, 93.5]
00546> *%-----------------|-------------------------------------------------------|
00547> CONTINUOUS STANDHYD ID=[2], NHYD=["VG-10"], DT=[15](min), AREA=[20.3](ha),
00548>                     XIMP=[0.4], TIMP=[0.5], DWF=[0](cms), LOSS=[1],
00549>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00550>                             DCAY=[4.14](/hr), F=[0](mm),
00551>                     Pervious   surfaces: IAper=[1.5](mm), SLPP=[1.5](%),
00552>                                          LGP=[50](m), MNP=[0.250], SCP=[0](min),
00553>                     Impervious surfaces: IAimp=[0.8](mm), SLPI=[0.3](%),
00554>                                          LGI=[560](m), MNI=[0.013], SCI=[0](min)
00555>                     Continuous simulation parameters:
00556>                     IaRECper=[3](hrs),  IaRECimp=[2](hrs),
00557>                     InterEventTime=[12](hrs),   END=-1
00558> *%-----------------|-------------------------------------------------------|
00559> ADD HYD             IDsum=[9], NHYD=["JockVG"], IDs to add=[2 3]
00560> *%-----------------|-------------------------------------------------------|
00561> SAVE HYD            ID=[9],  # OF PCYCLES=[-1],  ICASEsh=[1]
00562>                     HYD_COMMENT=["Flow from Van Gaal Drain at Jock River"]
00563> *%-----------------|-------------------------------------------------------|
00564> *##############################################################################
00565> *# DUMMY SECTION
00566> *##############################################################################
00567> CONTINUOUS STANDHYD ID=[1], NHYD=["JR-2"], DT=[15](min), AREA=[10.0](ha),
00568>                     XIMP=[0.9999999], TIMP=[0.9999999], DWF=[0](cms), LOSS=[1],
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00569>                     Horton: Fo=[76.20](mm/hr), Fc=[13.20](mm/hr),
00570>                             DCAY=[4.14](/hr), F=[0](mm),
00571>                     Pervious   surfaces: IAper=[2.5](mm), SLPP=[1.5](%),
00572>                                          LGP=[35](m), MNP=[0.250], SCP=[0](min),
00573>                     Impervious surfaces: IAimp=[2.5](mm), SLPI=[0.3](%),
00574>                                          LGI=[1000](m), MNI=[0.013], SCI=[0](min
00575>                     Continuous simulation parameters:
00576>                     IaRECper=[6](hrs),  IaRECimp=[6](hrs),
00577>                     InterEventTime=[12](hrs),   END=-1
00578> *%-----------------|-----------------------------------------------------------|
00579> CONTINUOUS NASHYD   ID=[1], NHYD=["JR-2"], DT=[15]min, AREA=[4.96](ha),
00580>                     DWF=[0](cms),  CN/C=[88], IA=[2.5](mm),
00581>                     N=[3], TP=[0.8]hrs,
00582>                     Continuous simulation parameters:
00583>                     IaRECper=[6](hrs),
00584>                     SMIN=[-1](mm),  SMAX=[-1](mm), SK=[0.03]/(mm),
00585>                     InterEventTime=[12](hrs)
00586>                     Baseflow simulation parameters:
00587>                     BaseFlowOption=[1] ,
00588>                     InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm)
00589>                     VHydCond=[1](mm/hr),   END=-1
00590> *%-----------------|-----------------------------------------------------------|
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00592> START               TZERO=[1969.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[69]
00593> START               TZERO=[1970.0501],  METOUT=[2],  NSTORM=[0],  NRUN=[70]
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00628> FINISH
00629>
00630>
00631>
00632>
00633>
```

VG-3

Year	Total Precipitation (mm)	Infiltration (mm)			
		Existing Conditions	Proposed Conditions		
			XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
1967	320.00	102.44	84.54	120.59	131.80
1968	461.00	189.00	120.01	171.21	188.75
1969	321.80	107.95	71.64	97.20	105.63
1970	456.30	184.08	104.99	146.91	160.73
1971	434.80	180.56	107.51	153.42	168.93
1972	679.10	251.50	170.88	238.94	261.70
1973	550.10	215.04	147.59	200.63	217.91
1974	276.80	105.33	58.61	85.96	94.55
1975	429.50	170.51	105.84	146.43	159.20
1976	415.60	164.97	91.02	134.14	149.54
1977	473.30	199.04	121.43	170.75	187.19
1978	440.00	188.18	100.57	140.74	154.67
1979	593.20	228.06	163.94	225.33	244.62
1980	447.40	183.69	104.20	152.85	169.90
1981	759.60	264.06	202.02	277.78	301.73
1982	407.30	184.05	102.21	147.37	162.09
1983	466.20	179.53	109.23	161.37	178.96
1984	349.30	141.51	92.16	133.02	145.74
1985	438.40	199.63	118.66	165.81	181.52
1986	759.20	277.13	198.01	286.29	316.06
1987	494.70	183.03	108.71	157.52	173.79
1988	468.00	183.31	111.30	152.89	165.72
1989	438.60	174.34	106.19	147.99	162.87
1990	538.40	204.53	136.85	191.96	210.22
1991	351.80	143.86	66.61	102.53	115.57
1992	529.60	202.43	120.20	171.02	188.35
1993	484.70	210.11	107.82	158.21	176.77
1994	450.90	174.42	117.99	166.79	181.48
1995	189.20	52.49	52.86	70.89	76.13
1996	354.30	141.50	85.22	124.71	137.88
1997	289.20	130.33	71.56	105.08	116.56
1998	429.60	177.20	101.10	147.53	162.76
1999	424.40	190.84	107.78	157.73	173.78
2000	506.30	187.61	123.79	175.37	193.40

VG-8

Year	Total Precipitation (mm)	Infiltration (mm)			
		Existing Conditions	Proposed Conditions		
			XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
1967	320.00	100.96	85.90	124.90	137.63
1968	461.00	186.67	121.98	176.81	195.44
1969	321.80	105.65	65.79	96.14	106.11
1970	456.30	181.50	101.45	148.50	164.22
1971	434.80	177.97	102.63	153.09	170.27
1972	679.10	248.37	171.81	245.80	270.50
1973	550.10	212.95	147.48	205.96	225.30
1974	276.80	103.38	53.01	83.83	93.66
1975	429.50	168.40	106.03	151.80	165.83
1976	415.60	162.01	84.20	131.34	147.93
1977	473.30	196.62	119.48	173.58	191.51
1978	440.00	185.04	89.66	135.47	151.57
1979	593.20	225.85	167.54	234.72	256.47
1980	447.40	180.82	96.08	149.50	168.07
1981	759.60	261.37	205.80	290.42	317.16
1982	407.30	181.16	93.55	144.09	160.90
1983	466.20	176.72	102.71	159.47	178.92
1984	349.30	140.11	91.78	136.34	150.93
1985	438.40	197.19	112.55	165.23	182.86
1986	759.20	273.56	197.27	291.98	323.97
1987	494.70	179.56	102.32	156.39	174.41
1988	468.00	180.21	105.44	153.16	168.20
1989	438.60	171.01	99.46	146.66	163.07
1990	538.40	201.43	134.71	195.39	215.57
1991	351.80	140.34	55.24	95.46	109.90
1992	529.60	199.27	119.78	174.83	193.68
1993	484.70	205.80	94.76	150.98	171.24
1994	450.90	171.87	114.20	169.15	186.51
1995	189.20	51.71	55.14	74.71	80.49
1996	354.30	139.12	78.59	122.55	137.34
1997	289.20	128.65	67.19	103.74	116.26
1998	429.60	174.58	93.93	145.30	163.04
1999	424.40	188.67	104.58	159.02	176.70
2000	506.30	185.06	115.15	172.10	191.94

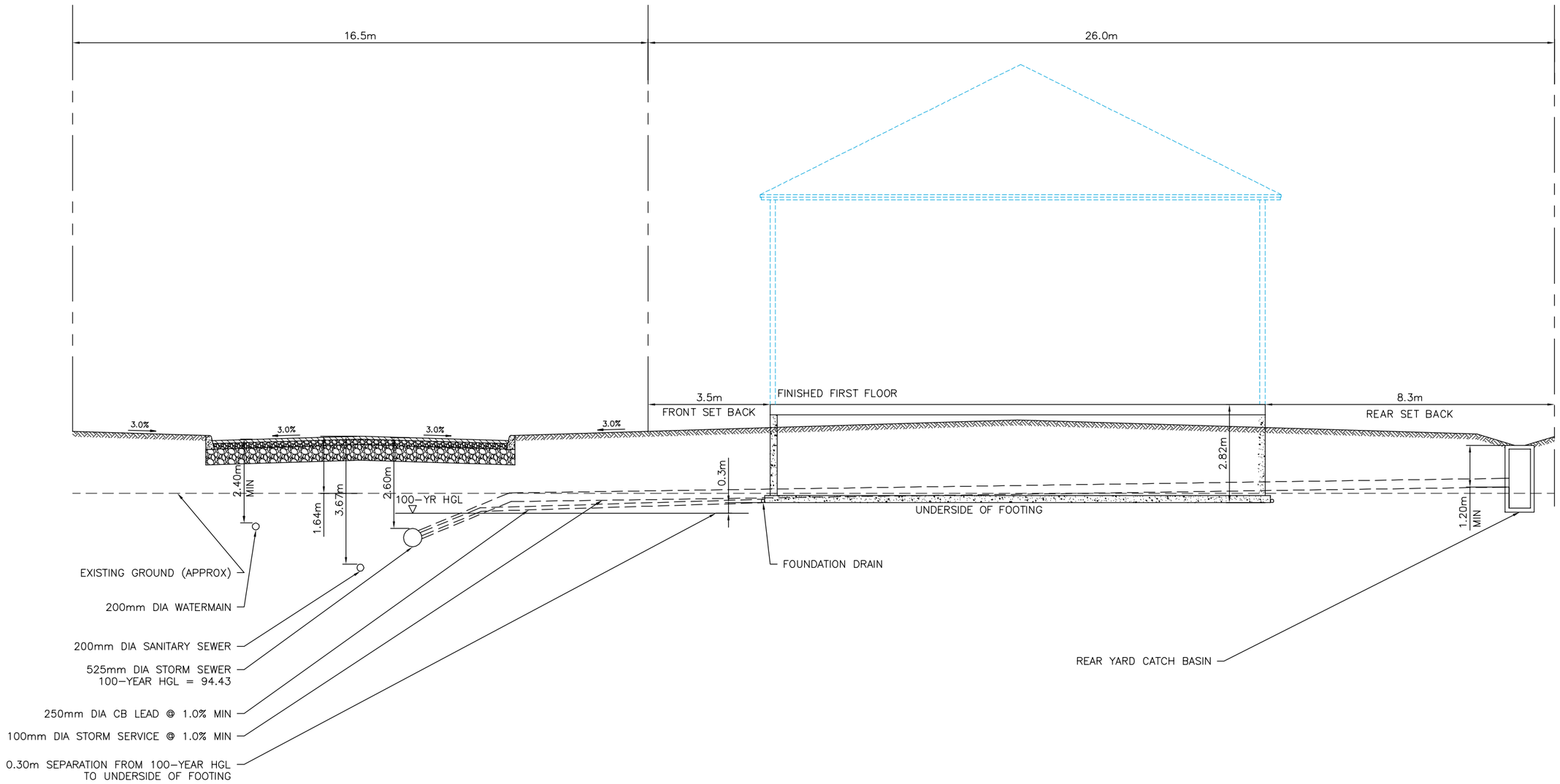
JR-2

Year	Total Precipitation (mm)	Infiltration (mm)			
		Existing Conditions	Proposed Conditions		
			XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
1967	320.00	102.44	81.76	120.71	133.47
1968	461.00	189.00	116.11	170.99	189.65
1969	321.80	107.95	62.62	92.95	102.84
1970	456.30	184.08	96.57	143.66	159.41
1971	434.80	180.56	97.70	148.20	165.36
1972	679.10	251.50	163.55	237.56	262.26
1973	550.10	215.04	140.38	198.87	218.15
1974	276.80	105.33	50.46	81.24	91.05
1975	429.50	170.51	100.93	146.53	160.57
1976	415.60	164.97	80.15	127.41	144.09
1977	473.30	199.04	113.74	167.84	185.70
1978	440.00	188.19	85.34	131.29	147.31
1979	593.20	228.06	159.48	226.62	248.24
1980	447.40	183.69	91.45	144.95	163.58
1981	759.60	264.06	195.89	280.26	307.04
1982	407.30	184.05	89.05	139.60	156.33
1983	466.20	179.53	97.77	154.60	174.10
1984	349.30	141.51	87.36	131.91	146.47
1985	438.40	199.63	107.14	159.81	177.44
1986	759.20	277.13	187.78	282.54	314.59
1987	494.70	183.03	97.40	151.47	169.53
1988	468.00	183.31	100.36	148.00	162.99
1989	438.60	174.34	94.67	141.94	158.49
1990	538.40	204.53	128.23	188.85	209.06
1991	351.80	143.86	52.58	92.93	107.42
1992	529.60	202.43	114.02	169.09	188.00
1993	484.70	210.11	90.20	146.59	166.99
1994	450.90	174.42	108.70	163.59	180.67
1995	189.20	52.49	52.49	71.97	77.73
1996	354.30	141.50	74.81	118.83	133.52
1997	289.20	130.33	63.96	100.56	113.08
1998	429.60	177.20	89.41	140.87	158.55
1999	424.40	190.84	99.55	153.92	171.61
2000	506.30	187.61	109.61	166.67	186.54

Subcatchment ID	Average Infiltration Rate (Existing Conditions) (mm/yr)	Average Infiltration Rate (Proposed Conditions) (mm/yr)		
		XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
VG-3	178.60	111.56	158.44	174.01
VG-8	175.99	107.56	159.36	176.69
JR-2	178.60	102.39	154.20	171.52

Subcatchment ID	Average % Decrease in Infiltration (Proposed Conditions)		
	XIMP=TIMP	XIMP=TIMP-0.15	XIMP=TIMP-0.20
VG-3	37.54	11.29	2.57
VG-8	39.77	10.77	1.07
JR-2	42.67	13.66	3.96

FIGURES



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FOUNDATION SERVICE TO STREET STORM SEWER

DATE:	APRIL 2012
SCALE:	1:125
PROJECT No.:	11-467
FIGURE	5

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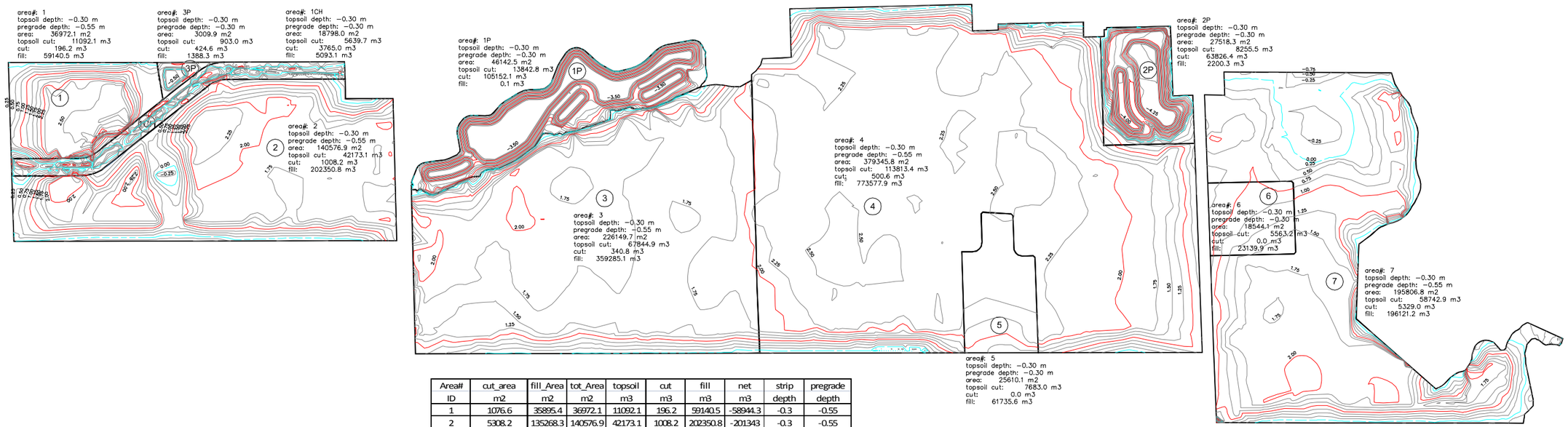

Area# ID	cut_area m2	fill_Area m2	tot_Area m2	topsoil m3	cut m3	fill m3	net m3	strip depth	pregrade depth
1	1076.6	35895.4	36972.1	11092.1	196.2	59140.5	-58944.3	-0.3	-0.55
2	5308.2	135268.3	140576.9	42173.1	1008.2	202350.8	-201343	-0.3	-0.55
3	1872.5	224277.2	226149.7	67844.9	340.8	359285.1	-358944	-0.3	-0.55
4	3703.4	375640.3	379345.8	113813.4	500.6	773577.9	-773077	-0.3	-0.55
5	0	25610.1	25610.1	7683	0	61735.6	-61735.6	-0.3	-0.3
6	0	18544.1	18544.1	5563.2	0	23139.9	-23139.9	-0.3	-0.3
7	27400.2	168257.2	195806.8	58742.9	5329	196121.2	-190792	-0.3	-0.55
1CH	8467.6	10329	18798	5639.7	3765	5093.1	-1328.1	-0.3	-0.3
1P	46098.2	7.4	46142.5	13842.8	105152.1	0.1	105152	-0.3	-0.3
2P	23694.9	3795.4	27518.3	8255.5	63826.4	2200.3	61626.1	-0.3	-0.3
3P	901.2	2108.6	3009.9	903	424.6	1388.3	-963.7	-0.3	-0.3
totals:			1118474	335553.6	180542.9	1684033	-1503490		

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VILLAGE OF RICHMOND

CUT & FILL OPTION 1

FOUNDATION SERVICE TO STORM SEWER

CITY OF OTTAWA

LEGEND

2.25 / 2.00 CUT/FILL CONTOUR

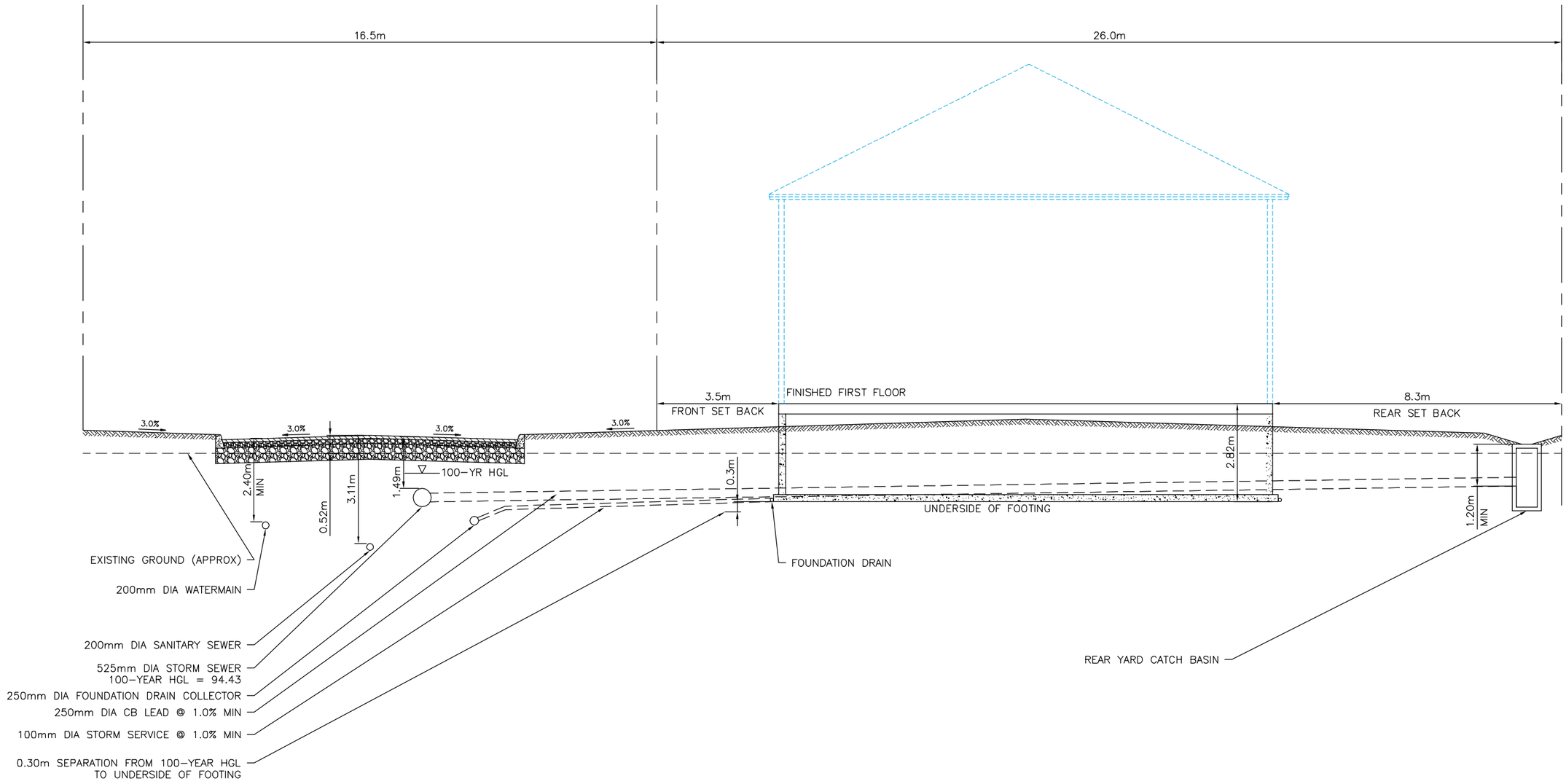
PROJECT No.: 11-468

DATE: APRIL 2012

DRAWN BY: KM / ADF

SCALE: 1:7,500

FIGURE: 6



z:\projects\11-468 caivan - richmond\b_design\b2_drawings\b2-2_main (dsel)\swm_alternatives\2012-04-20_swm_alternatives.dwg

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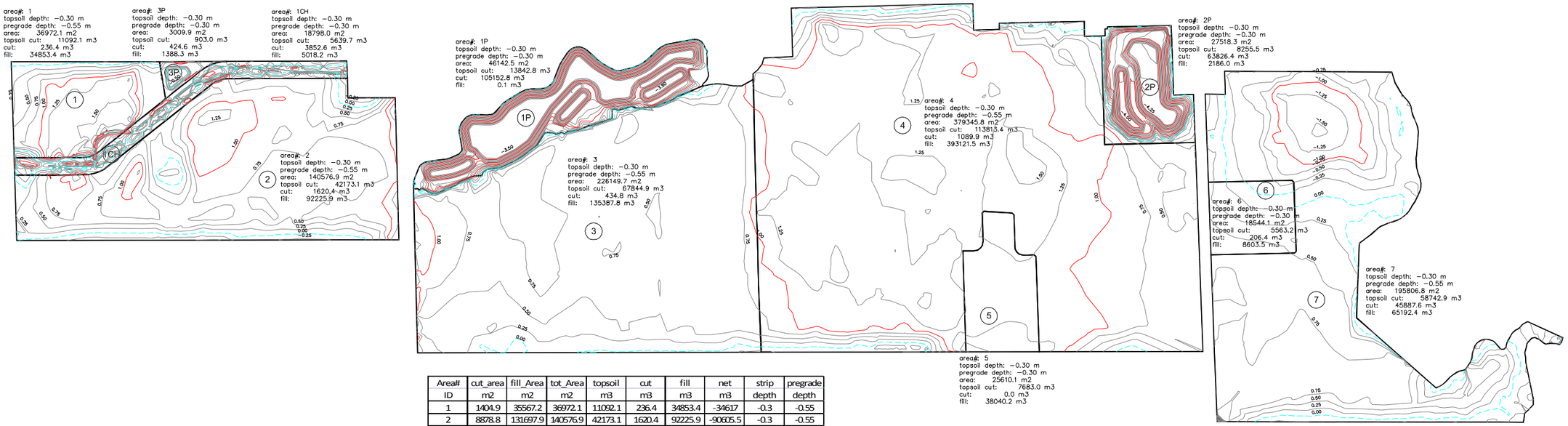
FOUNDATION SERVICE TO FOUNDATION COLLECTOR

DATE:	APRIL 2012
SCALE:	1:125
PROJECT No.:	11-467
FIGURE	7



Area# ID	cut_area m2	fill_Area m2	tot_Area m2	topsoil m3	cut m3	fill m3	net m3	strip depth	pregrade depth
1	1404.9	35567.2	36972.1	11092.1	236.4	34853.4	-34617	-0.3	-0.55
2	8878.8	131697.9	140576.9	42173.1	1620.4	92225.9	-90605.5	-0.3	-0.55
3	3044.3	223105.4	226149.7	67844.9	434.8	135387.8	-134953	-0.3	-0.55
4	7105.4	372240.2	379345.8	113813.4	1089.9	393121.5	-392032	-0.3	-0.55
5	0	25610.1	25610.1	7683	0	38040.2	-38040.2	-0.3	-0.3
6	1660.9	16875.4	18544.1	5563.2	206.4	8603.5	-8397.1	-0.3	-0.3
7	84034	111699.6	195806.8	58742.9	45887.6	65192.4	-19304.8	-0.3	-0.55
1CH	8515.7	10280.4	18798	5639.7	3852.6	5018.2	-1165.6	-0.3	-0.3
1P	46102.8	5.9	46142.5	13842.8	105152.8	0.1	105152.7	-0.3	-0.3
2P	23694.9	3795.4	27518.3	8255.5	63826.4	2186	61640.4	-0.3	-0.3
3P	901.2	2108.6	3009.9	903	424.6	1388.3	-963.7	-0.3	-0.3
totals:			1118474	335553.6	222731.9	776017.3	-553285		

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VILLAGE OF RICHMOND

CUT & FILL OPTION 2

FOUNDATION SERVICE TO FOUNDATION COLLECTOR

CITY OF OTTAWA

LEGEND

2.25 / 2.00 CUT/FILL CONTOUR

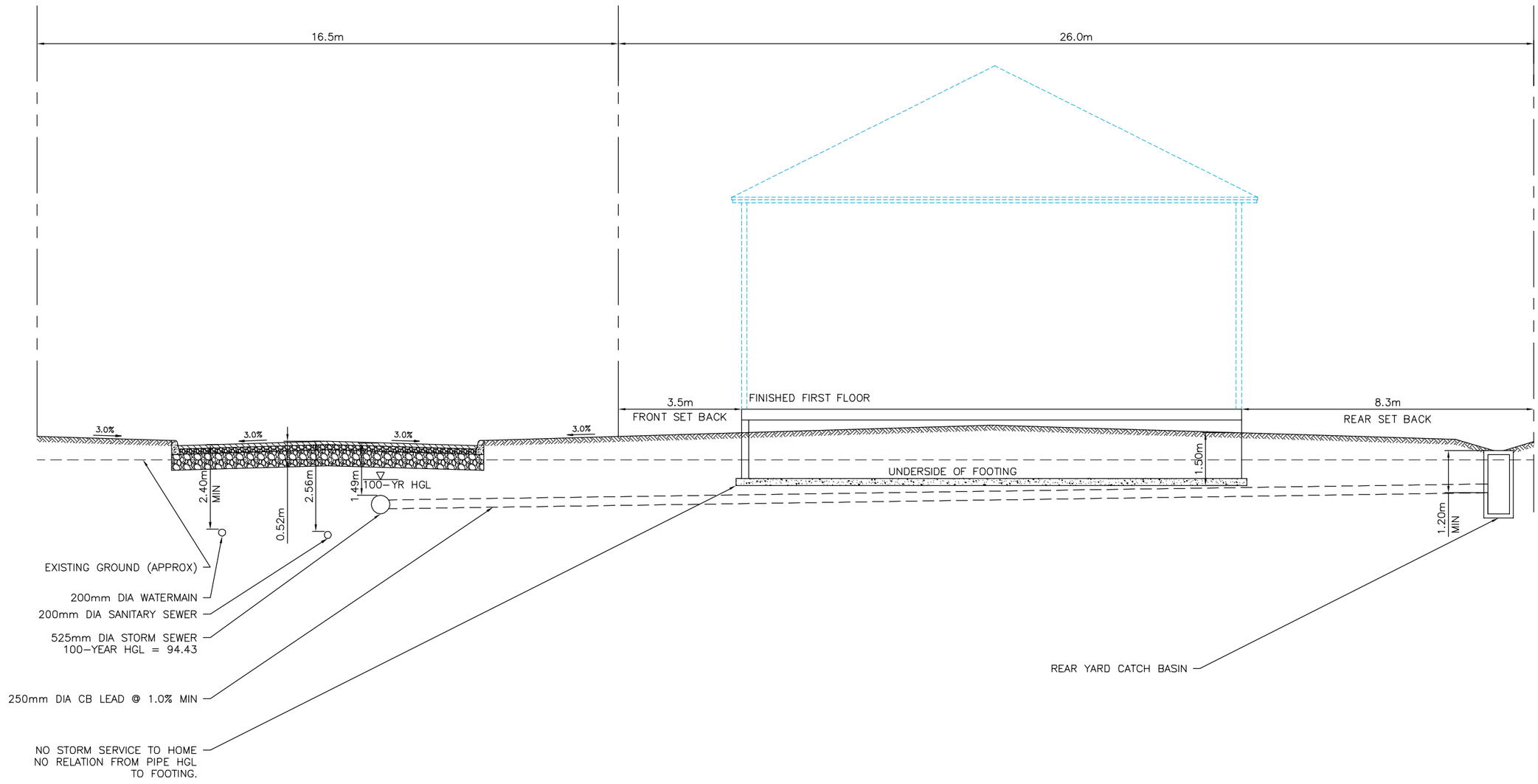
PROJECT No.: 11-468

DATE: APRIL 2012

DRAWN BY: KM / ADF

SCALE: 1:7,500

FIGURE: 8



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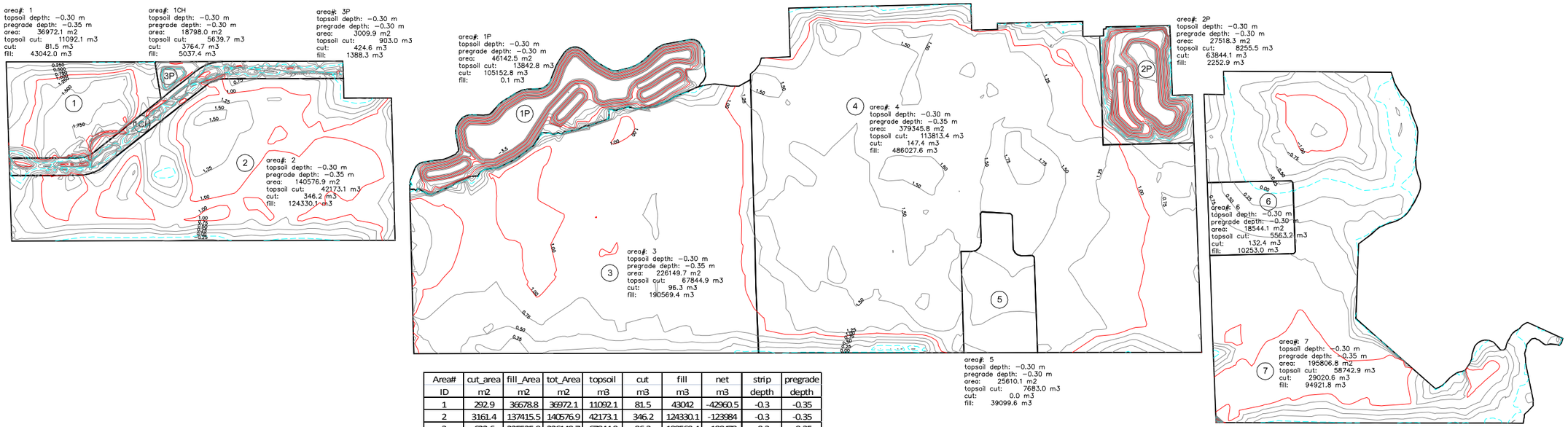
NO FOUNDATION SERVICE - SLAB ON GRADE UNITS

DATE:	APRIL 2012
SCALE:	1:125
PROJECT No.:	11-467
FIGURE	9

z:\projects\11-468 caivan - richmond\b_design\b2_drawings\b2-2_main (dsel)\swm_alternatives\2012-04-20_swm_alternatives.dwg



Area# ID	cut_area m2	fill_Area m2	tot_Area m2	topsoil m3	cut m3	fill m3	net m3	strip depth	pregrade depth
1	292.9	36678.8	36972.1	11092.1	81.5	43042	-42960.5	-0.3	-0.35
2	3161.4	137415.5	140576.9	42173.1	346.2	124330.1	-123984	-0.3	-0.35
3	622.6	225525.9	226149.7	67844.9	96.3	190569.4	-190473	-0.3	-0.35
4	1633.7	377708.6	379345.8	113813.4	147.4	486027.6	-485880	-0.3	-0.35
5	0	25610.1	25610.1	7683	0	39099.6	-39099.6	-0.3	-0.3
6	1344.2	17199.9	18544.1	5563.2	132.4	10253	-10120.6	-0.3	-0.3
7	57077.9	138648	195806.8	58742.9	29020.6	94921.8	-65901.2	-0.3	-0.35
1CH	8467	10329.7	18798	5639.7	3764.7	5037.4	-1272.7	-0.3	-0.3
1P	46102.8	5.9	46142.5	13842.8	105152.8	0.1	105152.7	-0.3	-0.3
2P	23644	3846.3	27518.3	8255.5	63844.1	2252.9	61591.2	-0.3	-0.3
3P	901.2	2108.6	3009.9	903	424.6	1388.3	-963.7	-0.3	-0.3
totals:			1118474	335553.6	203010.6	996922.2	-793912		

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VILLAGE OF RICHMOND

CUT & FILL OPTION 3

SLAB ON GRADE UNITS

CITY OF OTTAWA

LEGEND

2.25 / 2.00 CUT/FILL CONTOUR

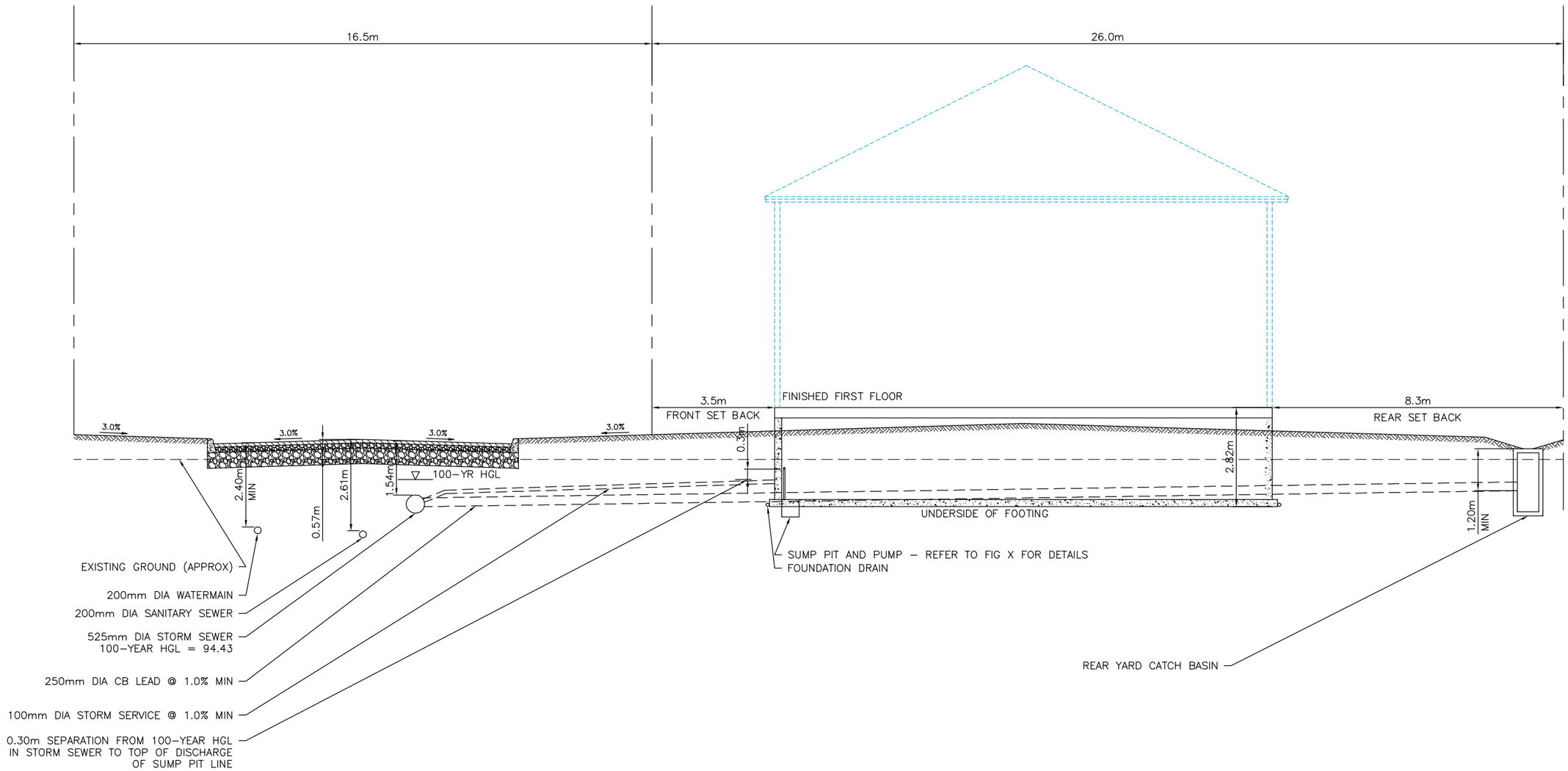
PROJECT No.: 11-468

DATE: APRIL 2012

DRAWN BY: KM / ADF

SCALE: 1:7,500

FIGURE: 10



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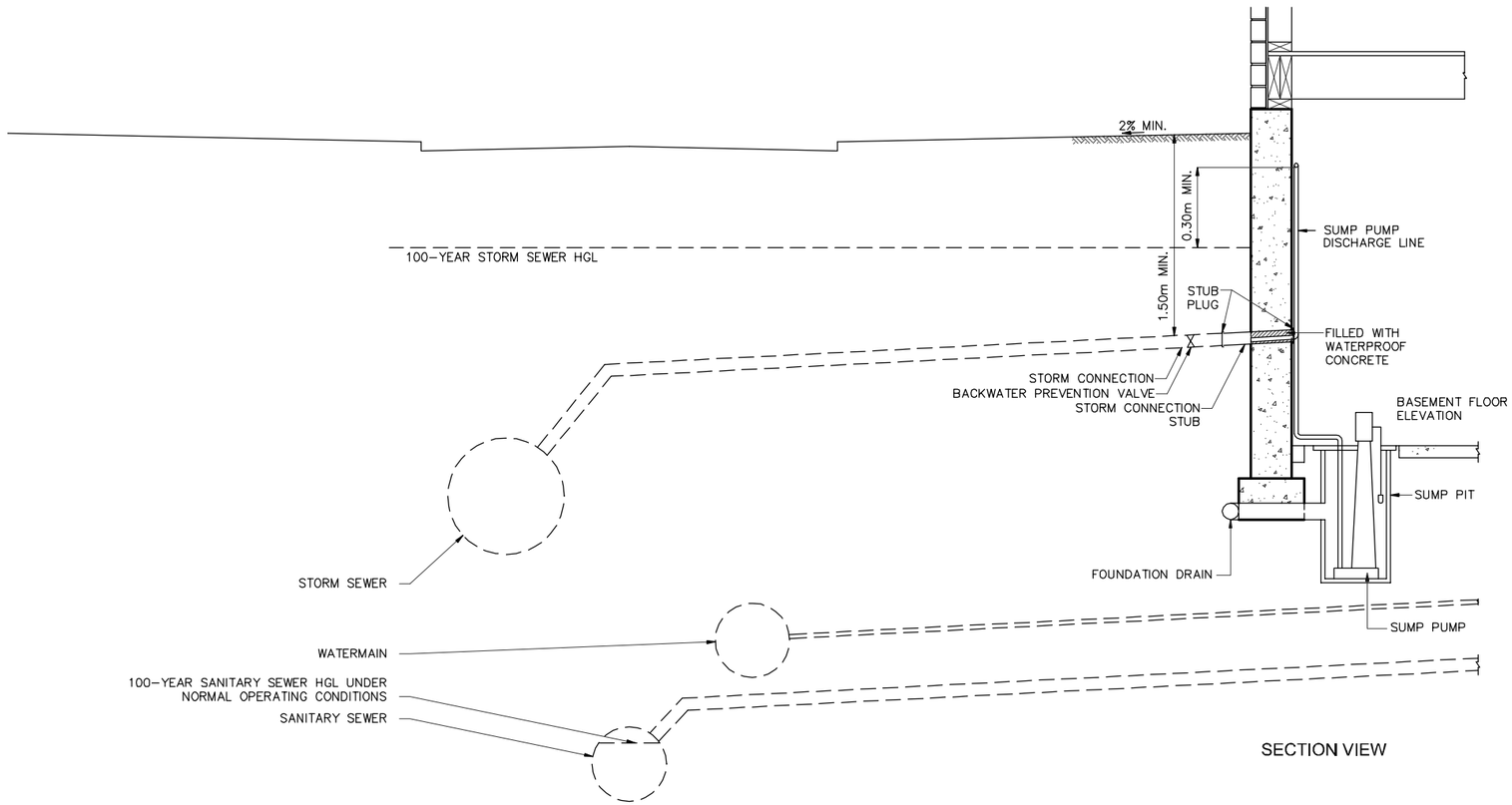
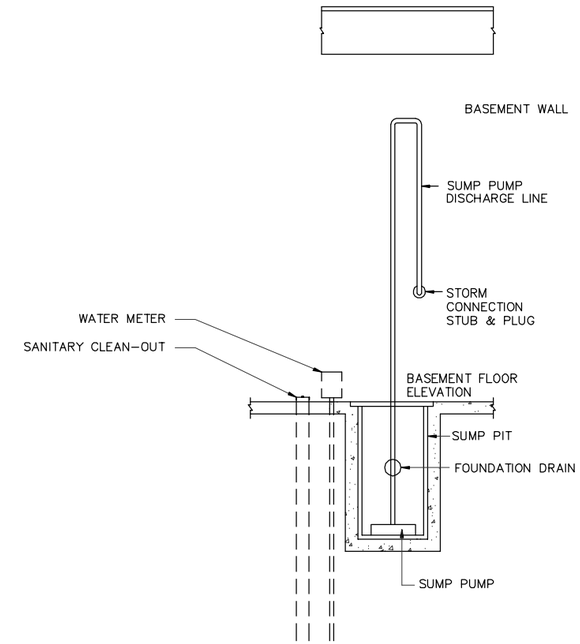
FOUNDATION SERVICE TO STORM SEWER - SUMP PUMP

DATE:	APRIL 2012
SCALE:	1:125
PROJECT No.:	11-467
FIGURE	11

z:\projects\11-468 caivan - richmond\b_design\b2_drawings\b2-2_main (dsel)\swm_alternatives\2012-04-20_swm_alternatives.dwg



SECTION VIEW



FRONT VIEW

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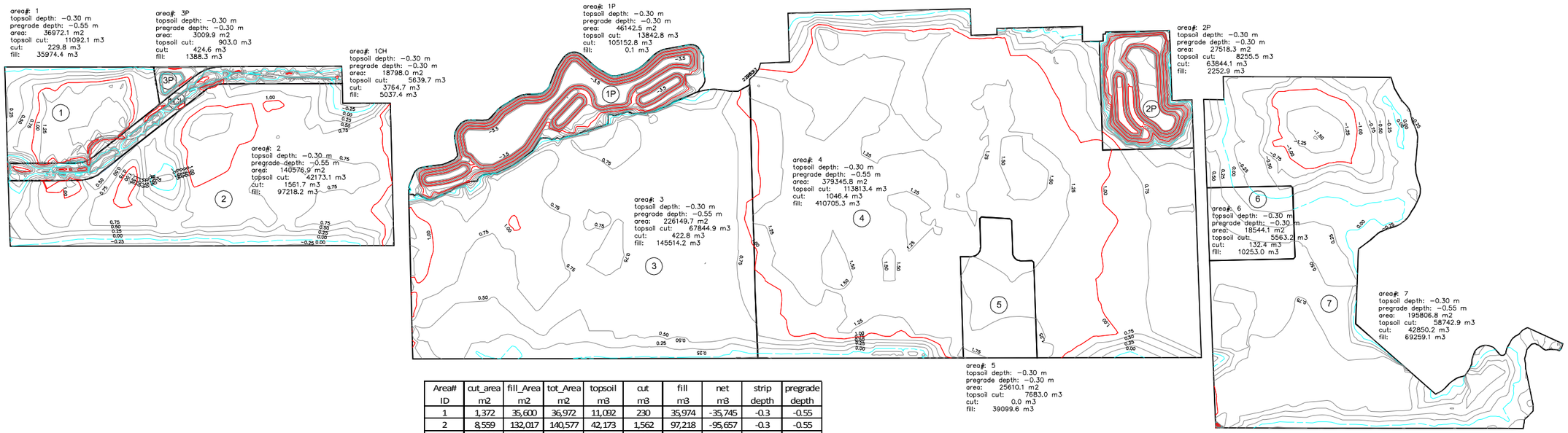
SUMP PUMP - DETAIL

DATE:	APRIL 2012
SCALE:	N.T.S.
PROJECT No.:	11-467
FIGURE	12

z:\projects\11-468 caivan - richmond\b_design\b2_drawings\b2-2_main (dsel)\swm_alternatives\sump-pump_detail.dwg



Area# ID	cut_area m2	fill_Area m2	tot_Area m2	topsoil m3	cut m3	fill m3	net m3	strip depth	pregrade depth
1	1,372	35,600	36,972	11,092	230	35,974	-35,745	-0.3	-0.55
2	8,559	132,017	140,577	42,173	1,562	97,218	-95,657	-0.3	-0.55
3	2,766	223,384	226,150	67,845	423	145,514	-145,091	-0.3	-0.55
4	6,860	372,486	379,346	113,813	1,046	410,705	-409,659	-0.3	-0.55
5	0	25,610	25,610	7,683	0	39,100	-39,100	-0.3	-0.3
6	1,344	17,200	18,544	5,563	132	10,253	-10,121	-0.3	-0.3
7	79,277	116,529	195,807	58,743	42,850	69,259	-26,409	-0.3	-0.55
1CH	8,467	10,330	18,798	5,640	3,765	5,037	-1,273	-0.3	-0.3
1P	46,103	6	46,143	13,843	105,153	0	105,153	-0.3	-0.3
2P	23,644	3,846	27,518	8,256	63,844	2,253	61,591	-0.3	-0.3
3P	901	2,109	3,010	903	425	1,388	-964	-0.3	-0.3
totals:			1,118,474	335,554	219,430	816,703	-597,273		

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VILLAGE OF RICHMOND

CUT & FILL OPTION 4

FOUNDATION DRAINAGE - SUMP PUMPS

CITY OF OTTAWA

LEGEND

2.25 / 2.00 CUT/FILL CONTOUR

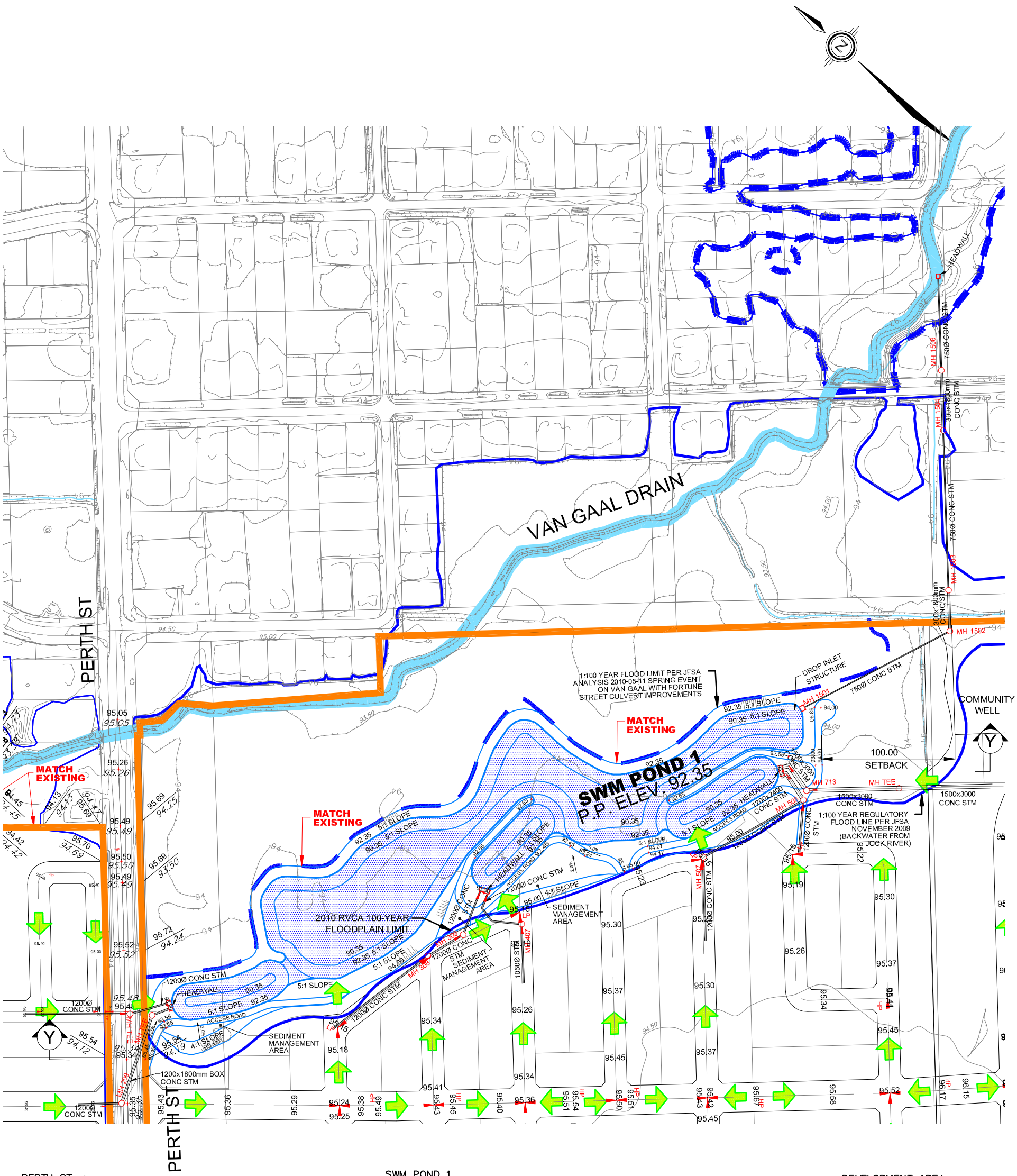
PROJECT No.: 11-468

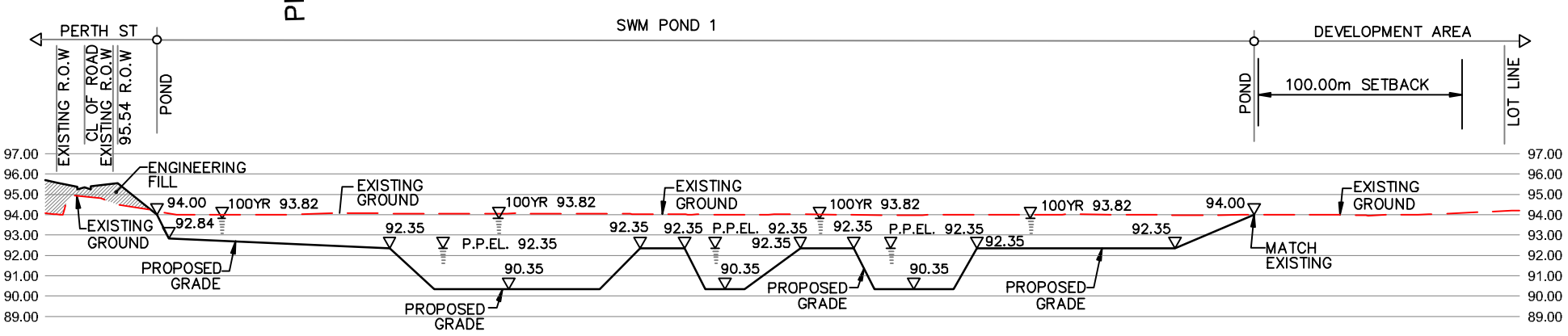
DATE: APRIL 2012

DRAWN BY: KM / ADF

SCALE: 1:7,500

FIGURE: 13





SWM POND 1
SECTION Y-Y
SCALE HOR. 1:3000
VER. 1:300

LEGEND

- STUDY LIMIT
- REGULATORY FLOOD LINE
- OVERLAND FLOW DIRECTION
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR

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VILLAGE OF RICHMOND

SWM POND 1

CITY OF OTTAWA

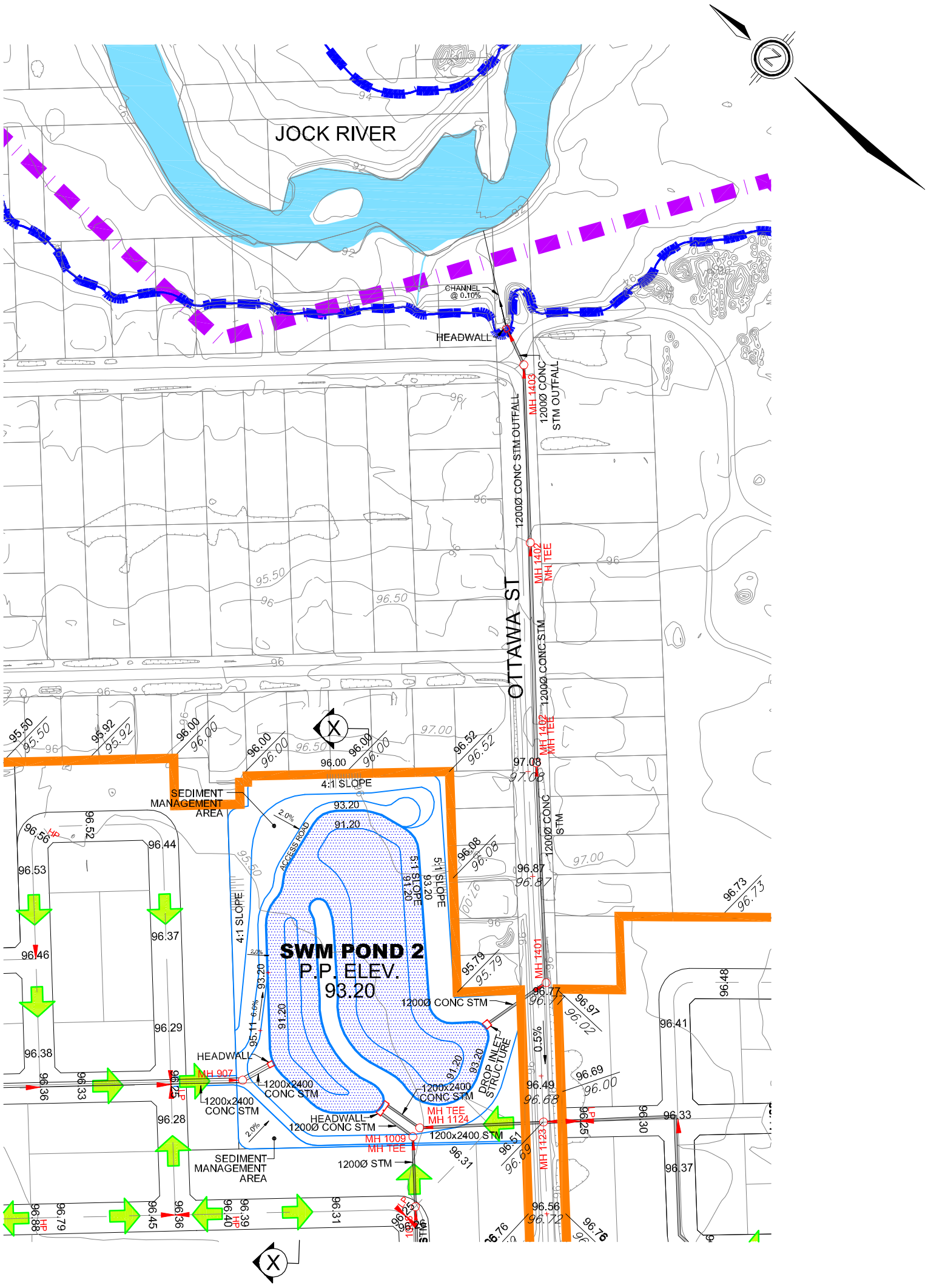
PROJECT No.: 11-468

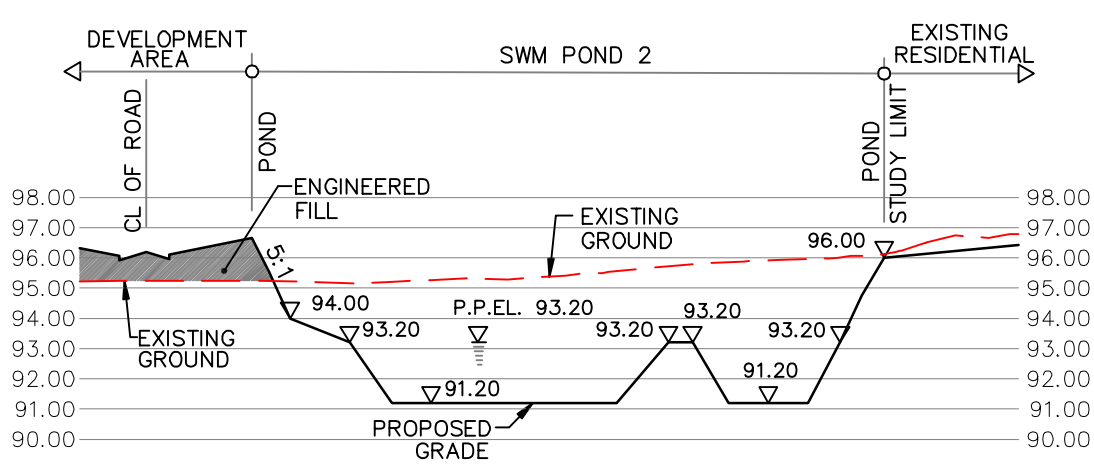
DATE: APRIL 2012

DRAWN BY: KM / ADF

SCALE: 1:3000

FIGURE: 14





SWM POND
SECTION X-X
SCALE HOR. 1:2500
VER. 1:250

LEGEND

- STUDY LIMIT
- REGULATORY FLOOD LINE
- OVERLAND FLOW DIRECTION
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR (95.00)

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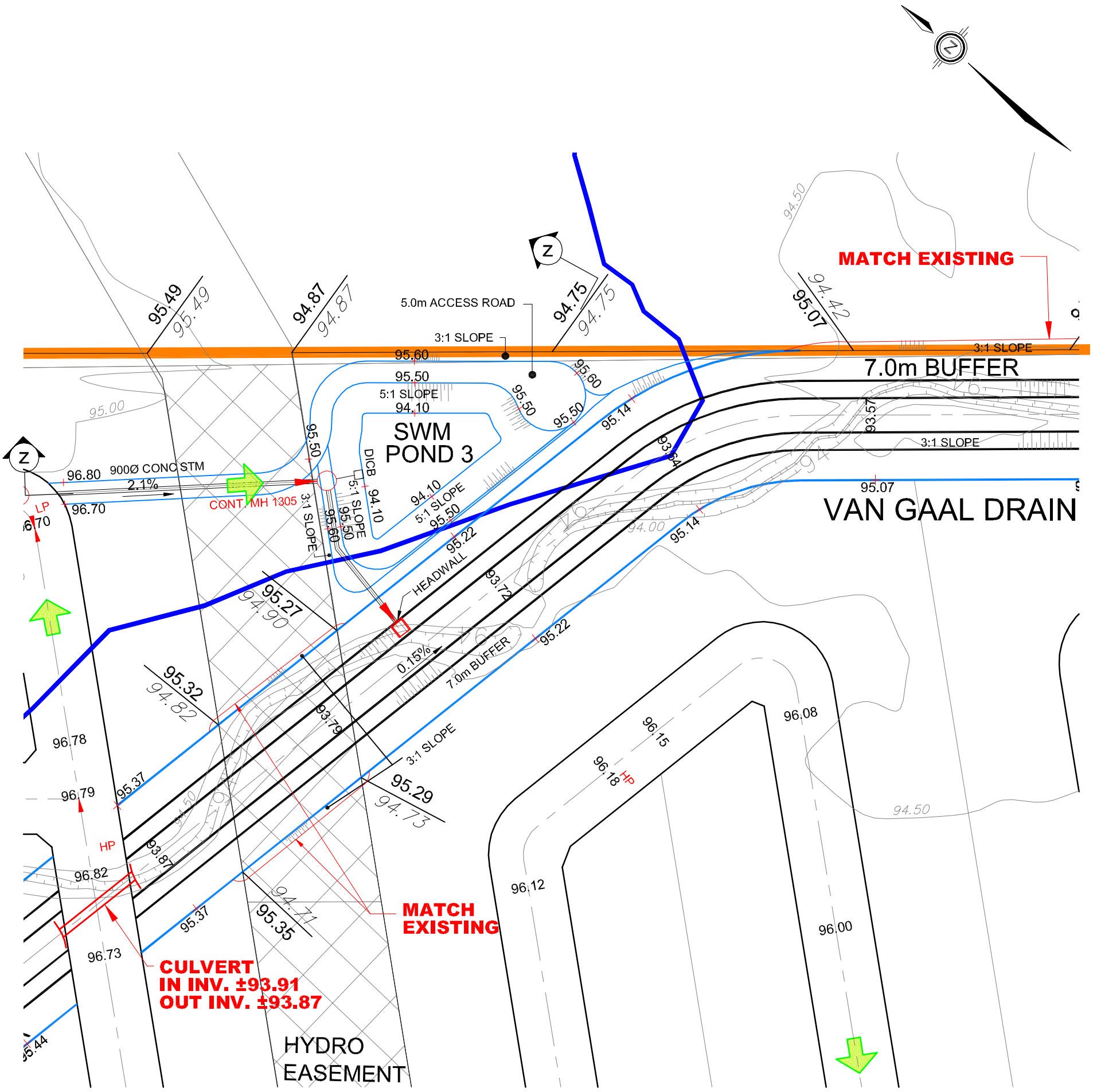
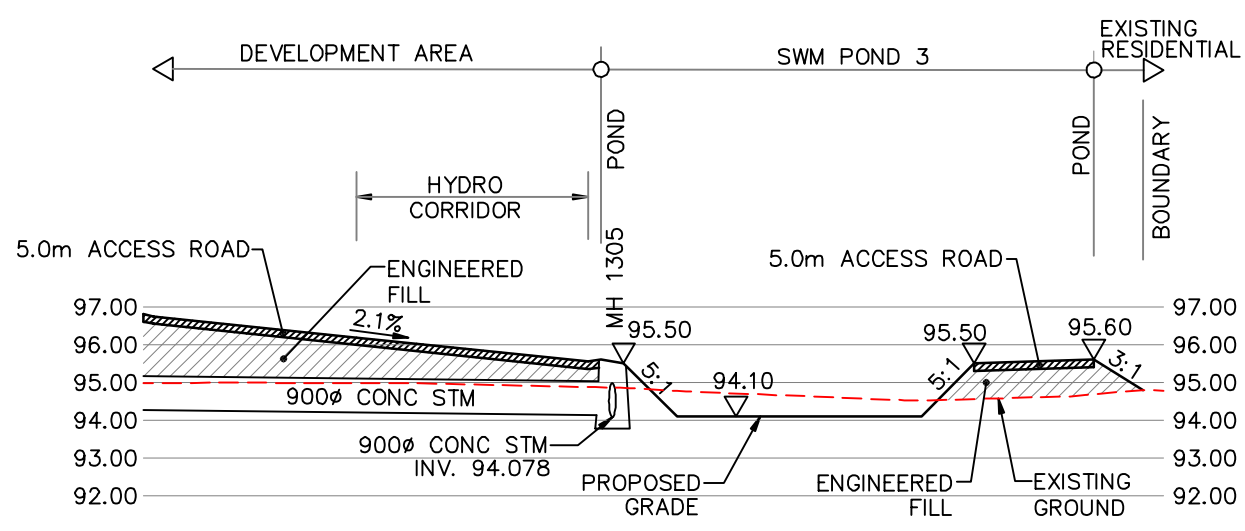
VILLAGE OF RICHMOND

SWM POND 2

CITY OF OTTAWA

PROJECT No.: 11-468
DATE: APRIL 2012
DRAWN BY: KM / ADF
SCALE: 1:2500
FIGURE: 15





SWM POND
SECTION Z-Z
SCALE HOR. 1:1000
VER. 1:200

LEGEND

- STUDY LIMIT
- REGULATORY FLOOD LINE
- OVERLAND FLOW DIRECTION
- EXISTING DITCH
- 95.00 EXISTING ELEVATION CONTOUR

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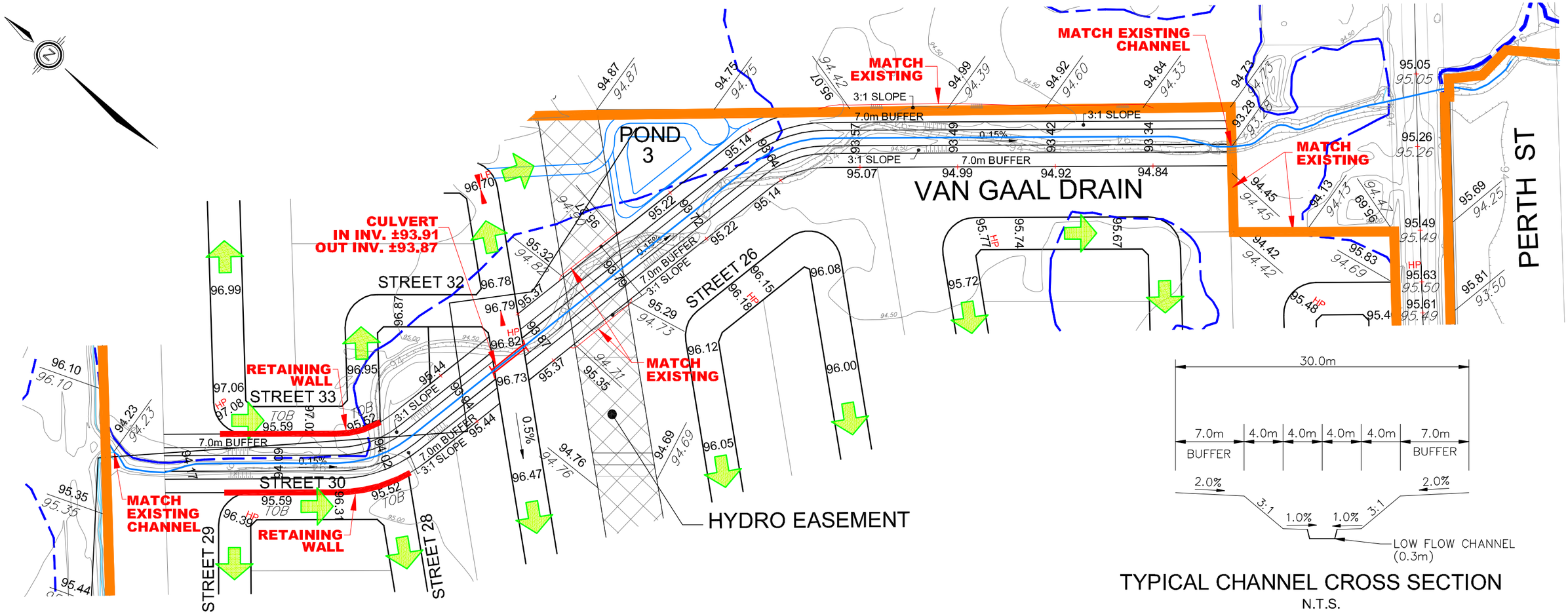
VILLAGE OF RICHMOND

SWM POND 3

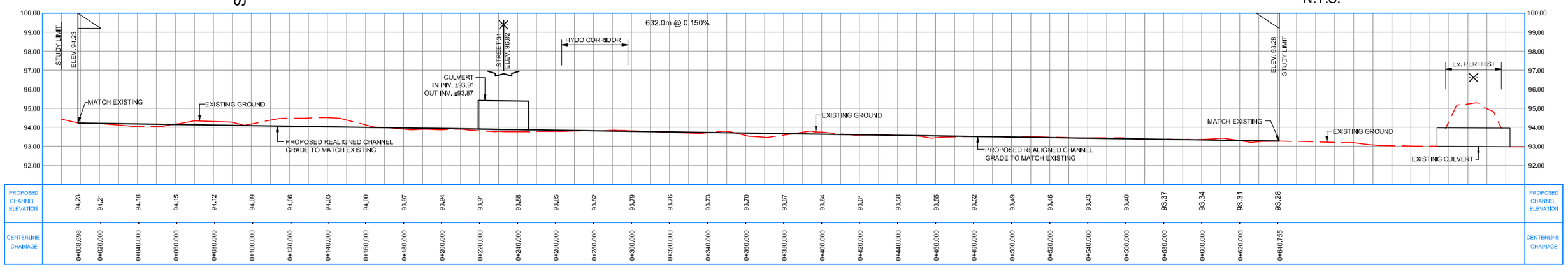
CITY OF OTTAWA

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:1000
FIGURE:	16



TYPICAL CHANNEL CROSS SECTION

N.T.S.



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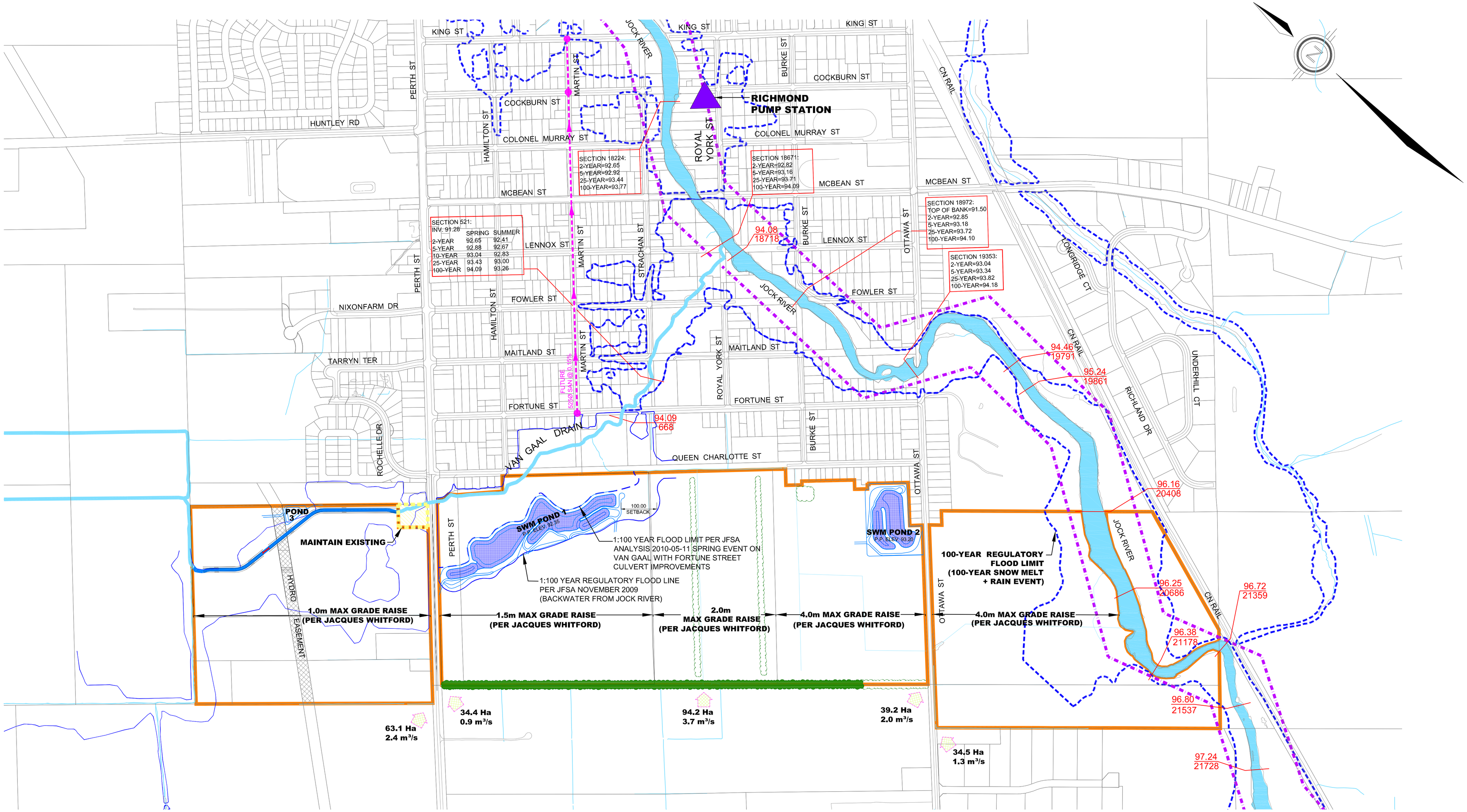
VILLAGE OF RICHMOND
VAN GAIL DRAIN
PLAN PROFILE
CITY OF OTTAWA

LEGEND

- STUDY LIMIT
- REGULATORY FLOOD LINE
- OVERLAND FLOW DIRECTION
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:2000
FIGURE:	17

DRAWINGS



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VILLAGE OF RICHMOND

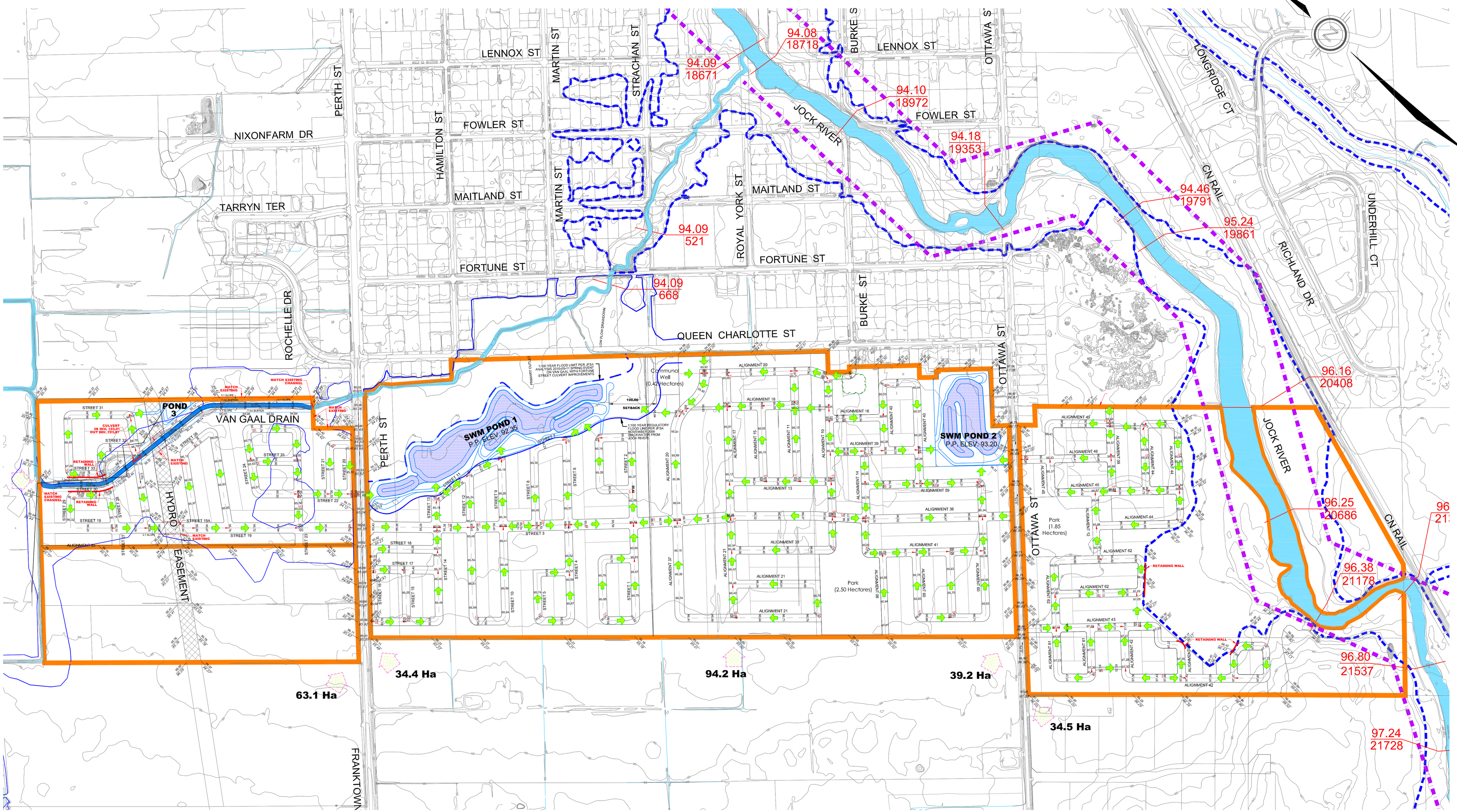
CONSTRAINTS PLAN

CITY OF OTTAWA

LEGEND

- STUDY LIMIT
- REGULATORY FLOOD LINE
- MEANDER BELT
- EXISTING DITCH
- 96.80 / 21537 — FLOOD LINE ELEVATION / FLOOD LINE SECTION
- 95.00 — EXISTING ELEVATION CONTOUR
- PROTECT EXISTING HEDGE
- EXTERNAL OVERLAND FLOW DIRECTION

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:5000
DRAWING:	1



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VILLAGE OF RICHMOND

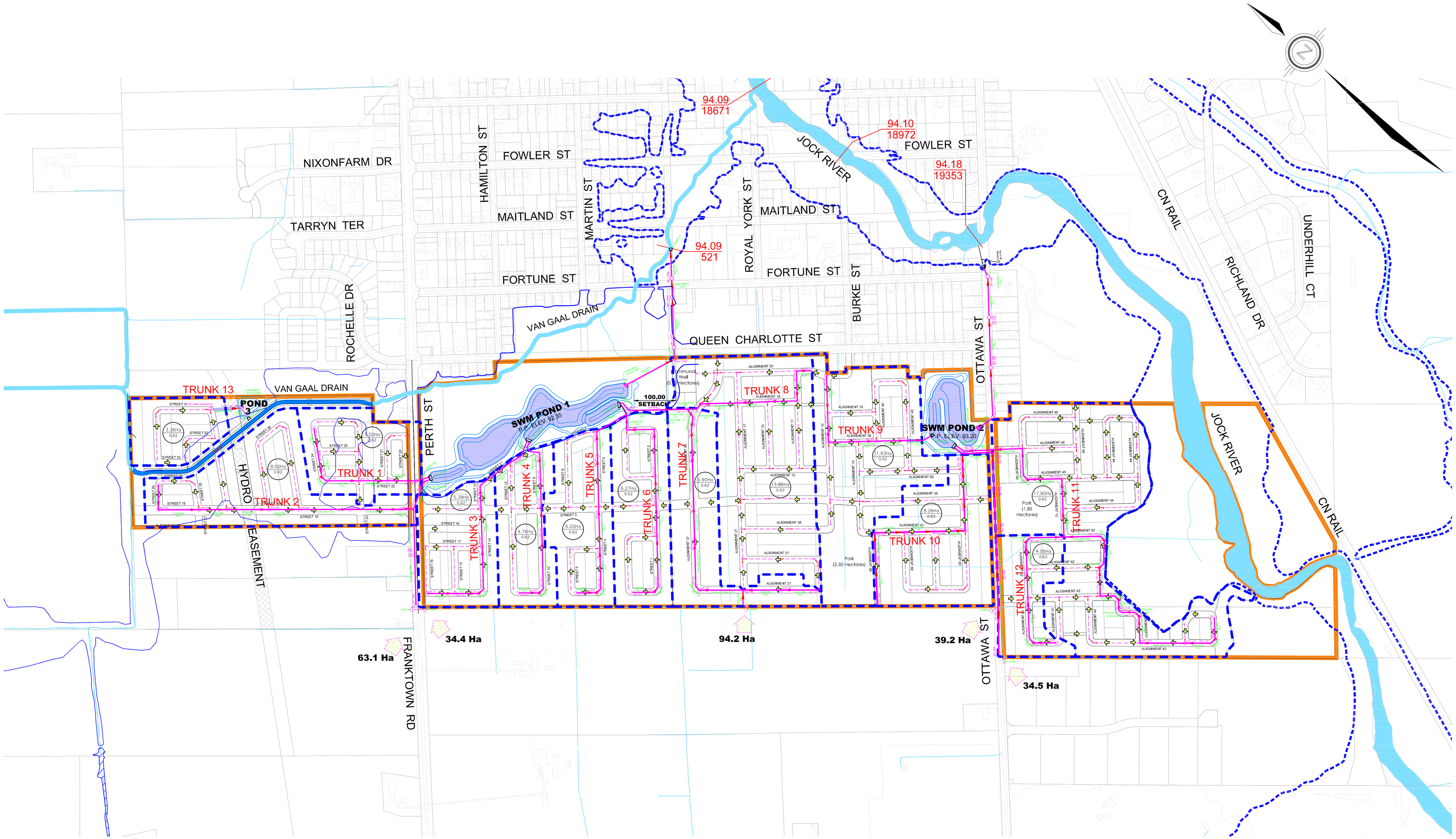
GRADING PLAN

CITY OF OTTAWA

LEGEND

- STUDY LIMIT
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR
- MAJOR OVERLAND FLOW
- EXTERNAL DRAINAGE

PROJECT No.: 11-468	
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:3500
DRAWING:	2



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VILLAGE OF RICHMOND

STORM SERVICING PLAN

CITY OF OTTAWA

LEGEND

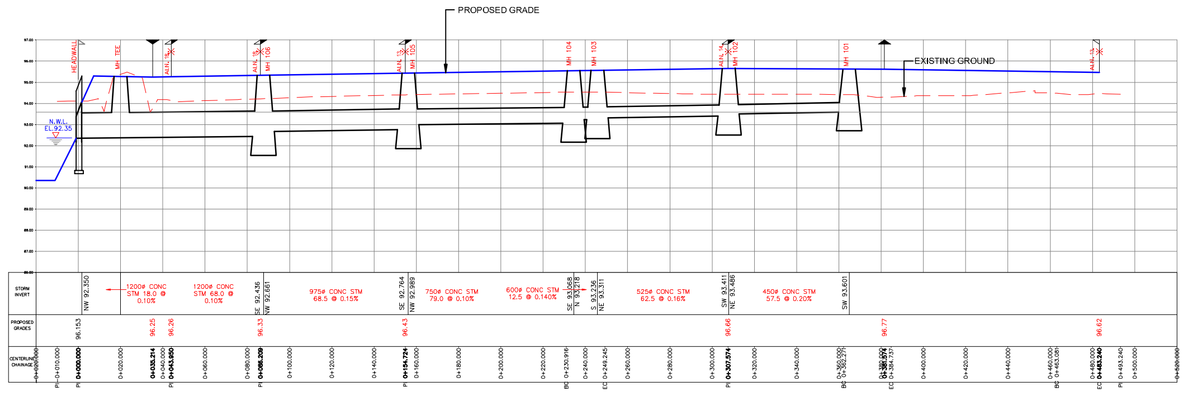
- STUDY LIMIT
- EXISTING DITCH
- STORM SEWER TRIBUTARY AREA
- STORM SEWER TRUNK
- LOCAL STORM SEWER
- 8.26Ha / 0.62 — DRAINAGE AREA / IMPERVIOUSNESS
- OVERLAND FLOW ROUTE
- EXTERNAL DRAINAGE

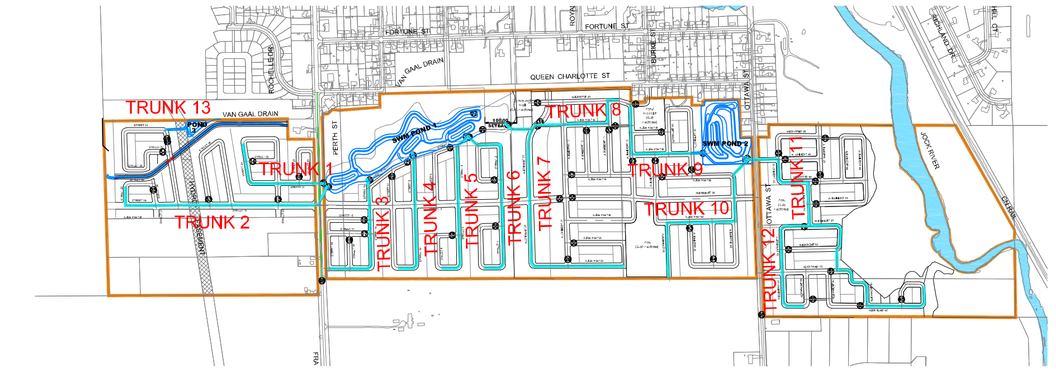
PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:4000
DRAWING:	3

STORM TRUNK 1

POND 2

1

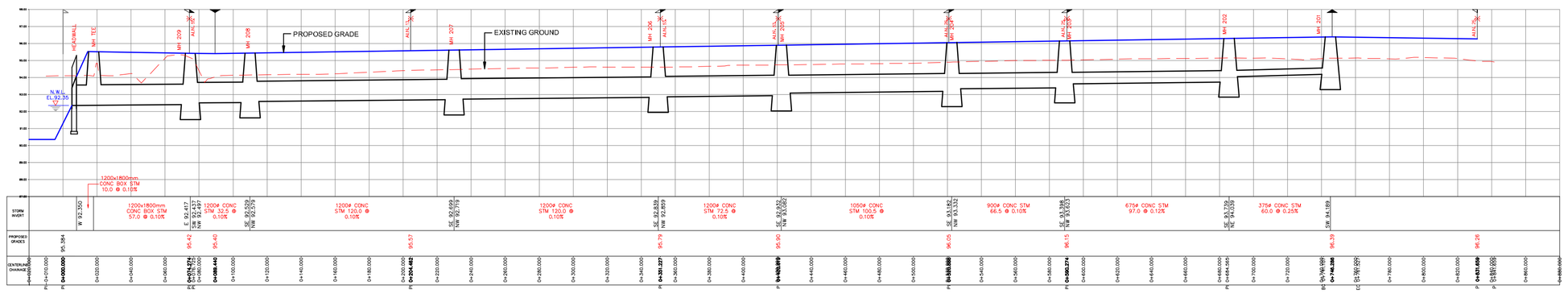




PROFILES KEYPLAN SCALE: 1:8000

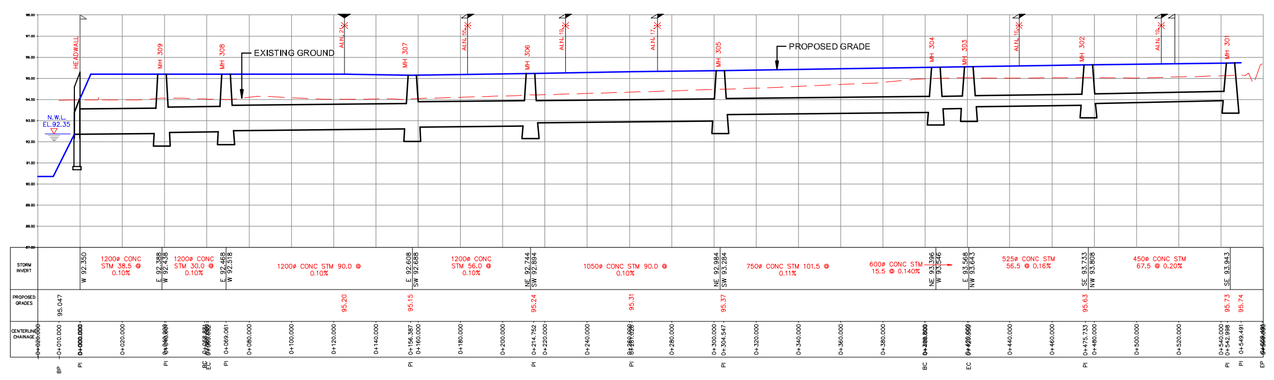
STORM TRUNK 2

2



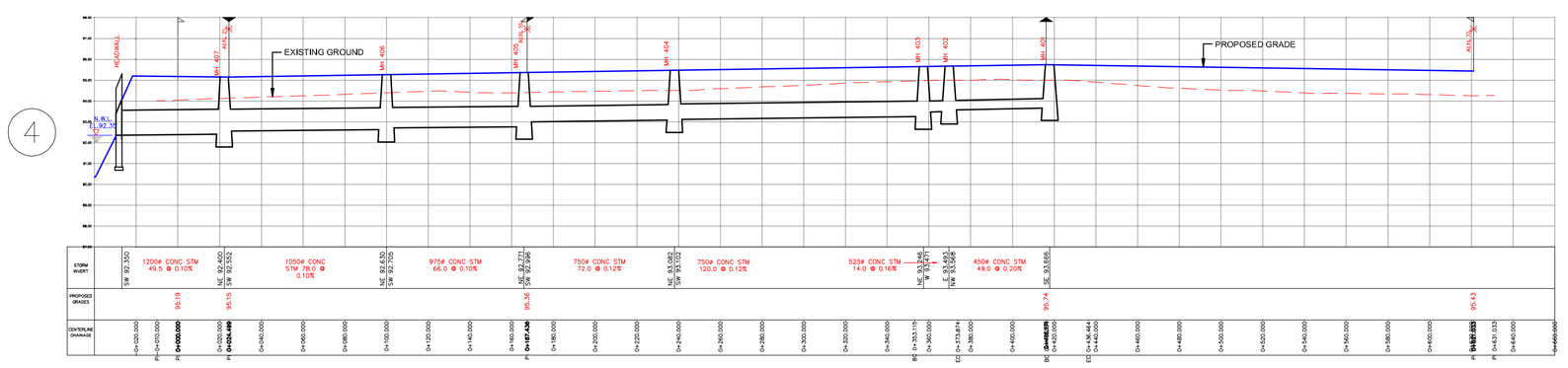
STORM TRUNK 3

3



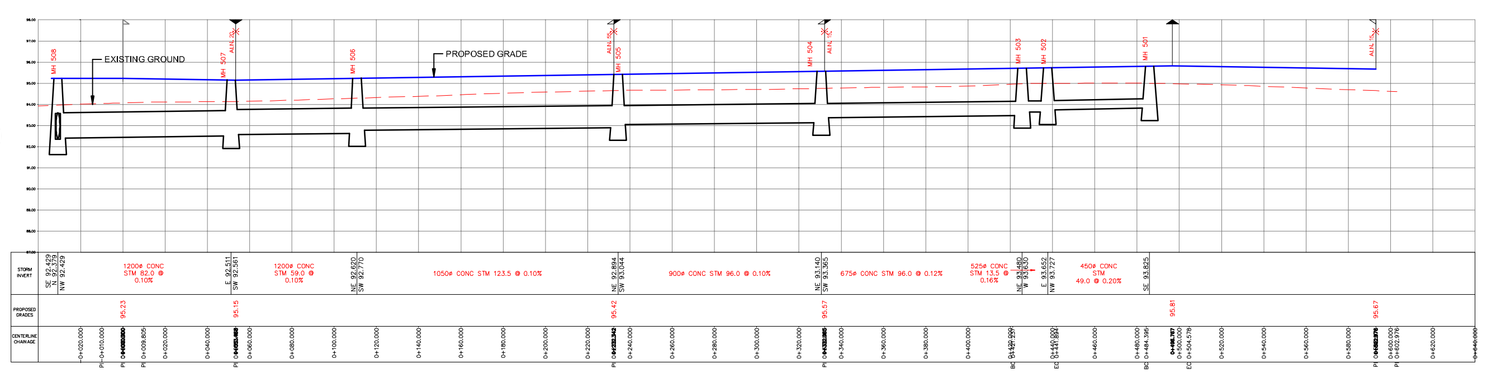
STORM TRUNK 4

4



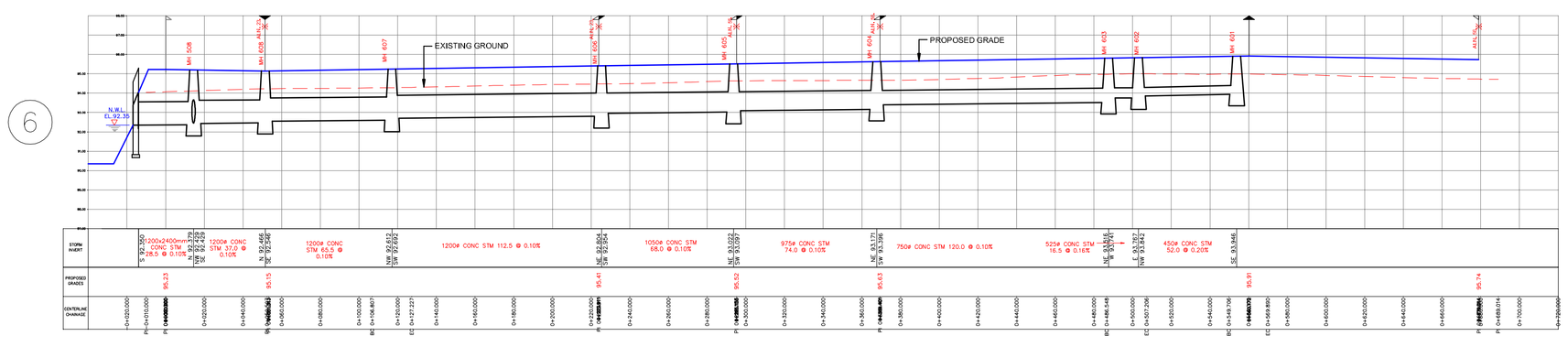
STORM TRUNK 5

5



STORM TRUNK 6

6



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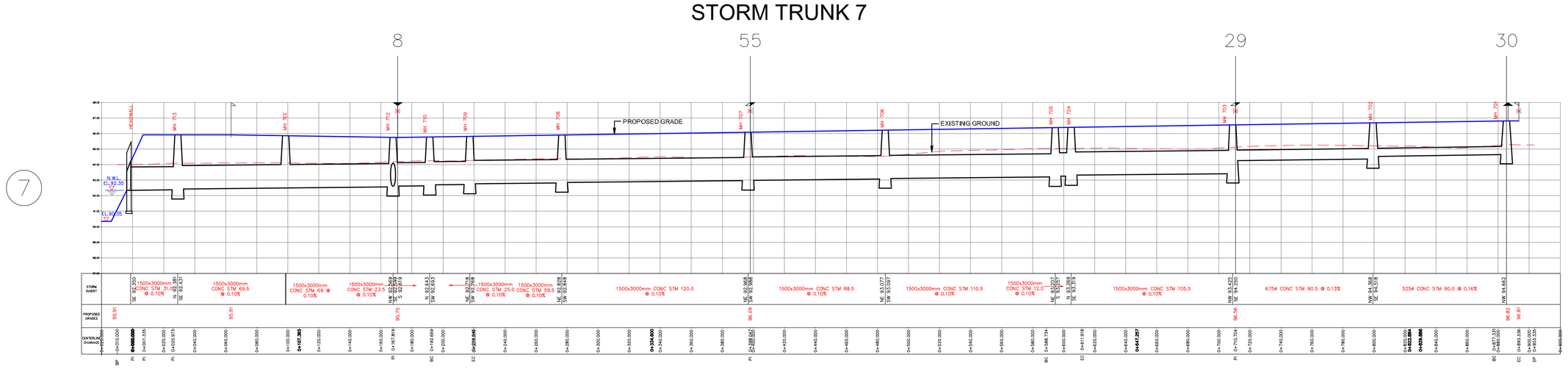
VILLAGE OF RICHMOND

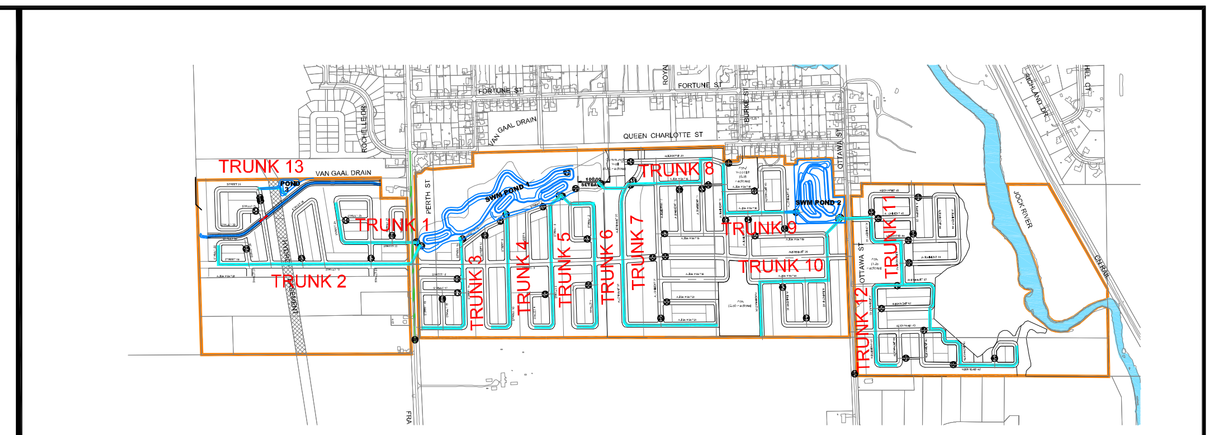
PROFILES

CITY OF OTTAWA

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:2000
DRAWING:	4

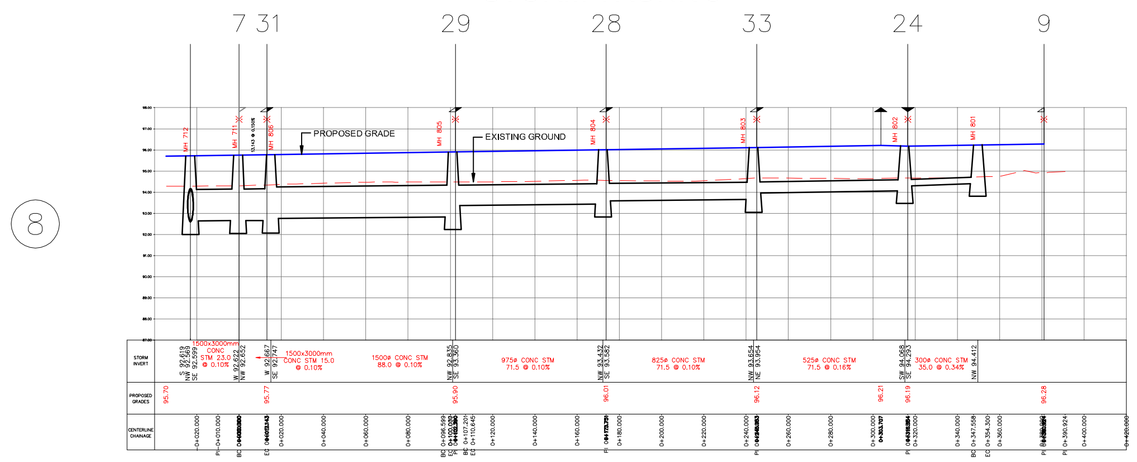
STORM TRUNK 7



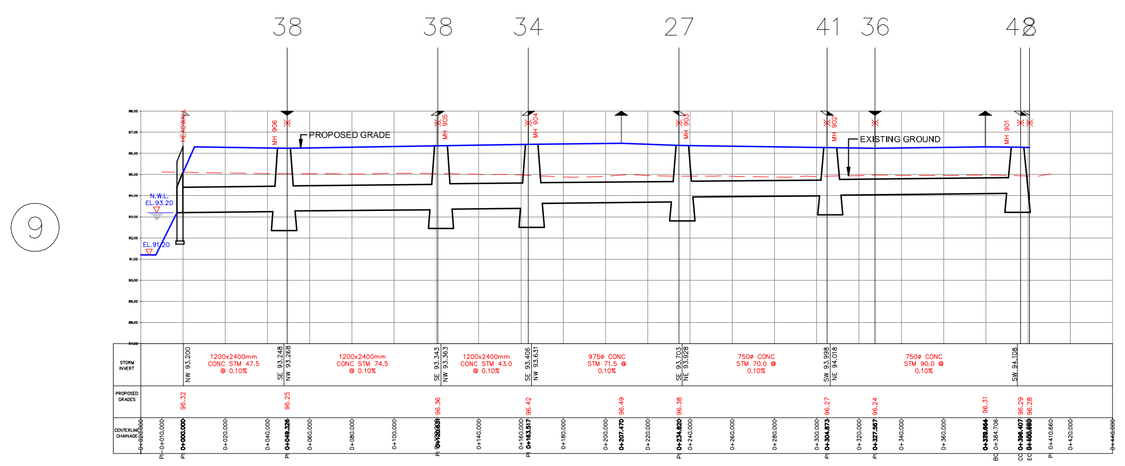


PROFILES KEYPLAN SCALE: 1:8000

STORM TRUNK 8



STORM TRUNK 9



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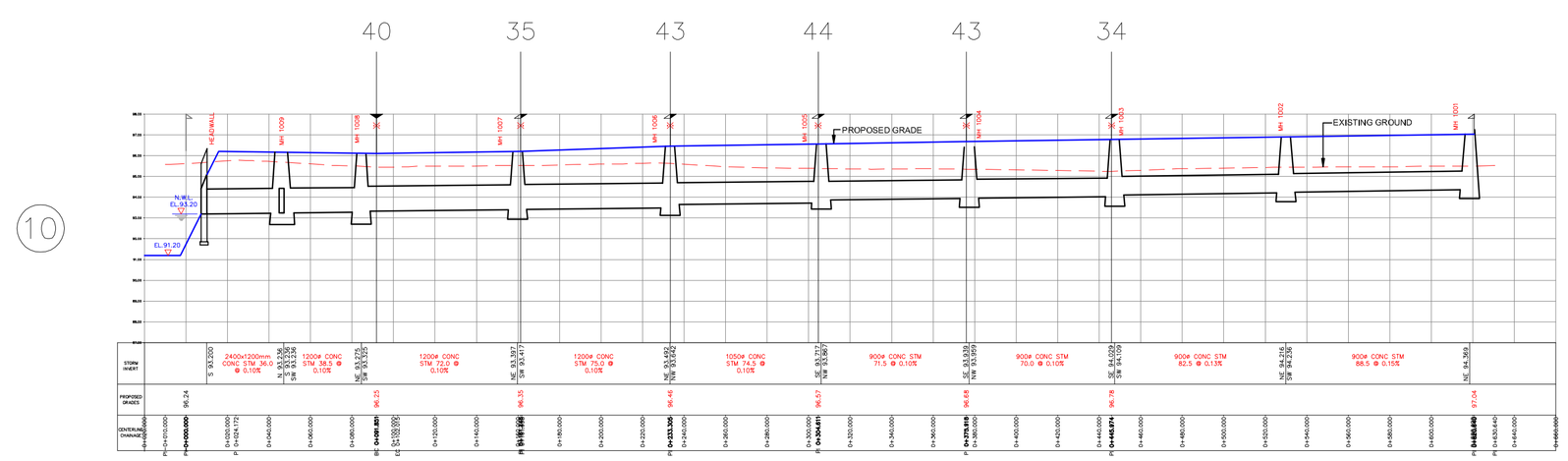
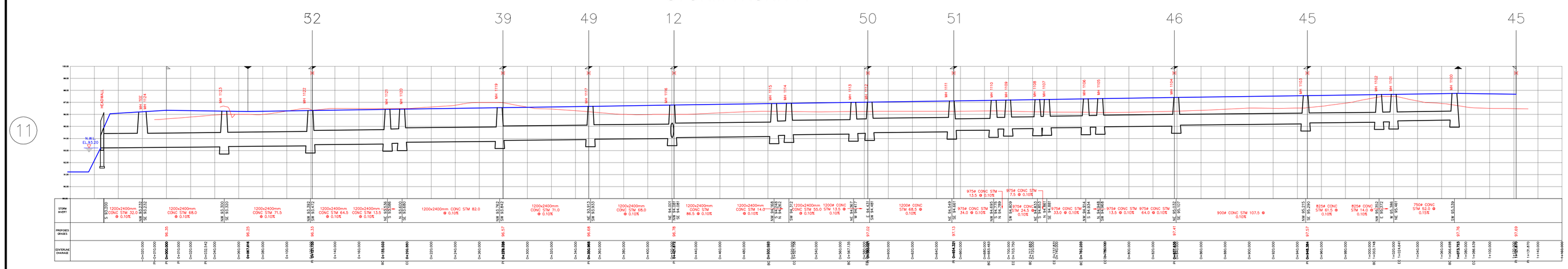


STORM TRUNK 11



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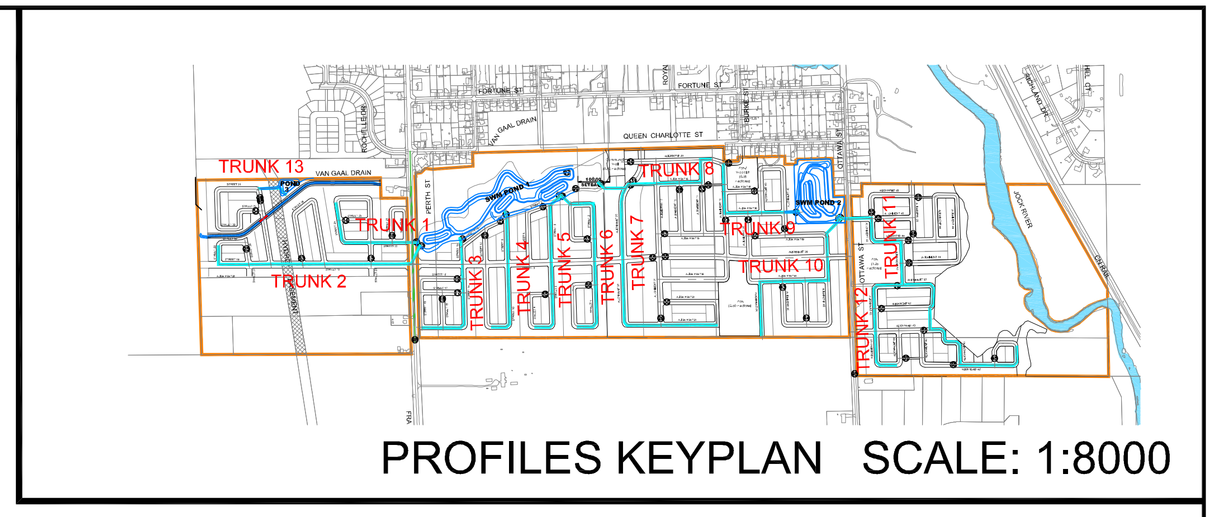
VILLAGE OF RICHMOND

PROFILES

CITY OF OTTAWA

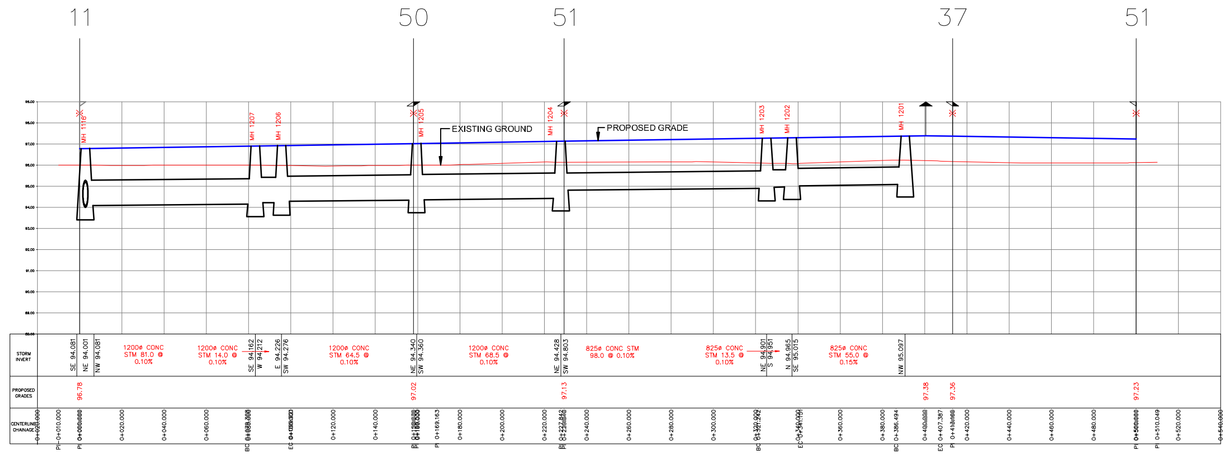
PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:2000
DRAWING:	5



PROFILES KEYPLAN SCALE: 1:8000

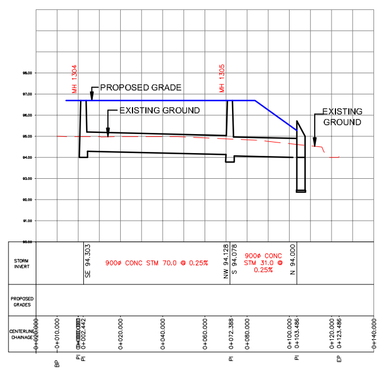
STORM TRUNK 12

12



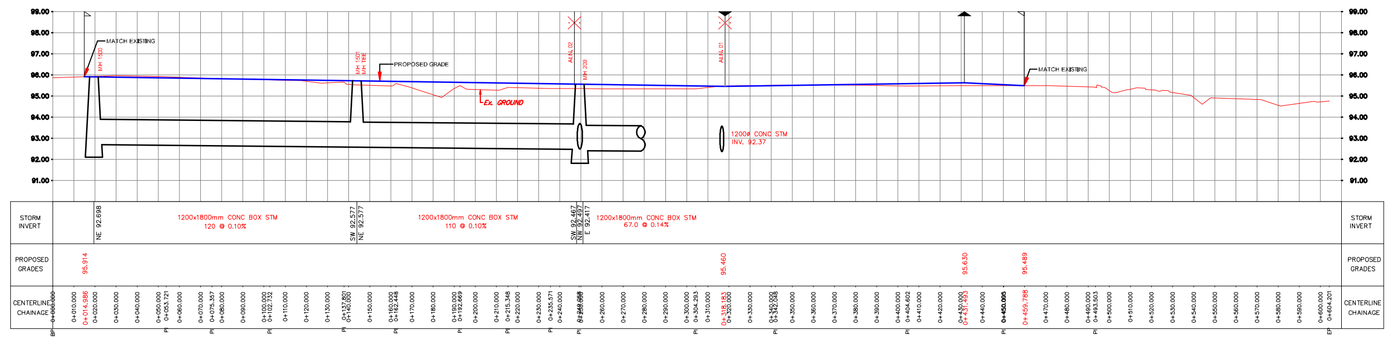
STORM TRUNK 13 OUTFALL TO POND 3

94



PERTH ST

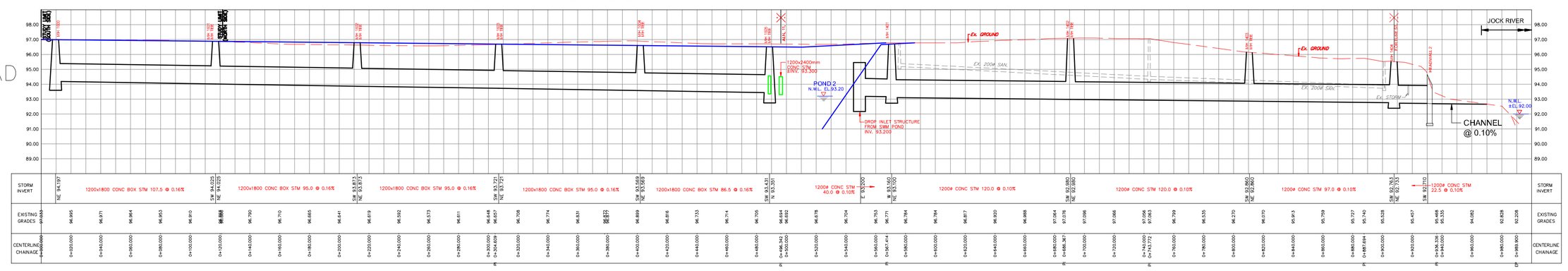
90



OTTAWA STREET

OTTAWA ROAD

95



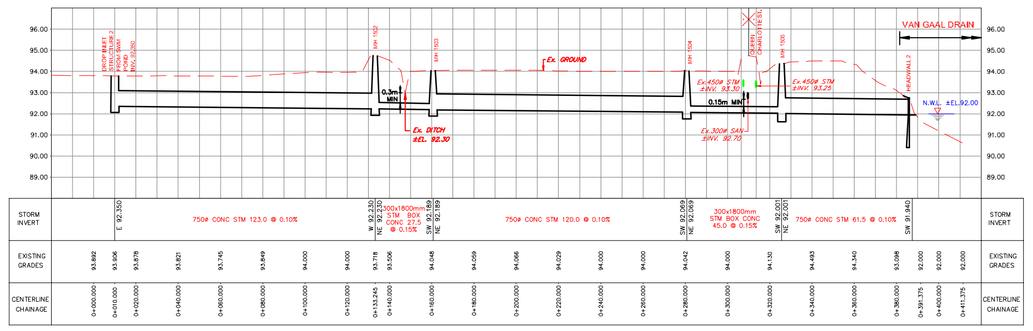
POND STORM OUTFALL 2

POND STORM OUTFALL 1

97

gis

org



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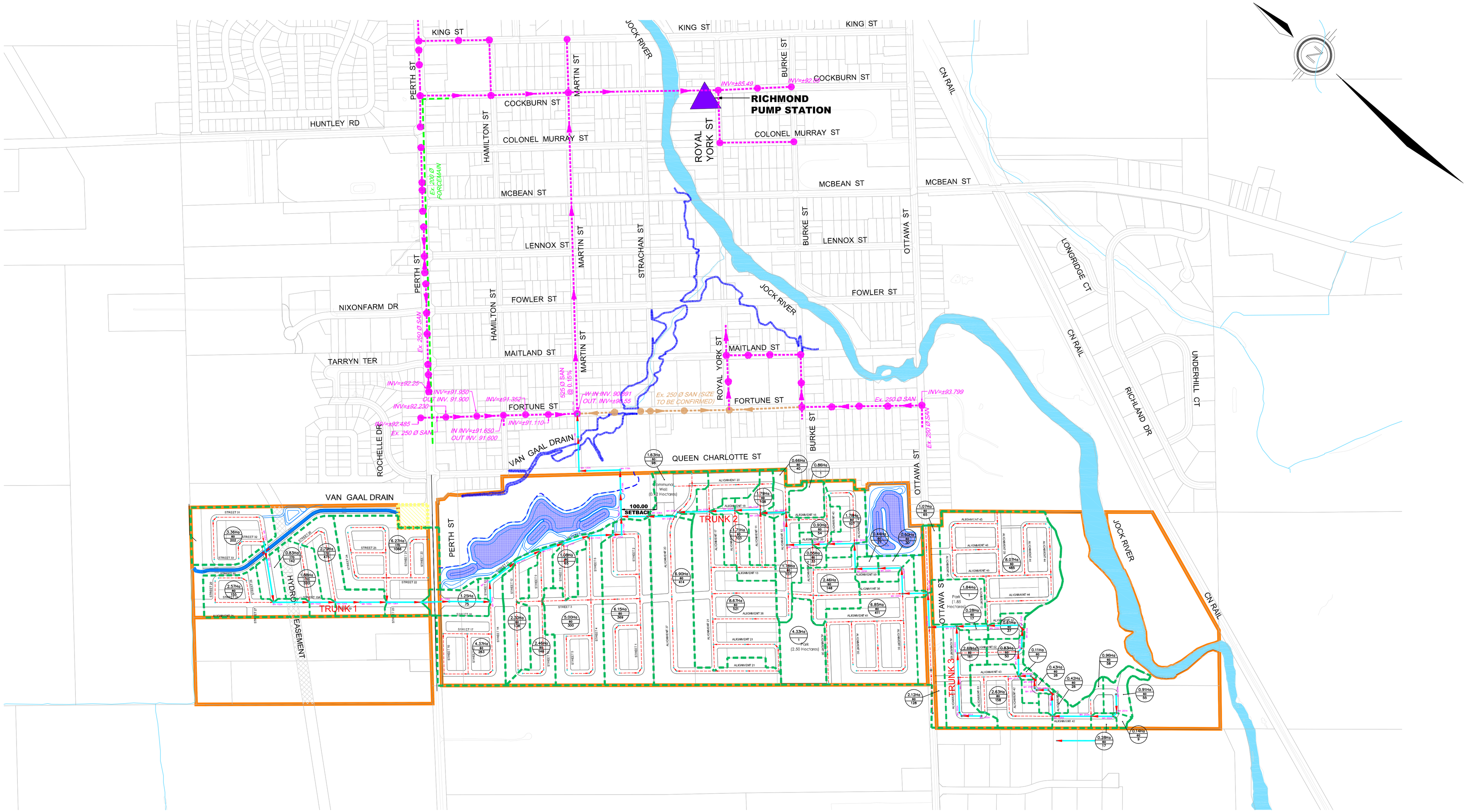
VILLAGE OF RICHMOND

PROFILES

CITY OF OTTAWA

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:2000
DRAWING:	6



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VILLAGE OF RICHMOND

SANITARY SERVICING PLAN

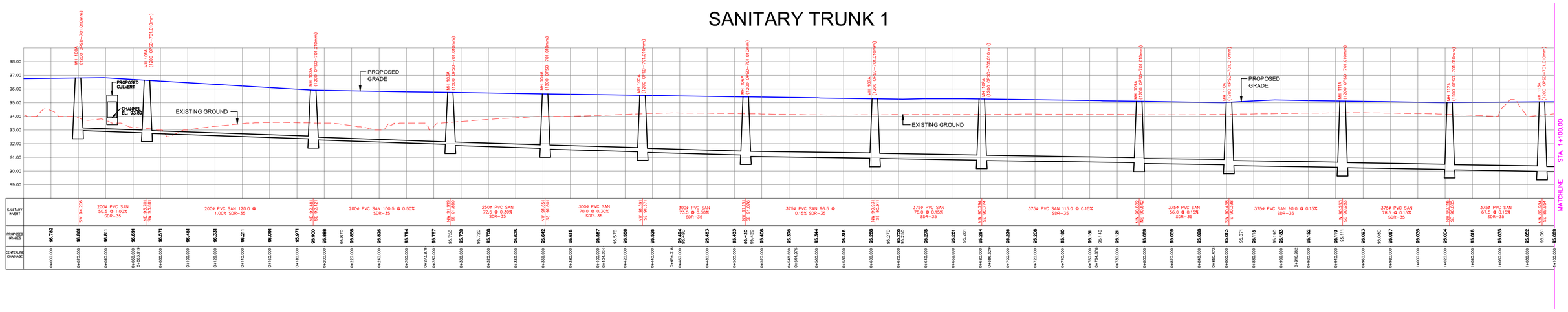
CITY OF OTTAWA

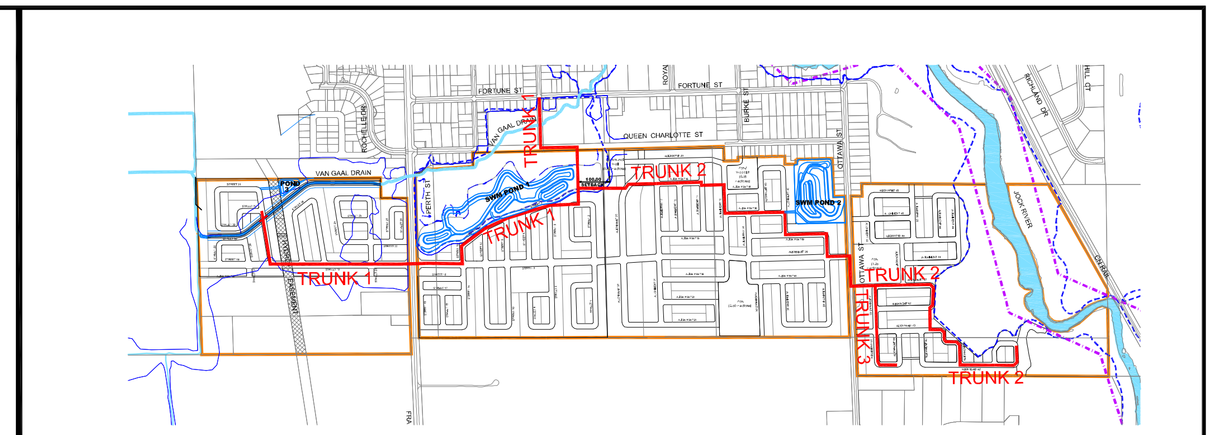
LEGEND

- STUDY LIMIT
- DRAINAGE AREA / POPULATION PER HECTARE / TOTAL POPULATION
- SANITARY DRAINAGE BOUNDARY
- PROPOSED SANITARY TRUNK
- PROPOSED SANITARY SEWER

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:5000
DRAWING:	7

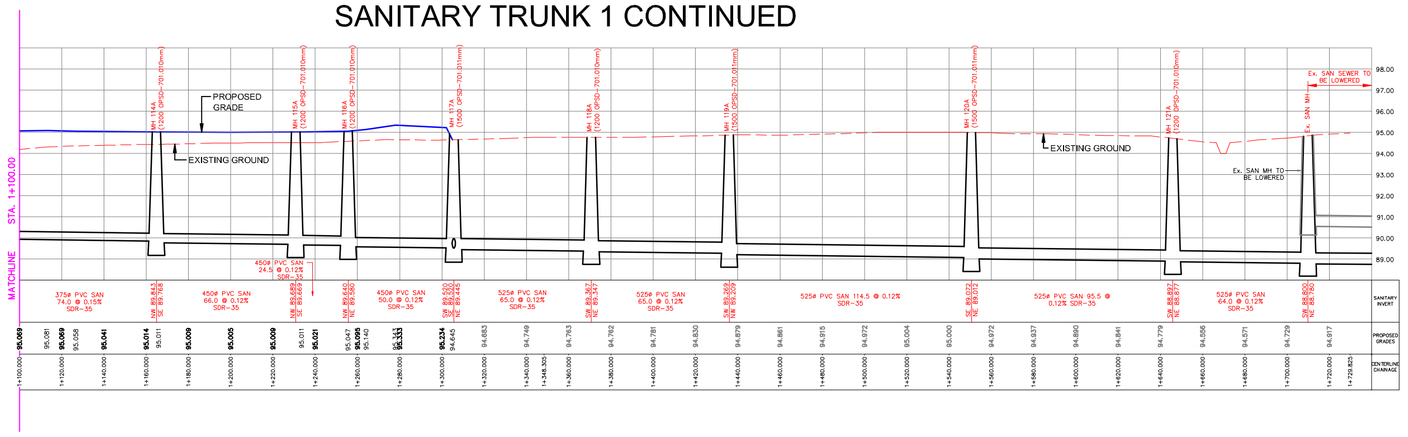
SANITARY TRUNK 1





PROFILES KEYPLAN SCALE: 1:8000

SANITARY TRUNK 1 CONTINUED



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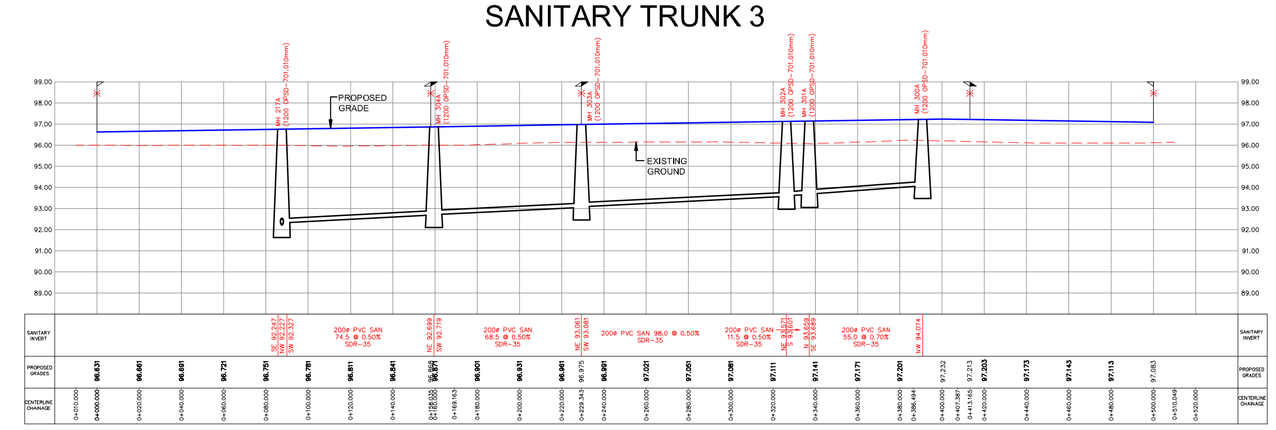

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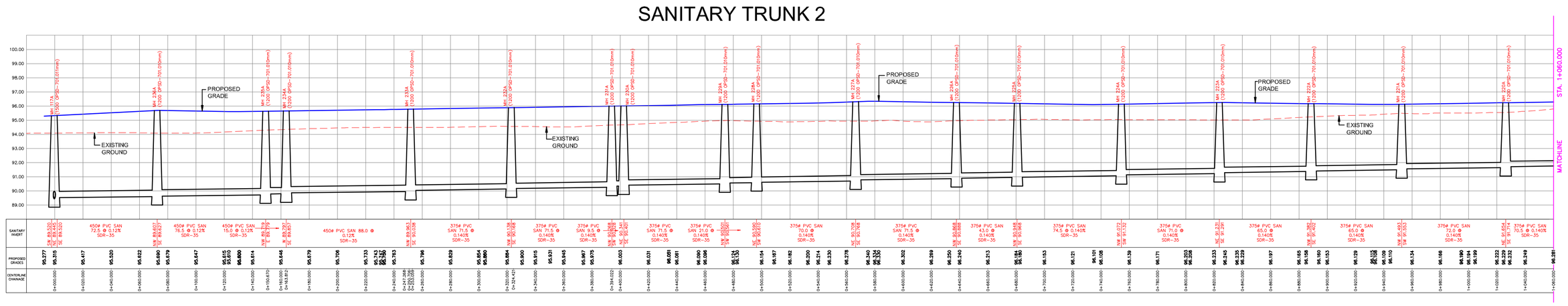
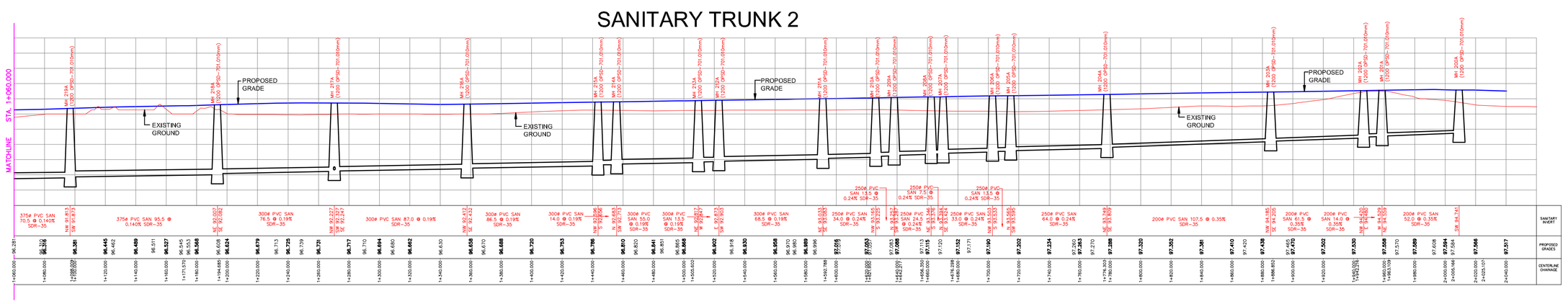


SANITARY TRUNK 2



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VILLAGE OF RICHMOND

SANIYTARY TRUNK PROFILES

CITY OF OTTAWA

PROJECT No.:	11-468
DATE:	APRIL 2012
DRAWN BY:	KM / ADF
SCALE:	1:2000
DRAWING:	8